DIVERSITY AND UNIVERSALITY IN CAUSAL COGNITION

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DIVERSITY AND UNIVERSALITY IN CAUSAL COGNITION

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Causality is one of the core concepts in any attempt to make sense of the world, and the explanations people come up with shape their judgments, emotions, intentions and actions. This renders causal cognition a core topic for the social as well as the cognitive sciences. In the past, however, research has been split into diverging paradigms, each pertaining to a distinct (sub)discipline and focusing on a specific domain, thus creating a rather fragmented picture of causal cognition. Furthermore, most of this previous research paid only incidental attention to culture as a possibly constitutive factor, leaving important questions unanswered: Is causality always perceived in the same way? Are causal explanations affected by the concepts to which people refer and/or the language they use? Is causal cognition domain-specific, and if so, how does it differ from agency construal? Is causal reasoning always based on the same cognitive mechanisms, or does the cultural background of people shape how they process respective information - and perhaps even their willingness to search for causal explanations in the first place?

By soliciting contributions that address questions like these, this research topic aimed at assessing the extent to which causal cognition may vary across species, cultures, or individuals at various stages of their development, and at integrating different perspectives across a broad range of disciplines. Originating from the work of a research group funded by the Center for Interdisciplinary Research (ZiF) at Bielefeld University, Germany, the scope of this research topic was broadened by inviting additional contributions from researchers with expertise in different fields of causal cognition, agency construal, and/or cultural impacts on cognition. In order to fully exploit the potential of cognitive science, we explicitly encouraged submissions from scholars from all its classic sub-disciplines (i.e., anthropology, artificial intelligence, linguistics, neuroscience, philosophy, psychology) as well as scholars from comparative psychology, cognitive archeology,

economics, and any other discipline interested in causal cognition. We welcomed empirical findings as well as theoretical contributions, with an emphasis on those factors that do – or may – constrain, trigger, or shape the way in which humans and other primates think about causal relationships and inform us about both the diversity and the universality of causal cognition.

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Editorial on the Research Topic

Diversity and Universality in Causal Cognition

The capacity to acquire and use causal knowledge belongs to the central cognitive competencies that allow us to orient in the world, and this knowledge shapes our cognitive, affective, and behavioral responses. Its central role renders causal cognition a core topic for the social and cognitive sciences. But is causal cognition a universal and uniform phenomenon, or are there cultural differences in the way people represent the causal texture of the world? In spite of extensive research on causal cognition in the past decades (Waldmann, 2017), little is known about cultural diversity in how people perceive, represent, and reason about causal relationships (Bender et al., 2017). The main goal of this research topic is therefore to compile evidence for both diversity and universality in causal cognition, with the aim of pushing the field forward.

One set of the contributions to this topic addresses questions revolving around *people's conceptualization of causality and agency*, with a focus on situations that involve a human agent. To this end, Le Guen et al. investigate how rural Mayan Yucatec and Tseltal speakers from Mexico and urban students from Mexico and Germany account for events for which the relations between intention, action, and outcome are varied. The groups converge in recognizing explicit links between actions and outcomes as causal, but differ in how they interpret non-law-like relations. Specifically, the notion of "chance" proved sensitive to task characteristics, cultural background, and language used.

Another topic that has attracted interest is the phenomenon of "causal deviance," which refers to situations in which an outcome satisfies an agent's intention, but is not brought about by this agent's action. For such cases, studies with US American participants have repeatedly reported a higher readiness to attribute intentionality to *immoral* than to *amoral* actions. For example, in a causally deviant situation the amoral action of "hitting a bull's eye" is not considered intentional in contrast to the immoral action of "hitting the aunt's heart." Seeking a more fine-grained understanding of this phenomenon, Sousa et al. find the asymmetry to be fairly robust across varying degrees of causal deviance, even if mediated by judgments of action and blame, which they interpret as evidence for the existence of multiple concepts linked to intentional action.

While these authors consider intentionality to be a basic and universal concept, Astuti and Bloch explore the possibility of cross-cultural variation by investigating the extent to which Malagasy people take intentionality into account when assessing acts of wrongdoing. They conclude that, while intentionality is indeed considered important in mundane cases of wrongdoing, its relevance decreases for events with more severe consequences for society, thereby pointing at both cross-cultural commonalities and differences (for a continuation of the debate, see also Sousa and Swiney, 2016).

A further factor that may tune people's attention to agency and intentionality is *language*. Agency information can be encoded in different ways, for instance through word order, case marking, or verb type. That these linguistic cues affect the assignment of causal roles has been demonstrated by Bender and Beller with speakers of German and Tongan.

An important area of causal cognition is *reasoning about complex systems*. Research reviewed here focuses on cases of economic decision-making, complex problem solving, and ethnomedical beliefs. In the first of these studies, Tucker et al. investigate the causal models Malagasy farmers, foragers, and fishermen use when explaining success and failure. Tucker and colleagues find that biological and economic events are attributed primarily to natural causes, whereas individuals' success and failure tend to be attributed to "supernatural" factors. As natural and supernatural factors represent distinct sets within a single explanatory framework—with the supernatural forces driving the natural ones—the Malagasy data suggest a type of "integrative thinking" that the authors consider to be common in unpredictable environments. A suitable context for testing this hypothesis is the large-scale project described in Bennardo's contribution, which seeks to identify the main causal forces in cultural models of nature across a broad range of populations.

Both economic decisions under uncertainty and cognitive models of nature are paradigmatic test cases for investigating causal reasoning about *complex systems*. Simulations of systems (*microworlds*) are used to study complex problem solving, with participants being responsible for retaining a balance between several interconnected factors. Complex systems are characterized by non-transparent relations and non-linear processes, which pose substantial challenges for problem-solving and management (Funke). Because successful problem-solving typically involves updating a cognitive model of the interactions, microworlds can be used to diagnose causal perception, reasoning, understanding, and intervention. As argued by Güss and Robinson, participants' models and strategies may be affected by cultural background on several levels: knowledge, problem-solving heuristics, and perceptions of control by culturally mediated experiences; priorities in problem-solving by culture-specific values; and the temporal horizon for planning and decision-making by the cultural learning environment. To what extent microworlds are useful for cross-cultural research, whether problems of different complexity require different types of causal cognition, or whether they constitute qualitatively different phenomena is discussed both within the research topic (Funke; Greiff and Martin) and beyond (Dörner and Funke, 2017).

A particularly relevant example of reasoning about complex causal relations is the diagnosis of mental disorders. Taking causal model theory as the starting point, Hagmayer and Engelmann derive predictions for systems of causal beliefs, applied here to lay theories of depression. Their analysis of data from a systematic literature review reveals cross-cultural convergence about relevant observable causes (e.g., stress), but

substantially less cross-cultural agreement for hidden, especially supernatural causes.

The third set of contributions to the present research topic addresses *methodological problems* typically encountered in cross-cultural research, and discusses possible solutions and their relevance for theoretical advances in the field. Beer and Bender investigate how people in an unfamiliar socio-cultural setting account for the behavior of others conditional upon their category membership. Setting off as an attempt to explore information search strategies among the Wampar in Papua New Guinea, the contribution turns into a discussion of the difficulties with parallelizing cognitive tasks across cultures.

Not only designing new tasks for cross-cultural investigations of causal cognition is challenging—even the attempt to interpret available evidence is tricky. Ethnographic fieldwork has gathered a plethora of potentially relevant data that can be reconstructed as examples of causal reasoning (e.g., reasoning about witchcraft). However, in these studies the data are often not described in terms of abstract causal theories. Thus, relevant information is hard to localize and difficult to identify as relevant. How ethnographic descriptions can still be used to investigate causal reasoning is laid out by Widlok, pointing to culture-specific notions of time and extensions of personhood and agency as essential components of causal understanding (see also Peeters, 2015).

The malleability of cultural perspectives over time and the inalienability of contextual information, a critical point raised by Widlok, is emphasized further by Iliev and ojalehto who call for diachronic analyses within single cultures as an essential complement to synchronic investigations across cultures. They introduce automated text analyses as a valuable tool for tracking how the concern with causality, the usage of causal vocabulary, and causal concepts themselves have changed over time.

Extending this historic perspective to the evolutionary roots of causal cognition, Haidle scrutinizes archaeological findings as evidence of causal cognition in our ancestors. Based on the idea that tool construction presupposes considerations of cause-effect relations, she uses data on the composition of tool remains to infer, by way of reverse-engineering, which components of causal cognition allowed our ancestors to invent these tools.

Finally, Kronenfeld in his theoretical piece reverts the usual reading of *causal cognition* to explore possible ways in which cognition may be considered causal, focusing in particular on collective practices.

In summary, the 15 contributions to this research topic address a broad range of aspects of causal cognition: from perceptions and representations of causal relations through judgments of blameworthiness and punishment to ways in which illnesses are explained and treated. The articles describe approaches from a broad range of disciplines—including anthropology, archaeology, linguistics, philosophy, and psychology—and provide evidence for both the universality and diversity of causal cognition. Jointly, they support the assumption that core components of causal cognition are widely shared across historic and cultural contexts, but are also refined, shaped, and occasionally altered through processes of

cultural elaboration and transmission that are characteristic for our species. Thus, these contributions highlight the need for more in-depth investigations of the cultural impacts in this domain, preferably through concerted efforts across disciplines, timescales, and levels of analyses (Bender and Beller, 2016).

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial and direct intellectual contribution to the work and approved it for publication.

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Making sense of (exceptional) causal relations. A cross-cultural and cross-linguistic study

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In order to make sense of the world, humans tend to see causation almost everywhere. Although most causal relations may seem straightforward, they are not always construed in the same way cross-culturally. In this study, we investigate concepts of "chance," "coincidence," or "randomness" that refer to assumed relations between intention, action, and outcome in situations, and we ask how people from different cultures make sense of such non-law-like connections. Based on a framework proposed by Alicke (2000), we administered a task that aims to be a neutral tool for investigating causal construals cross-culturally and cross-linguistically. Members of four different cultural groups, rural Mayan Yucatec and Tseltal speakers from Mexico and urban students from Mexico and Germany, were presented with a set of scenarios involving various types of causal and non-causal relations and were asked to explain the described events. Three links varied as to whether they were present or not in the scenarios: Intention-to-Action, Action-to-Outcome, and Intention-to-Outcome. Our results show that causality is recognized in all four cultural groups. However, how causality and especially non-law-like relations are interpreted depends on the type of links, the cultural background and the language used. In all three groups, Action-to-Outcome is the decisive link for recognizing causality. Despite the fact that the two Mayan groups share similar cultural backgrounds, they display different ideologies regarding concepts of non-law-like relations. The data suggests that the concept of "chance" is not universal, but seems to be an explanation that only some cultural groups draw on to make sense of specific situations. Of particular importance is the existence of linguistic concepts in each language that trigger ideas of causality in the responses from each cultural group.

Keywords: causality, chance, cross-cultural cognition, coincidence, intentionality

INTRODUCTION[1]

Humans see causality everywhere and in everything. Because the interpretation of causality is so omnipresent in everyday life, it is no surprise that it has been the subject of many studies (Shaver, 1895; Sperber et al., 1996, inter alia; Bender and Beller, 2011b; Bender et al., 2012). Interdisciplinary studies of causal thinking remain, however, rare in the social sciences[2]. Psychologists typically study physical and social causality in controlled laboratory settings, but seldom consider cross-cultural comparisons. Anthropologists, in contrast, are primarily interested in the cultural and cross-cultural study of concepts like "chance," "witchcraft," and "fate," but seldom investigate these questions in a rigorously controlled manner, for example by using experimental tasks (for exceptions see Bloch, 1998; Tomasello et al., 2005; Astuti and Bloch, 2015). Linguists have looked systematically at how causality is encoded in the grammar of various languages (e.g., Wolff, 2003; Sanders and Sweetser, 2009; Sanders et al., 2009; Kwon, 2012), yet the cultural consequences of such variation are rarely discussed (exceptions include Evans, 2009; Bohnemeyer and Pederson, 2011; San Roque et al., 2012). It should be noted, however, that an interdisciplinary approach is increasingly common and has been shown to provide more comprehensive results in various domains, especially in cross-cultural studies (see for instance, Atran et al., 2002; Bang et al., 2007; Bender and Beller, 2011b). This paper is an outcome of an interdisciplinary research group that united, among others, psychologists, anthropologists and linguists to address the issue of causality from a cross-cultural perspective. Although our study is mainly exploratory, we believe it shows promising results for future cross-cultural comparisons of causal cognition.

In this paper, we explore how people in different cultural settings explain typical causation but also exceptional relations between events, such as non-law-like relations between cause and effect—what in English is referred to under labels such as "chance," "coincidence," or "luck." One motivation for this study and for the chosen cultural groups lies in the fact that some languages seem to lack words for such expressions, as is the case in the Mayan languages in contrast with most Indo-European languages (like German or Spanish). The main questions behind this study are these: Do humans from different cultural groups have a similar understanding of causality? To what extent is causation or the absence of clear causal links interpreted in culturally specific ways? Do people in all cultures have a concept of "chance" or "coincidence" despite the fact that some might lack linguistic labels for such concepts? In order to try to answer these questions, we designed a verbal task that consists of various systematically varied scenarios which participants are asked to interpret. Although causal reasoning can be considered a basic cognitive process, language is crucial not merely to express causal relations but also, we argue, to codify them (hence to interpret causality in terms of categories of events).

In order to explore causation across cultures and avoid ethnocentricity, we chose not to start with a priori concepts like "chance" or "bad luck" for instance, but instead to use a logical combination of causal links so that our scenarios were structurally identical across cultures. We used the framework proposed by Alicke (2000) that was originally developed to examine aspects of blame attribution. The central idea is that causal relations are divided into separate links between intention, action, and outcome. As this segmentation allows for a more detailed analysis of the single causal components involved, it provided a good basis for designing a "neutral" tool to investigate causal cognition cross-culturally and cross-linguistically. Such a tool, which we present in more detail below, allows us to examine cultural patterns of the inferences people draw related to causality and how these are linguistically codified.

This tool was tested within four groups of different cultural backgrounds and languages. The four groups consist of German students from the university of Göttingen, Mexican Spanish-speaking students from the UNACH University (Chiapas, Mexico), and people from two indigenous Mexican groups: Yucatec Mayans from the Yucatec Peninsula and Tseltal Mayans from the highlands of Chiapas. Both groups of students (German and non-indigenous Mexican) have a high level of literacy and live in an urban environment, while members of both Mayan groups are in their great majority non-literate and live mainly a peasant lifestyle based on slash and burn agriculture.

The choice of these four groups was primarily motivated by the decision to compare groups from "western"[3] cultures (i.e., WEIRD, western, educated, post-industrial, rich, developed, etc., see Henrich et al., 2010), the Germans and the Mexicans, with "non-western" (subsistence, rural, traditional) groups, the Mayans. In addition to their lifestyle, the groups differ linguistically: German and Spanish are Indo-European languages; Tseltal and Yucatec are Mayan languages. We also

[2]We can cite studies like Choi et al. (1999), Morris and Peng (1994), or Morris et al. (1995), but these mainly focus on the eastern-western, individualism-collectivism distinction, which we will not address in this paper since we consider that these are quite arbitrary and would not apply in our study. We thank one of the reviewers for pointing out these lines of research to us.

[3]Throughout we use the terms "western" and "non-western" in quotation marks as shorthand for the more accurate WIERD term advocated by Henrich et al. (2010), to avoid its evaluative implications, although clearly some far-eastern and far southern cultural groups (e.g., Japanese, Australian, respectively) belong to the "western" category and many cultural groups—including our Mayan samples—situated in the western hemisphere belong to our "non-western" category.

wanted to control for effects within the two language families, i.e., the German vs. the Mexican Spanish and the Tseltal Maya vs. the Yucatec Maya. Furthermore, the comparison between the Mexican Spanish group and the Mayans is interesting, since all three groups live in the same region but have quite different ways of life.

The two Mayan groups were chosen because they lack explicit words for "coincidence" or "chance" and, despite both groups having related cultural and linguistic backgrounds, they seem to have different ideas about non-law-like relations between events (as shown below). The German student group was chosen as a typical student sample from a western university. The Mexican Spanish student group was included to contrast with both, the German students and the Mayans. Mexican Spanish belongs to the Romance family and non-indigenous Mexicans do not share many of the Mayan cultural traits. However, Mayans and Mexicans live in the same country and have a different way of life from that of most European groups (like German or Iberian Spanish people).

Causality and Non-law-like Relations between Events

The notion of causality is omnipresent in science and in daily life and applies to physical events as well as to human (inter)actions. In the social domain with which we are concerned, judgments of causality are often related to judgments about responsibility (Sousa, 2009), blame (Shaver, 1895; Alicke, 2000), or intentionality (Searle, 1983). In this section, we propose some basic working definitions of what we will consider "causality" or "causation" and what we consider to be "(non-)law-like relations between events." We consider causality to be the relationship between an event 1 (the *cause*) and an event 2 (the *effect*), where the second event is understood as a consequence or the outcome of the first. The issue of causality is far from unproblematic since causal reasoning is, for humans, generally based not so much on observable processes but on assumptions that arise by reason of observations between events or prior knowledge (see Lagnado et al., 2007). Sometimes the relation between two events is considered to be a causal one even without any known causal (physical) mechanism that links the one to the other; for example, in the social domain, where a person's frowning can cause another person to react. As Waldmann and Hagmayer point out, "the main question of how we distinguish causal relations from accidental sequences of events remains highly debated" (Waldmann and Hagmayer, 2001, p. 28), and this is the very reason for exploring how people from different cultural backgrounds do or do not make this distinction and how they differ in judging such sequences of events.

In the psychological literature about causal judgments (based on empirical studies that are typically conducted with undergraduates of "western" universities), statistical relations, temporal order, intervention and prior knowledge are known cues for causal structure, i.e., for the question whether a relation between two events is considered to be a causal one (Lagnado et al., 2007). However, it is known that there sometimes are cultural differences in causal attribution (Bender and Beller, 2011a, 2013) and it is thus possible that other factors influence

the causal judgments that people who are from other cultural backgrounds than the "western" population make.

One interesting idea in this regard is that an agent's intentions or desires can cause things to happen—even without any physical connection (e.g., without being mediated by the agent's action). The influence of mental states like intentions on the occurrence of events is sometimes called "magical thinking" or "mental causation" and it has been claimed that it is more prevalent in some cultural groups than in others. In some cultures it is, for example, not uncommon to infer a causal relationship between somebody's thoughts about a snake and its appearance a few seconds later (see Ojalehto et al., 2013). Although there may be superstitious beliefs and magical thinking among the "western" population too (for instance if a soccer fan believes that his wearing a fan scarf will contribute to the chance of his team's win), psychological studies about causal judgments of "western" undergraduates consistently deal with *events*, such as actions or physical processes, negating the possibility that mental states can be considered as causes for events that become manifest in the physical world.

What is important to note, though, is that only a very low percentage of events that are contiguous in space and time are causally related to each other. For example, the pressing of the doorbell button might be causally related to the doorbell ringing, whereas the simultaneous scratching of one's nose probably is not. There are millions of events that happen more or less at the same time, but most of them are not recognized as being even possibly related to each other. When attention is driven toward two (or more) events that happen in direct sequence but are not known to be directly causally related, English speakers would use words such as "chance," "coincidence," or "(bad) luck," in order to make sense of the temporal correspondence of these events. These words refer to events that are somehow related but leave some margin of interpretation, in contrast, for instance, with a direct causal formulation such as "I rang the doorbell" (which also is, in reality, an interpretation since the speaker might not know if there is indeed a causal relation between the pressing of the button and the bell ringing). We will refer to concepts like "chance," "coincidence," or "(bad) luck" as "non-law-like relationship explanations," in contrast to direct causal explanations for events.

An interesting framework to account for the influence of "mechanical" connections between an action and an outcome, the use of non-law-like-relationship explanations and the influence of mental states on the attribution of causal relationships is provided by Alicke's *Culpable Control Model* (Alicke, 2000), which was developed to capture lay people's blame judgments. In this model, the causal impact of an agent's action on an outcome (i.e., Causal Control) is only one of three components of *personal control* which is crucial to blame and responsibility judgments. Next to this causal control link between action and outcome (A→O; also considered *behavior to consequence* by Alicke), blame evaluations are also based on volitional behavior control that is represented by the link from intention to action (I→A; or *mind to behavior*) and on volitional outcome control represented by the link from intention to outcome (I→O; or *mind to consequence*). Whereas

the Intention-to-Action link determines whether an action was intended or not, the Intention-to-Outcome link defines the desire of the agent, i.e., whether (s)he foresaw and wanted the outcome event to happen. Personal control, which is crucial to blame judgments, is maximized if all three links are present: an agent who wanted the outcome to happen and who intentionally performed a certain action that caused the outcome is more blameworthy than an agent whose accidental action caused an outcome (s)he did not want (Alicke, 2000; Cushman, 2008). If a boy breaks his neighbor's window, for example, his action is usually considered to be more blameworthy when he wanted to destroy the window and intentionally kicked a ball in the direction of his neighbor's house compared to a situation in which he accidentally broke it, without wanting it or being able to foresee that his shot could lead to this damage.

Although evaluations of blame and responsibility will not be directly addressed in this study, we consider Alicke's structural linkages to serve as a neutral framework for our aim of investigating causal attribution and non-law-like relationship attributions in social contexts among people from different cultures. As mentioned earlier, we are especially interested in evaluating the extent to which participants consider intentionality to be relevant with regard to the realization of the outcome. One hypothesis is that, in some cultural contexts, intentionality is not considered to be a relevant element for the attribution of causality. According to this hypothesis, A→O is the most relevant link, with or without the I→O or I→A link, and whenever it is missing the relationship is seen as non-law-like. Another hypothesis is that, in contrast, mental states can be seen as adequate causes for physical events, so that, in the most extreme case, the I→O link is sufficient for the attribution of a causal relationship. This attribution of a causal relation between an intention and an outcome without obvious causal links involving physical actions can be seen as an example of "magical thinking." Based on the fact that legal systems all over the world consider the actual actions of a person (and not his or her mental states) as important for convicting him or her, and based on psychological studies of causal attribution, we predict that in every culture the Action-to-Outcome (A→O) link will be the most important for attributing causation. However, the anthropological literature suggests that the principle of magical thinking might be more relevant in certain "non-western" cultural groups compared with those in "western" societies; i.e., although in most "western" cultures intentionality is important in blame attribution, it is less often considered a relevant causal factor. We therefore anticipate that intentionality might have more weight in the non-western samples. We will elaborate our predictions in Section Predictions and discuss this issue in relation to our results in Section Cross-cultural Comparison of the Conceptualization of Causality.

The Linguistics of Causality
While the previous section was concerned with ideas and cultural preferences regarding concepts of causality, we want to emphasize the point that ideas and concepts are also (maybe sometimes even essentially) encoded in words. In every language, words and grammatical structures are not simply a tool for expressing pre-existing thoughts, but they also, to some extent, guide thinking processes (Sapir, 1933; Whorf, 1956; Lucy, 1992). For anthropologists as well as for linguists and cross-cultural psychologists, attention to lexical categories is crucial, for they represent "conceptual packages" with which speakers analyze and categorize their physical and social worlds. This point has been made extensively in the literature about color terms, for instance (Berlin and Kay, 1969; Hardin and Maffi, 1997; Levinson, 2000). Although colors can be objectively categorized using a color chart, color terms in any specific language cut the color space into categories, and different languages do this differently. The implications of this—including the extent to which the "linguistic relativity" hypothesis is valid (i.e., how people construe the world based on linguistic variations)—have been hotly debated (Lucy, 1992; Gumperz and Levinson, 1996).

Why is this debate important for a cross-cultural and cross-linguistic analysis of (exceptional) causality? The answer is simple: If people do not have a lexical label to express a concept like "chance," "accident," "coincidence," they might not be able to interpret events that speakers of other languages construe as falling into those categories. Additionally, local folk theories might encourage the idea of a uni-causal interpretation. Thus, people from different cultural contexts and different language communities would give different explanations for the same situation. These explanations might or might not vary from each other in terms of causation but still be systematic within each community. How much people's judgments will be consistent and how much disparity there is across the interpretations of members of the same group were exactly the questions that drove our research.

MATERIALS AND METHODS

Because our aim is to determine how participants from different cultures conceptualize causal links between events and, in particular, if they have some word or expression to relate events with each other in a non-law-like way, we designed a task that involved different scenarios under various conditions following a systematic structure. According to that structure eight scenarios represented different configurations of causal links, which were instantiated in eight cover stories providing different content to the causal structures (see details in Section Materials).

Participants[4]
The German sample was composed of 64 participants, all students recruited from the campus of the University of Göttingen (Germany). Among the participants there were 32 women, 31 men, and one person who didn't specify his or her gender. The mean age was 24.97 ($SD = 4.55$). One person did not specify age. German participants were asked spontaneously on campus, mostly in cafeterias. They received sweets as compensation.

The Yucatec Maya sample was composed of 16 participants (nine women), all native speakers of Yucatec Maya; 14 were from the village of Kopchen (state of Quintana Roo) and two females from the village of Chican (state of Yucatán). Their mean age was 38.4 years (ranging from 18 to 50). None of the participants had more than a high school degree. Although all are native speakers of Yucatec Maya, some also speak Spanish. Yucatec Mayans participants were compensated indirectly through gifts, following a fieldwork procedure used since 2002 by Le Guen.

The Tseltal Maya sample was composed of 16 participants (eight women) all native speakers of Tseltal; all were from the community of Tenejapa (state of Chiapas). Their mean age was 32.8 years (ranging from 23 to 58). Education level varied; none had more than a high school degree. Tseltal participants volunteered in response to Brown's invitation to participate to the study. Each participant received 70 Mexican pesos per session (in which they also participated in other tasks).

The Mexican sample was composed of eight students from an undergraduate Spanish literature class at the UNACH University (Universidad Autonoma de Chiapas), studying for their Bachelor degree. Four of the students were female. All were from the state of Chiapas and all were native speakers of Spanish (one participant said he also speaks Mam (a Mayan language) but considers himself to be Mestizo, i.e., from the Mexican Spanish culture). The mean age of participants was 20.4 (between 18 and 24). Participants were offered candy or coffee as remuneration.

Materials

We used the structural linkages of the *Culpable Control Model* by Alicke (2000) as the basis for designing our task. In this model, the relation between the intentionality of an agent, the action and the outcome is divided into three links: Intention-to-Outcome, Intention-to-Action, and Action-to-Outcome. The presence of the Intention-to-Outcome link (I→O) implies the desire of an agent that a certain event (the outcome) shall happen whereas its absence implies that the agent neither foresaw nor wanted the outcome to happen. The presence of the Intention-to-Action link (I→A) implies that the agent intended a certain action. This link can be present even though the Intention-to-Outcome link is absent and vice versa (see scenarios 3, 5, 6, and 7). Finally, the presence of the Action-to-Outcome link (A→O) implies that the action leads to a particular outcome. All combinations of the presence and absence of the mentioned three links lead to eight different scenarios, each with a unique pattern of links. **Table 1** presents all eight combinations of the three possible links.

Scenarios 1 and 8 will be considered our baseline scenarios. Scenario 1, with all three causal links present, exemplifies a case of *direct causation*. For instance, consider the case of a successful event of killing a deer (our cover story 1). A hunter wants a dead deer (i.e., the I→O link is given, as there is an intention to an outcome), so he pulls the trigger with the purpose of shooting at the deer (i.e., the I→A link is given, as there is an intention to an action fulfilled). Eventually, the shot of the hunter leads to the dead deer (i.e., the A→O link is also given, as the action and the respective outcome are realized).

TABLE 1 | For each scenario (Sc), the structure considers the combination of the three possible links: Intention to Outcome (I→O), Intention to Action (I→A), and Action to Outcome (A→O).

	English gloss	Links		
		I → O	I → A	A → O
Sc1	"direct causality"	√	√	√
Sc2	"failure"	√	√	–
Sc3	"accident"	–	√	√
Sc4	"luck"	√	–	√
Sc5	"unintentional"	–	–	√
Sc6	"magical thinking"	√	–	–
Sc7	"intended action"	–	√	–
Sc8	"pure coincidence"	–	–	–

The signs √ and – represent, respectively, the presence or the absence of a link.

By contrast, scenario 8 is made up of purely *coincidental* events, that is, the three events just happen at the same time without any obvious causal link present between them, as, for example: A hunter goes into the forest and wants to clean his gun (i.e., no intention to kill the deer). While cleaning the trigger he accidentally pulls it. The gun doesn't fire because there was no bullet in the barrel. At the same moment a deer falls down, dead, some meters away from the hunter (i.e., no action from the agent leads to the outcome)[5].

Scenario 2, where the link Action-to-Outcome is absent, is a typical case of *failure*, since intentionality is present but does not make the outcome happen. Scenario 3, which lacks the Intention-to-Outcome link, could be considered a case of *accident*, because there is an intention toward the action but no intention toward the outcome. Scenario 4, which lacks the Intention-to-Action link can be considered a prototypical case of *luck*. In the literature, this scenario has been referred to as a "deviant" causal chain (Chisholm, 1966; Searle, 1983; Pizarro et al., 2003). Scenario 5 can be referred to as *unintentional* as it represents a case in which neither the intention toward the action nor the intention toward the outcome is present, although, in the end, the outcome is caused by the action of the agent. Scenario 6, which presents only the Intention-to-Outcome link, is a case of *magical thinking*: the agent wants the outcome to happen and events (magically) turn out to comply with his or her wishes. Again, taking our cover story 1 as an example: A hunter wants a dead deer (i.e., link 1 is fulfilled, for there is an intention to an outcome). While walking in the forest he stumbles over a root and pulls the trigger accidentally. The gun does not fire because there was no bullet in the barrel (i.e., no intention leading to an action). At the same

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[5]Although scenario 8 could be considered as purely coincidental, it is also likely that, because of the interactional context of the task where participants are asked to judge scenarios, such a story triggers the assumption that some relevance must exist between the different events narrated. Indeed, the default assumption when someone tells a story is that it should have some relevance or some communicational intent (Grice, 1957). Consequently, we expected either that participants would see no causal link (i.e., consider it pure coincidence) or that they would be puzzled and perhaps invent some causal link not originally present in the story. In this latter case, we anticipated considerable inconsistency among participants of the same cultural group as well as between groups.

moment a deer falls down, dead, some meters away from the hunter (i.e., no action from the agent leads to the outcome). Finally, scenario 7 (*intended action*), with only the Intention-to-Action link, represents a situation in which an outcome happened that was neither intended nor was it the result of the agent's action.

What is important to note is that even while the eight scenarios differ regarding their constellation of linkages, there are three factors that remain constant across all scenarios: (a) there is always an agent mentioned whose behavior (event 1) is temporally and spatially near to the outcome (event 2), (b) the behavior of the agent leads to an event that happens constantly regardless of whether it is intended by the agent, and (c) all scenarios end with a similar outcome (e.g., the deer being dead, the window being broken, etc.).

Eight different cover stories were created, so that each scenario was combined once with each cover story leading to 64 different story-scenario-combinations. These were created to control for content effects; the stories have a different content but share the causal-link structure of the eight scenarios. With eight different scenarios and eight different cover stories we were able to vary possible combinations of the two to counterbalance our data in order to improve its reliability. The eight cover stories are the following:

1. A hunter shooting a deer
2. A boy kicking a ball and breaking a window
3. A fisher fishing a fish
4. A woman starting a fire
5. A woman breaking a plate, waking up her husband
6. A man spilling a drink on his boss
7. A man cutting down a cornstalk
8. A man killing an insect with a newspaper.

Stories were originally designed in English and then translated into the four languages. In the choice of contents, a main priority was to be as culturally neutral as possible. Alicke (Alicke, 2000; Alicke et al., 2008) was primarily interested in blame attribution, and in his model he recognizes the role of norms as fundamental as much as the valence of the outcome (positive or negative). This is why we avoided outcomes with strong valence (like human death or severe injuries), especially because human agents are involved in every story. Careful attention was taken to have culturally interpretable content of the stories also for the two Mayan groups[6].

Design and Procedure
Design
The eight cover stories were designed in order to control for content effects. The strategy of assignment of the scenarios/cover stories to the participants differed across the four groups. For the

Mexican Spanish, the Tseltal and the Yucatec participants, the full set of cover stories was used. Each participant got all eight scenarios, each with a different cover story, in a pre-randomized order that is presented in Appendix 1 of Supplementary Material. For the eight Mexican Spanish subjects this results in one data point for each scenario. For the two Mayan groups, after the first eight participants, the same structure was repeated with the next eight participants, resulting in two data points for each scenario. In Germany, only two stories (taken randomly from the eight cover stories) were presented to each participant since it was possible to recruit many more subjects compared to the other three groups. The two stories presented to a participant were randomly combined; the assignment was restricted in three ways: (1) every scenario for every cover story had to be assigned twice, one participant could neither (2) get two different scenarios for the same cover story nor, (3) the same scenario for two different cover stories. Each participant thus got two different scenarios with two different cover stories. The described procedure also results in two data points for each scenario.

Procedure
The scenarios were presented to the participants in their native tongue in a randomized order (given in Appendix 1 of Supplementary Material). In the case of the German students, the subjects were given the task on a sheet of paper and participants noted their answers down. For the other three groups, the cover stories/scenarios were presented orally; they were read as many times as necessary for the participant to understand them correctly. Participants answered verbally and their responses were noted on a note pad. Responses were also audio-recorded for the Mexican Spanish and the Tseltal and video recorded for the Yucatec.

Participants were asked to provide an interpretation of the (assumed) causal or other relation between the links for each scenario. They were asked three questions:

1. Temporal question: Why did the outcome occur just then?
2. Agency question: Did the actor cause the outcome to happen?
3. Counterfactual question: If the actor had not been there, would the outcome have happened anyway?

The first question was an open, temporal question on the timing of the outcome: "Why did the outcome occur just then?" The temporal criterion is fundamental in order to assess the coincidence of events. As pointed out by Hume (2003) and Lagnado and Channon (2008)[7], people's attribution of causal relations can vary if events are considered earlier or later in the chain of events. As Alicke (2000) suggests, a closer proximity between action and the outcome might reveal a greater control by the agent and a higher degree of causality. This question, prompting for a free interpretation of the scenario, also enabled us to make a linguistic analysis of the concepts participants used to characterize the event described.

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[6]Brown has been working for more than 40 years among the Tseltal Maya and Le Guen for almost 15 years among the Yucatec. Both are fluent in the local language (which they exclusively use for all interactions) and have been conducting ethnographic and linguistic studies as well as (psycho-) linguistic tasks for many years. Because of their experience (and the consulting of a native speaker in the case of Le Guen), possible cultural incongruities in the scenarios were avoided.

[7]The latter consider the criteria of "location," but time and space are closely linked in our scenarios.

The second question focuses on the agency of the actor: "Did the actor cause the outcome to happen?"[8]. This was asked to determine whether participants recognize a causal relation between the intention or the action of the agent regarding the outcome.

The final question is formulated counterfactually: "If the actor had not been there, would the outcome have happened anyway?" This question was designed to determine how participants consider the agent to be determinant in the outcome (it contrasts directly with the agency question). It is important to point out that while the open question was aimed at eliciting explanations of the event, the two closed questions addressed directly the (causal) involvement of the agent in each scenario.

Coding

All answers were translated back into English in order to allow for multiple coders. Questions 2 and 3 triggered yes/no/I don't know answers and these three types of answers were considered. Question 1 was an open question, so answers were coded into one of six mutually exclusive categories according to the following criteria.

(1) *Causal Story-based Explanations*. Answers in this category include a causal connection between the agent mentioned in the story (or a part of the mechanism between the agent's action and the outcome) and the outcome. When the Action-to-Outcome link was present (i.e., in scenarios 1, 3, 4, and 5), it suggests that participants recognized the causal connection between the agent's action and the outcome. By contrast, when the scenario structure did not have the Action-to-Outcome link, it suggests that the participant did not accept the scenario as such, but created a causal connection from the agent to the outcome although it was not originally present.

(2) *Causal Imposed Explanations*. Answers in this category include an invented causal connection between a causal factor that was not mentioned originally in the story and the outcome. Examples of such answers are: "There was another hunter who shot the deer at the same time" (cover story 1) or "something hit the window, though it wasn't the ball" (cover story 2).

(3) *No cause, it happened by itself, chance, coincidence*. Answers that belong to this category are those where the agent mentioned in the story has nothing to do with the outcome and no other causal mechanism is added by the participant in order to make sense of the story. Examples of such answers are: "it was chance that the deer died in that moment" (cover story 1) or "it fell down all by itself" (cover story 6).

(4) *Fate, destiny*. Answers belonging to this category suggest that the outcome happened because it was "meant to be," without the participant specifying any other causal mechanism. Examples of such answers are: "it was [the] destiny [of the deer to die]" or "it was [the fisher's] fate to catch [the fish],

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God took it out of the water so the fisher could catch it" (cover story 3). A typical word used in Yucatec Maya was *sweerte* "fate," or equivalently, *Schicksal* "karma, fate, destiny" among the German participants.

(5) *I don't know*. Answers belonging to this category suggest that the participant could not name a specific causal factor or could not categorize the story under a specific label. It is also the case that an "I don't know"-response reflects some degree of insecurity.

(6) *Miscellaneous, not classifiable*. Answers that did not belong to any of the previous categories were coded as not classifiable. Such answers generally revealed that the participant did not answer the question or that the answer was unrelated to the question (e.g., "people will still say it's [the boy who broke the window]") (cover story 2).

Because these were open answers, we decided to conduct a test of inter-rater reliability. The specialist of each cultural group coded the answers and translated them into English. A second coder blind-coded the first coder's answers, and, for cases in which the two raters did not agree, a third, independent rater decided which category the open answer in question was to be assigned to. For the German sample, the inter-rater reliability for the two raters was found to be excellent ($\kappa = 0.97$) according to Landis and Koch (1977). Reliability was lower, but nevertheless substantial agreement could be found both for the two raters of the Tseltal participants' answers ($\kappa = 0.78$) and for the two raters of the answers of the Yucatec subjects ($\kappa = 0.68$). For the Mexican Spanish participants, the inter-rater reliability for the two raters was only moderate ($\kappa = 0.50$). The differences in reliability partly reflect the extent to which a rater had prepared his or her coding task beforehand, but they also result of how much open answers were detailed. The answers of the German participants, for instance, were very detailed—perhaps because they were written down instead of orally given. It could therefore have been easier to classify them. However, the agreement between two raters on the assignment of categories was at least "substantial" for three of the four groups and the worst degree of agreement was still "moderate" (after Landis and Koch, 1977). We therefore consider the implementation of the coding system to be successful and that our use of the open answer-data is justified.

Predictions

One main concern in this study is to explore the ways in which different cultural groups consider what we could consider "core or basic causality." In particular, we are interested in the causal link between an Action and an Outcome (A→O), which is classically referred to as "causality" in Western societies. There are two possibilities: first, either all participants from every culture consider this link as fundamental or, alternatively, in some cultures this link is not taken to be so important in relation to other links (like Intention-to-Outcome or Intention-to-Action).

The Action-to-Outcome link determines whether an agent's action is seen as the cause of an outcome or not. The interest of considering the relevance of the Action-to-Outcome link for the interpretation of causality cross-culturally primarily lies in the

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[8]We used the direct transitive formulation, e.g., "Did the hunter kill the deer?," rather than the periphrastic formulation "Did the hunter cause the deer to die," as the transitive is the least marked way to formulate this question about direct causation.

TABLE 2 | Percentage of Yes-Answers to the question "Did the agent cause the outcome to happen?" for each language and for the presence and absence of each link.

Language	Percentage of Yes-Answers					
	A-O link present (sc. 1, 3, 4, and 5)	A-O link absent (sc. 2, 6, 7, and 8)	I-A link present (sc. 1, 2, 3, and 7)	I-A link absent (sc. 4, 5, 6, and 8)	I-O link present (sc. 1, 2, 4, and 6)	I-O link Absent (sc. 3, 5, 7, and 8)
German	79.69	21.88	40.63	60.94[a]	54.69	46.88
Tseltal	57.81	29.69	50.00	37.50	54.69	32.81
Yucatec	89.06	42.19	73.44	57.81	67.19	64.06
Mexican Spanish	59.38	25.00	37.50	46.88	46.88	37.50

Note that each scenario was answered by 16 German, 16 Tseltal, 16 Yucatec, and 8 Mexican Spanish participants so that the percentages in each column refer to 64 German, 64 Tseltal, 64 Yucatec, and 32 Mexican Spanish participants.

[a]*The German and Mexican Spanish subjects gave more "yes" answers in the absence compared to the presence of the I→A link. This difference can be explained by the presence or absence of the A→O link: there generally tend to be more "yes" answers for those scenarios in which the A→O link is present (1, 3, 4, 5) and more "no" answers in those in which the A→O link is absent (2, 6, 7, 8). Regarding the four scenarios in which the I→A link is absent, for instance, the higher percentage of "yes" answers can solely be attributed to the two scenarios 4 and 5 in which the A→O link is present (German subjects: 15 "yes" and 1 "no" answer to scenario 4, 13 "yes" and 2 "no" answers to scenario 5, 6 "yes" and 6 "no" answers to scenario 6, 5 "yes" and 10 "no" answers to scenario 8; Mexican Spanish subjects: 5 "yes" and 3 "no" answers to scenario 4, 5 "yes" and 3 "no" answers to scenario 5, 2 "yes" and 6 "no" answers to scenario 6, 3 "yes" and 4 "no" answers to scenario 8).*

fact that in the anthropological literature, it was a frequent claim among early ethnographers that members of many non-western cultural groups base a lot of their daily behavior on the principle of "magical thinking," mostly related to various kinds of taboos (Frazer, 1911; Lévy-Bruhl, 1922; Evans-Pritchard, 1937; Lévi-Strauss, 1990; Malinowski, 1992), see discussion in section Cross-cultural Comparison of the Conceptualization of Causality. According to this notion, the other two links, (Intention-to-Outcome and Intention-to-Action) could likewise contribute to the perception of causality. If some cultural differences were to be expected, they would be between the German and the Mexican participants on the one hand, who should behave in the way expected of "western" groups, and the Tseltal and Yucatec participants on the other hand, who might show evidence of the kind of reliance on the I-O link typical of "magical thinking."

RESULTS

We examine the results according to the three questions we asked our participants. For practical reasons, we consider first the agency question (Did the actor cause the outcome to happen?), then the counterfactual question (If the actor had not been there, would the outcome have happened anyway?) and finally the open, temporal question (Why did the outcome occur just then?). We look at both differences *within* cultures, depending on the absence or presence of each link (A→O, I→A, and I→O), and differences *between* cultures, given the presence of each link.

The Agency Question

Answers to the question "Did the actor cause the outcome to happen?" reveal how much participants attribute causation to the actor in each scenario, and allow us to determine how much weight the different links are given in the recognition of causation. This question could be answered with "yes," "no," or "maybe." A yes-answer would indicate that the agent is seen as cause of the outcome. For the calculation of the within-group contrasts, we used a 2 (link present vs. link absent) × 3

(response: yes/no/maybe) contingency table[9]. For the between-group contrasts, we used a 2 (group 1 vs. group 2) × 3 (yes/no/maybe) contingency table for the presence-case of each link (A→O, I→A, and I→O). The descriptive results are presented in **Table 2**.

Comparison within Cultures

For subjects of all four cultural backgrounds, the only significant differences between the absence and the presence of a link were found for the A→O link: if it is present, the agent is significantly more often seen as cause compared to when it is absent [German: $\chi^2_{(2, N=128)}$[10] $= 43.51$; $p < 0.001$, Tseltal: $\chi^2_{(2, N=128)} = 10.86$; $p = 0.004$, Yucatec: $\chi^2_{(2, N=128)} = 31.38$; $p < 0.001$, Mexican Spanish: $\chi^2_{(2, N=64)} = 9.36$; $p = 0.009$]. Only for the Tseltal subjects, a second link seems to have been important in order to answer the question: the I→O link. They stated significantly more often that the agent did not cause the outcome if the outcome was not intended compared to when it was intended [$\chi^2_{(2, N=128)} = 6.88$; $p = 0.03$].

So as predicted, for the participants of all four cultural backgrounds the most important link to decide whether an agent caused the outcome is the link from the agent's action to the outcome. However, there could be differences regarding the importance of the links between the participants of the different cultural backgrounds; that the agent's action caused the outcome, for instance, could still be more important for some than for others.

Comparison between Cultures

To see whether there are differences in the relative importance of the three links between participants of the four cultural backgrounds, we analyzed the differences between every pair of

[9]Please note that in some cases two of the six cells were empty (no "maybe" responses). In these cases, a 2 × 2 contingency table was considered.
[10]Please note that in all chi-square tests, the N reported represents the number of data points of the comparison, and not the number of participants.

groups, resulting in six comparisons: German–Tseltal, German–Yucatec, German–Mexican Spanish, Tseltal–Yucatec, Tseltal–Mexican Spanish and Yucatec–Mexican Spanish[11].

If the A→O link is present, the vast majority of the German subjects see the agent as cause (79.69%). Their answer pattern is different from that of the Tseltal and Mexican subjects [German–Tseltal: $\chi^2_{(2, N = 128)} = 17.54$; $p < 0.001$, German–Mexican Spanish: $\chi^2_{(2, N = 96)} = 11.42$; $p = 0.003$]. A consideration of the adjusted standardized residuals[12] revealed that these differences were due to the preponderant majority of German subjects endorsing the agent as a cause compared to more evenly distributed answers in the Tseltal and Mexican-Spanish samples and, at least for the German-Tseltal comparison, due to more "maybe"-answers on the part of the German subjects. The answer pattern of the Yucatec subjects resembles that of the Germans (the general answer pattern did not differ significantly; $\chi^2_{(2, N = 128)} = 5.4$; $p = 0.067$); the adjusted standardized residuals merely revealed that the Germans gave more maybe-answers compared to the Yucatec sample (see Appendix 2 in Supplementary Material). Also the Yucatec–Tseltal and the Yucatec–Mexican comparison revealed significant differences: Yucatec subjects less often deny and more often state that the agent is the cause if the A→O link was present in comparison with the Tseltal subjects [$\chi^2_{(1, N = 128)} = 16.02$; $p < 0.001$] or the Mexican Spanish subjects [$\chi^2_{(1, N = 96)} = 11.4$; $p < 0.001$].

If the I→A link is present, the answer pattern of the German subjects differs significantly from that of the Tseltal subjects [$\chi^2_{(2, N = 128)} = 12.04$; $p = 0.002$]. The adjusted standardized residuals indicate that this difference stems from more "maybe"-answers of the German subjects. This finding, however, might be due to differences in how the data were collected: the German subjects were given a written questionnaire with "maybe" as an answer option whereas the Tseltal subjects were asked to answer verbally and thus the answer "maybe" might not have come readily to their mind. For the Yucatec participants, the agent is more often seen as the cause of the outcome if he intended the action than for the German and Mexican subjects (German–Yucatec: $\chi^2_{(2, N = 128)} = 17.19$; $p < 0.001$, Yucatec–Mexican $\chi^2_{(2, N = 96)} = 11.87$; $p = 0.003$). The German participants, additionally, gave more "maybe"-answers compared to the Yucatec participants, as the adjusted standardized residuals indicate.

Regarding the I→O link, only the German subjects seem to have given a slightly different answer pattern compared to the Tseltal [$\chi^2_{(2, N = 128)} = 13.57$; $p = 0.001$]. This is, as the analysis of the adjusted standardized residuals indicates, again due to the higher frequency of maybe-answers from the German subjects.

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[11] We used Bonferroni-corrected p-values for the six single comparisons between the languages so that the chi-square results were considered to be significant if the corresponding p-value was lower than 0.008 in these cases.

[12] As proposed by one reviewer, we looked at the adjusted standardized residuals to determine which cells contributed most to the significant differences indicated by the conducted chi-square tests. Values higher than 2 or lower than −2 were considered to make a big contribution and the corresponding results are thus reported in the text. The tables with all adjusted standardized residuals are also provided in Appendix 2 of Supplementary Material.

Summary

The results from the agency question overall show that intentionality does not play the major role for attributing causality to an agent, at least among these four cultural groups, while the A→O link seems to be the most important one for determining whether an agent is the cause of an outcome. However, there are differences between participants from the four cultural backgrounds: compared to the German and Yucatec subjects, the Tseltal and Mexican Spanish subjects deny the agent's causal role more often even when the story is more likely to represent the agent's action as causing the outcome. In addition, compared to the other three groups the Yucatec participants see the agent more often as cause even if he merely intended the action. For some cultural groups, the intentionality of an action therefore seems to play an additional role in their causal attributions.

Counterfactual Factor

The counterfactual question ("If the actor had not been there, would the outcome have happened anyway?") was designed to test whether counterfactual evidence would cancel a causal interpretation. Possible answers for this question were again "yes," "no" or "maybe." Note, however, that the representation of the agent as cause of the outcome would be indicated by a negation of the question ("No, the outcome would not have happened without the agent being there"). The within-contrasts were again calculated using a 2 (link present vs. link absent) × 3 (response: yes/no/maybe) contingency table (Tseltal and Yucatec participants were less likely to answer "maybe"; see footnote 8). The between-contrasts, again, were calculated using a 2 (group 1 vs. group 2) × 3 (yes/no/maybe) contingency table for the presence-case of each link (A→O, I→A, and I→O). The descriptive results are presented in **Table 3**.

Comparison within Cultures

As for the agency question, the only significant differences between the absence and presence of one link can be found for the A→O link. If the agent's action caused the outcome, more participants say that the outcome would *not* have happened without the agent's presence than that it *would* have happened without him. This difference is significant for the German subjects [$\chi^2_{(2, N = 128)} = 33.91$; $p < 0.001$], for the Tseltal subjects [$\chi^2_{(2, N = 128)} = 15.72$; $p < 0.001$], for the Yucatec subjects [$\chi^2_{(1, N = 128)} = 27.81$; $p < 0.001$] and marginally significant for the Mexican Spanish subjects [$\chi^2_{(2, N = 64)} = 5.48$; $p = 0.06$].

The responses of the majority of subjects of all cultural backgrounds indicate that, in cases in which the A→O link is present, the outcome would not have happened if the agent had not been there.

Comparison between Cultures

For both the Tseltal and the Yucatec subjects, the comparisons with the other cultural groups revealed significant differences if the A→O link is present. All Tseltal participants denied that the outcome would have happened without the agent and thus gave more no-answers and less maybe-answers than the German subjects [$\chi^2_{(2, N = 128)} = 18.29$; $p < 0.001$], although

TABLE 3 | Percentage of No-Answers to the question "If the actor had not been there, would the outcome have happened anyway?" for each language and for the presence and absence of each link.

Language	Percentage of No-Answers					
	A–O link present (sc. 1, 3, 4, and 5)	A–O link absent (sc. 2, 6, 7, and 8)	I–A link present (sc. 1, 2, 3, and 7)	I–A link absent (sc. 4, 5, 6, and 8)	I–O link present (sc. 1, 2, 4, and 6)	I–O link absent (sc. 3, 5, 7, and 8)
German	75.00	25.00	43.75	56.25[a]	50.00	50.00
Tseltal	100.00	78.13	89.06	89.06	89.06	89.06
Yucatec	84.38	39.06	65.63	57.81	56.25	67.19
Mexican Spanish	68.75	40.63	43.75	65.63	62.50	46.88

Note that each scenario was answered by 16 German, 16 Tseltal, 16 Yucatec, and 8 Mexican Spanish participants so that the percentages in each column refer to 64 German, 64 Tseltal, 64 Yucatec and 32 Mexican Spanish participants.

[a]As already noted for question 2, the German and Mexican Spanish subjects gave more "yes" answers to question 3 if the I→A link was absent compared to when it was present. The Yucatec subjects gave more "yes" answers if the I→O link was absent compared to when it was present. These differences can predominantly likewise be also be attributed to the presence of the A→O link. This link was present in two of the four scenarios in which the I→A link was absent, scenarios 4 and 5, and also in two of the four scenarios in which the I→O link was absent, scenarios 3 and 5. (German subjects: 1 "yes" and 13 "no" answers to scenario 4, 3 "yes" and 13 "no" answers to scenario 5, 7 "yes" and 3 "no" answers to scenario 6, 7 "yes" and 7 "no" answers to scenario 8; Mexican Spanish subjects: 0 "yes" and 7 "no" answers to scenario 4, 1 "yes" and 5 "no" answers to scenario 5, 0 "yes" and 6 "no" answers to scenario 6, 2 "yes" and 3 "no" answers to scenario 8; Yucatec subjects: 2 "yes" and 14 "no" answers to scenario 3, 2 "yes"—and 14 "no" answers to scenario 5, 8 "yes" and 8 "no" answers to scenario 7, 9 "yes" and 7 "no" answers to scenario 8.)

the majority of German subjects also answered "no" (75%). For the same reason (because of the large amount of no-answers on the part of the Tseltal), the comparison with the Yucatec and Mexican subjects also reveals significant differences [Tseltal–Yucatec: $\chi^2_{(1, N=128)} = 10.85$; $p < 0.001$, Tseltal-Mexican: $\chi^2_{(2, N=96)} = 22.34$; $p < 0.001$]. In addition, the Yucatec subjects' answer pattern differs significantly from that of the Germans [$\chi^2_{(2, N=128)} = 11.35$; $p = 0.003$] and Mexican subjects [$\chi^2_{(2, N=96)} = 15.27$; $p < 0.001$]: both the German and the Mexican Spanish participants gave more maybe-answers than the Yucatec participants, as the analysis of the adjusted standardized residuals revealed.

So, given the presence of the A→O link, *all* Tseltal subjects answered "no" to the counterfactual question as to whether the outcome would have happened if the agent had not been there. The Yucatec participants sometimes answered "yes," and only the German and Mexican participants also answered "maybe" (although rarely).

Regarding the importance of the I→A link, again for both the Tseltal and the Yucatec subjects, the comparisons with the other cultural groups revealed significant differences concerning their answers if the I→A link is present. Compared to the German subjects [$\chi^2_{(2, N=128)} = 29.48$; $p < 0.001$], the Yucatec subjects [$\chi^2_{(2, N=128)} = 20.71$; $p < 0.001$] and the Mexican subjects [$\chi^2_{(2, N=96)} = 22.75$; $p < 0.001$], the Tseltal subjects gave significantly more no-answers if the agent intended his action, suggesting that he was seen to be a *causal* agent based on the presence of the I→A link. As likewise indicated by the adjusted standardized residuals, the German and Mexican Spanish participants also gave more maybe-answers compared to the Tseltal participants.

Also for the Yucatec subjects, however, the presence of the I→A link seems to influence the representation of the agent as cause in a stronger way than for the German [$\chi^2_{(2, N=128)} = 22.44$; $p < 0.001$] and Mexican subjects [$\chi^2_{(2, N=96)} = 22.35$; $p <$

0.001]. Compared to them, the adjusted standardized residuals show that the Yucatec participants gave more no-answers and fewer maybe-answers—indicating that they considered the agent to be "more causal" if the I→A link was present.

Finally, as for the other two links, the comparisons between the Tseltal and the Yucatec subjects with all other cultural groups revealed significant differences concerning their answers if the I→O link is present. The Tseltal subjects denied significantly more often that the outcome would have occurred without the agent if the outcome was intended by the agent compared to the German [$\chi^2_{(2, N=128)} = 23.19$; $p < 0.001$], Yucatec [$\chi^2_{(2, N=128)} = 25.74$; $p < 0.001$] and Mexican participants [$\chi^2_{(2, N=96)} = 9.93$; $p = 0.007$]. The role of the link between intention and outcome therefore seems to be most important for the Tseltal subjects: if the I→O link is present, the agent is seen as "more causal." The German and Mexican subjects, again, also gave more maybe-answers than the Tseltal participants. Interestingly, the Yucatec subjects gave more yes-answers and fewer maybe-answers than the Mexican subjects [$\chi^2_{(2, N=96)} = 19.05$; $p < 0.001$] and the German subjects [$\chi^2_{(2, N=128)} = 25.74$; $p < 0.001$] as the adjusted standardized residuals reveal. This indicates that, compared to the German and Mexican subjects, the agent is "less causal" for the Yucatec participants if the I→O link is present. However, the Yucatec participants did not give fewer no-answers compared to these two samples (see Appendix 2 in Supplementary Material)—which would be the necessary counterpart for this conclusion—suggesting that this result might be an artifact resulting from the general tendency of the Yucatec participants to not give maybe-answers.

Summary

For the participants of all cultural backgrounds, the A→O link was the most important link to determine whether the outcome would have happened in the absence of the agent. However, there were differences across the four groups. Whereas for

the German and Mexican subjects, the presence of the A→O link seems to have been the only relevant information for answering the counterfactual question, the Yucatec participants and even more so the Tseltal participants seem to have considered the other two links as well for their judgment. This can be interpreted as an influence of the story agent's mental state on the participant's causal representation of the event. Also the finding of the agency question supports this interpretation: even if the agent's action caused the outcome, Tseltal and Yucatec participants seem to be more willing to say that the agent is not the cause of the outcome. This could be because, for them, the agent's intentionality toward the action and the outcome plays a bigger role than for the German and Mexican participants.

However, there is a pattern in the Tseltal data—a strong contrast between the responses to the agency question and the counterfactual question—that differs from that for all three of the other cultures. The Tseltal responses to the agency question more rarely attributed causality to the agent compared to German and Yucatec responses (i.e., they provided more no-answers), suggesting that the agent is not seen to be as much a source of causality as in the data of the German or Yucatec participants. Yet the majority of Tseltal responses to the counterfactual question support the idea across all scenarios that the event could only have happened if the agent were present. In other words, they appear to be seeing the agent as less responsible in the first case but as a prerequisite for the outcome to happen in the second case. This unique pattern for Tseltal suggests the possibility that Tseltal participants took a different perspective in the counterfactual case, for example they might have viewed the agent as an essential witness of the scenario who is important for the story to be perceived and retold, and therefore, the agent might be a prerequisite for each scenario[13]. What exactly the implications are of this Tseltal response pattern for Tseltal understandings of causality and agency clearly requires further research.

The Temporal Question

The temporal question "Why did the outcome occur just then?" aimed at generating an open answer. As mentioned, the time criterion was crucial to avoid participants inferring other potential causal links that were not provided in the original story. The open answers participants gave were categorized in one of six categories: (1) causal-story based, (2) causal-imposed, (3) chance, (4) fate, (5) I don't know, and (6) miscellaneous. A causal representation of the agent would clearly be indicated by the first category (see Section Materials for details). For the calculation of the within-contrasts, we used a 2 (link present vs. link absent) × 6 (type of explanation: causal-story based, causal imposed, fate, chance, don't know, miscellaneous) contingency table with 12 cells for each language group. For the between-contrasts, we used a 2 (group 1 vs. group 2) × 6 (type of explanation: causal-story based, causal imposed, fate, chance, don't know, miscellaneous) contingency table for the presence-case of each link. The results are presented in **Table 4**.

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[13]We are grateful to reviewer 2 for this interesting suggestion.

Comparison within Cultures

As in the responses to the other two questions, the A→O link seems to be the most crucial one for the participants of all cultural backgrounds when it comes to their causal representation of the scenario. The answer pattern of all groups differed significantly when scenarios in which the agent's action caused the outcome are compared with those in which it does not [German: $\chi^2_{(5, N=128)} = 49.88; p < 0.001$, Tseltal: $\chi^2_{(4, N=128)} = 18.58; p < 0.001$, Yucatec: $\chi^2_{(5, N=128)} = 41.76; p < 0.001$, Mexican Spanish: $\chi^2_{(2, N=64)} = 11.25; p = 0.01$]. This is most likely because of more answers categorized as "causal-story based" in the first compared to the latter case.

Comparison between Cultures

If the A→O link is present, the answer pattern of the Tseltal subjects differs significantly from that of the Yucatec subjects [$\chi^2_{(5, N=128)} = 16.51; p = 0.005$]. The analysis of the adjusted standardized residuals shows that the Tseltal subjects more often give a causal-story based answer compared to the Yucatec subjects, whereas the Yucatec subjects give more fate-answers. The comparison between all other groups revealed no significant differences (all $\chi^2 < 14.42$, all $p > 0.013$, i.e., higher than the necessary p-value of 0.008; see footnote 10).

If we now consider the I→A link, we notice that again, the answer pattern of the Tseltal subjects differs significantly from that of the Yucatec subjects [$\chi^2_{(5, N=128)} = 24.32; p < 0.001$], and also from that of the Mexican Spanish subjects [$\chi^2_{(4, N=96)} = 14.42; p = 0.006$]. According to the adjusted standardized residuals, this difference can likely be attributed to the higher amount of causal-story based answers and the lower amount of causal-imposed answers on the part of the Tseltal subjects compared to the other two groups. Moreover, the Yucatec participants gave more fate-answers than the Tseltal participants (who never gave a fate answer, actually).

Finally, for the I→O link, as for the presence of the other two links, the Tseltal participants' answer pattern differs significantly from those of the Yucatec subjects [$\chi^2_{(5, N=128)} = 25.92; p < 0.001$] and the German subjects [$\chi^2_{(5, N=128)} = 16.0; p = 0.007$]. Again, looking at the adjusted standardized residuals suggests that this is because of more causal-story based answers by the Tseltal subjects. For the comparison between the Tseltal and the Yucatec subjects, the significant difference additionally stems from the higher number of fate-answers on the part of the Yucatec participants. In addition, the German subjects gave more miscellaneous-answers compared to the Tseltal subjects. The answer pattern of the German and Yucatec participants also differs significantly [$\chi^2_{(5, N=128)} = 19.63; p = 0.001$]. The adjusted standardized residuals reveal that the two groups do not differ regarding the amount of given causal-story based answers, but rather regarding some other answers: whereas the German participants give some chance answers, the Yucatec subjects more often give causal-imposed and fate answers.

Summary

The clearest finding regarding the open answers the participants gave in response to the temporal question is that the A→O

TABLE 4 | Percentage of responses to the question "Why did the outcome occur just then (i.e., at that very moment)?" according to major categories of responses for each language and for the presence and absence of each link.

Language	A–O-link	Type of response in %					
		Causal-story based	Causal-imposed	Chance	Fate	I don't know	Miscellaneous
German	Present	75.00	0.00	12.50	1.56	1.56	9.38
	Absent	18.75	28.13	20.31	9.38	12.50	10.94
Tseltal	Present	92.19	1.56	1.56	0.00	3.13	1.56
	Absent	62.50	17.19	14.06	0.00	4.69	1.56
Yucatec	Present	67.19	7.81	3.13	12.50	1.56	7.81
	Absent	15.63	42.19	1.56	28.13	6.25	6.25
Mexican Spanish	Present	75.00	12.50	6.25	0.00	0.00	6.25
	Absent	34.38	43.75	12.50	0.00	0.00	9.38

Language	I–A-link	Type of response in %					
		Causal-story based	Causal-imposed	Chance	Fate	I don't know	Miscellaneous
German	Present	43.75	18.75	15.63	4.69	4.69	12.50
	Absent	50.00	9.38	17.19	6.25	9.38	7.81
Tseltal	Present	75.00	9.38	9.38	0.00	3.13	3.13
	Absent	79.69	9.38	6.25	0.00	4.69	0.00
Yucatec	Present	45.31	23.44	1.56	15.63	4.69	9.38
	Absent	37.50	26.56	3.13	25.00	3.13	4.69
Mexican Spanish	Present	46.88	37.50	6.25	0.00	0.00	9.38
	Absent	62.50	18.75	12.50	0.00	0.00	6.25

Language	I–O-link	Type of response in %					
		Causal-story based	Causal-imposed	Chance	Fate	I don't know	Miscellaneous
German	Present	48.44	10.94	14.06	6.25	6.25	14.06
	Absent	45.31	17.19	18.75	4.69	7.81	6.25
Tseltal	Present	73.44	14.06	6.25	0.00	4.69	1.56
	Absent	81.25	4.69	9.38	0.00	3.13	1.56
Yucatec	Present	46.88	23.44	0.00	20.31	1.56	7.81
	Absent	35.94	26.56	4.69	20.31	6.25	6.25
Mexican Spanish	Present	50.00	28.13	9.38	0.00	0.00	12.50
	Absent	59.38	28.13	9.38	0.00	0.00	3.13

Note that each scenario was answered by 16 German, 16 Tseltal, 16 Yucatec, and 8 Mexican Spanish participants so that the percentages in each column refer to 64 German, 64 Tseltal, 64 Yucatec, and 32 Mexican Spanish answers

link determines whether a causal-story based answer is given or not. It is interesting, however, that the Tseltal subjects give many causal-story based answers irrespective of this link—depending on the mental state of the agent (intention toward the action and intention toward the outcome). These findings seem to reflect in part the findings for the agency and the counterfactual questions, for which it can likewise be concluded that, for the Tseltal participants, mental states play a bigger role in the identification of causality. For the Yucatec participants, this conclusion can probably be drawn from the results of the agency and counterfactual questions but not for the open temporal question. Regarding the Yucatec, it is interesting that fate seems to be an adequate explanation in several cases, whereas neither the Tseltal nor the Mexican Spanish participants gave fate answers.

GENERAL DISCUSSION

In this section we first present a summary of the main results of our study with regard to the predictions made in Section Predictions. Then, we point out some limitations of our study. We also propose a linguistic analysis of the answers from the open question before entering into a discussion of the cross-cultural comparison of the conceptualization of causality, looking in particular at the issue of the "magical thinking" principle from a cross-cultural perspective.

Summary of the Results and Answers to Predictions

In Section Predictions we presented a set of predictions which we can now compare to our cross-cultural results. Regarding the

first prediction about the importance of the Action-to-Outcome-link, the reported findings suggest that, for the participants of all four groups, this link is indeed the most crucial one for the attribution of causality. Within each group and for all three questions, this link determines whether the agent is seen as cause (agency question), whether the outcome would have happened even without the agent (counterfactual question) or whether a causal story based answer is given or not (open, temporal question). It can be concluded therefore that in general, people from very different cultural backgrounds base their causal attributions on more or less the same "mechanistic" principle, i.e., whether there was a causal mechanism (an action leading to an outcome in our examples) that produced an outcome.

However, there are also differences between the answers of the four cultural samples we compared that might shed light on the validity of our second prediction, that is, if in every culture the Action to Outcome link is equally important for recognizing causation. It seems that the role of intentionality for the perception of causality differs slightly across the four groups. Whereas the German participants seem to attribute causality to the agent whenever the A→O link is present, the Tseltal and Yucatec participants sometimes do not see the agent as cause although his action led to the outcome—depending on whether intentionality to the action or to the outcome was present or not. In particular, the open answers of the Tseltal subjects reveal that causal story based answers were not limited to the presence of the A→O link.

To sum up, these findings suggest that for the attribution of causality, mental states like intentionality play a bigger role for the Tseltal and Yucatec participants compared with the German and Mexican Spanish subjects. Interestingly however, the intentional dimension is not present in the linguistic answers of the participants, as detailed in Section Linguistic Analysis of Open Answers below.

Limitations of the Study

Because our study is original and exploratory in various aspects, it has some limitations that we would like to point out for further comparative work.

First, we designed eight scenarios with abstract structures that were filled with different cover stories in order to prevent the task from being confusing or annoying for participants. Despite our best efforts, it seems that content did influence to some extent the interpretation of certain scenarios. However, this limitation is not critical for our study for two reasons. First, we could detect some content effects, as in the case of dreams for the Yucatec Mayas: some participants said, for example, that the man woke up because he dreamt of the event about to happen, which is, in accordance with the local concept of "fate"[14]. Second, content

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[14]This type of explanation was used for answers to some puzzling outcomes when the cover story implied a dream was under consideration. For instance, in scenario 4, the answer of one participant was that the man dreamed about the plates being broken just before they were actually broken, and woke up even though he had not heard them break. Precognition through dreams is an important principle, for it also explains why, for the Yucatec Mayas, things are not construed to just happen randomly and almost everything is ultimately attributed to "fate."

effects were minimized because each abstract structure was filled with different cover stories and tested with various participants (see Appendix 1 of Supplementary Material on the structure of the stories).

Sample size is another limitation that was almost inevitable in our case. It should be noted that recruiting willing participants in non-western nonacademic contexts is difficult and time-consuming. Our results, however, can be seen as primary data and future work can build on these findings.

Finally, a factor that could have been a limitation is that, while for both Maya populations and for the Mexican one the answer categories to the agency and counterfactual questions were read to them only once at the beginning of the task, for the Germans it was printed and thus available. It is possible therefore that "maybe" was not as salient as a possible answer as in the printed version. However, other studies run among the same Mayan groups by the same researchers would seem to point to the fact that not using "maybe" as an answer is habitual (Le Guen, 2006; Le Guen and Pool Balam, 2012).

Linguistic Analysis of Open Answers

The question that drove this study is whether people in different cultural groups have a similar understanding of causality and whether and how different cultural groups conceptualize exceptional, non-law-like relations between events (see Ojalehto and Medin, 2015 for a review). Specifically, we wanted to establish whether people from cultural settings other than the familiar Indo-European ones have concepts like "chance," "coincidence," or any other way to characterize non-obvious causal relations. The results from our comparative study in four cultures through the open, temporal question show that the construal of causality is culturally and linguistically driven. We found that German and Mexican students express non-law-like relations between events using concepts such as *Zufall* or *casualidad* ("(by) chance"), but neither of the Mayan groups expressed this idea, instead expressing the same events in a different way. Further, although the Mayan groups are culturally and linguistically related, they seem to have different ideas when judging non-law-like relations between events. Although both Mayan groups seem to put more emphasis on agency, Tseltal Mayas tend to segment a causal link into micro-causal links, i.e., enabling conditions that are distinct from the mind of the agent; they use the concept of *y-oloj* "by itself," "of its own volition" to suggest, for example, that the machete chopped the cornstalk down of its own accord without any input from the man. Yucatec Mayas, in contrast, tend to regard all events as predetermined and ultimately dictated by fate *(sweerte)* and God's will, i.e., independently of the mind of an agent (or guiding it without his or her knowledge). We turn now to the main concepts used in open answers in each language.

The German Notion of *Zufall*

In German, the notion of *Zufall* covers various concepts glossed in English as "chance," "randomness," "accident" but also "coincidence." In the responses of German participants, *Zufall* was used with all of those meanings.

In the German answers to the open, temporal question, the concept of *Zufall* was used when some links between events were

missing, in particular if the Action to Outcome was realized without any intentionality. However, *Zufall* was also used if there was only Intentionality to Outcome but without an Action to Outcome link. Participants seem to have used it as an explanation in non-causal scenarios to imply that there was "no (obvious) cause" to the outcome (e.g., scenario 4), similarly to the English idea of "coincidence," but also in causal scenarios to imply that the outcome was not intentional (like in scenario 6), closer to the notion of "accident" in English. Sometimes *Zufall* was used to express the realization of the cause itself. For instance, one answer to the question of why the outcome happened when the action took place in Scenario 7 was literally "through, by, or due to *Zufall*." Another answer to Scenario 2 was: "[it happened] because of *Zufall*." Such answers convey the heterogeneous meanings of *Zufall* in German to express the recognition of exceptional causation: on the one hand it is used to express the absence of a cause in a given scenario, on the other hand it is used—linguistically—to express a kind of cause.

Notions of Coincidence and Chance in Spanish

Spanish, like other Indo-European languages, has several ways of expressing the notion of non-law-like causal relations. Mexican participants used the words *coincidencia* "coincidence" (sc. 2, 3), *casualidad* "(by) chance" (sc. 4, 6), *buena suerte* "good luck" (sc. 7, 8) or *accidentalmente* "accidentally, by accident" (sc. 5, 7). In this respect Spanish is not significantly different from English or German. Because the language has words to express cultural concepts of non-law-like relations between events, participants have the resources to classify these events in comparable categories.

Yucatec Maya and the Notion of Sweerte "fate"

There is no native lexicon in Yucatec Maya that relates to a notion of non-law-like relations between events like "chance" or "coincidence." Lexical categories of this kind are borrowed from Spanish, and have been semantically altered in the process from their meanings in the source language.

One crucial notion is the one of *sweerte* "chance-fate." The word *sweerte* in Maya comes from the Spanish *suerte* meaning "luck," "chance" or "fortune." However, when borrowed into Maya, the term refers to some kind of chance but more generally implies "fate." Although *sweerte* in Maya can mean chance, it seems that ultimately, Yucatec Mayas consider that everything is meant to be, i.e., predetermined, so "good, bad or dumb luck" is written or determined by God. It is not uncommon to hear in everyday conversation regarding positive but also dramatic events (e.g., someone marrying an old lover or someone falling from a ladder to end up dead) the following expression: *bey usweerte máak* "that's people's fate" or *usweerte beya* "it was his/her fate like this," meaning that what happened to the person in question was his/her fate regardless of circumstances or his/her will. This idea was very explicit in many Yucatec Mayan participants' responses as well as in interviews conducted after the task: although the first meaning "luck" actually refers to "punctual luck" (e.g., the hunter while cleaning his gun, shoots the deer), ultimately, more detailed explanation leads

participants to say that it was fate. So luck is only a superficial reading of the event and not an explanatory recourse, ultimately everything can be explained by fate. In the counterfactual case, some participants agreed that the deer would have died anyway, maybe not in these particular circumstances but it would have died at this particular moment and the hunter would have killed a deer, maybe not this particular deer, but one deer.

In Yucatec Maya there is no word that encodes the concept of coincidence, although there are ways to express non-law-like relations (e.g., pointing to the simultaneity of events). One way is to use terms like "to think" or "to guess" with negation to refer to unplanned or fortuitous events. For Yucatec Mayas, foreseeing events or places (i.e., precognition) is considered to be actually possible. It is common to listen to people talking about dreams they have had about future events or distant places (see Groark, 2009 for a similar analysis among the Tsotsil Mayas).

The Tseltal Language of Causality and Non-causal Events

Tseltal has a range of ways of expressing "no causal outcome." Although there are no words in Tseltal for "by chance" or "accidentally," related ideas can be expressed using other expressions such as *jowil* "for no reason, to no (good) purpose," *ma'yuk y-ajwal* "there was no "owner" (of the deed), no one made it happen," or *s-tukel* "by itself, without external agent."

In contrast to Yucatec Maya, however, Tseltal Mayas in this task did not express strong views about fate or predetermined outcomes as an explanation for events. Instead, answers from Tseltal participants tended to decompose causal links into smaller causal chains. In particular, they used constructions with *y-oloj* which can be translated as "on purpose, deliberately, of his/its own volition." While prototypically this term is used to explicitly attribute intentionality to an agent ("He did it on purpose"), interestingly—and this is where the semantics differs from the English glosses—even inanimate things can make things happen "on purpose" or "by their own volition." The expression *y-oloj* is somewhat close to English "responsibility"—who is to be held responsible for making the thing happen. This expression is usually used to attribute responsibility for something bad happening, and differs from English "responsibility" in that it can apply to inanimates. For instance, one's heart will be "responsible" if one has a heart attack or it will be the mud, if one falls in the mud, etc. (see also Polian, forthcoming).

Tseltal participants had no difficulty in not attributing intentionality to the actor described in the task scenarios; they tended to generally break causal links into smaller ones suggesting that the presence of the agent's intention is not necessary to their interpretation. Hence in scenarios where the Action to Outcome link is not present (scenarios 2, 6, 7, and 8), Tseltal participants tended to use *y-oloj* "on its own responsibility," bypassing the agent in favor of another element in the event chain to characterize non-intentional causality. Using this concept of *y-oloj* in these contexts seems to skip over the mental state (they do not need to pay attention to the agents' intentions) and attribute causal force to another link in the chain

(e.g., to the instrument, or to the conditions in which the event occurred).

Cross-cultural Comparison of the Conceptualization of Causality

As already mentioned, it was frequently claimed by early ethnographers that members of many non-western cultural groups base a lot of their daily behavior on the principle of "magical thinking," mostly related to various kinds of taboos (Frazer, 1911; Lévy-Bruhl, 1922; Evans-Pritchard, 1937; Lévi-Strauss, 1990; Malinowski, 1992). It was especially emphasized by Evans-Pritchard that not only do assumed causes for specific events differ across cultures, but also the coincidence of selected events (for example, people sitting down, a granary collapsing) require an explanation. For people in most "western" cultures, it might be seen as "bad luck" for the particular Azande individuals who happened to be sitting beneath a granary which suddenly collapsed due to termites—the causal explanation of the granary collapsing (termites) and the reason why people had been sitting under this particular granary (sun protection) would be considered to be independent from one another. For the Azande, however, "[w]itchcraft explains the coincidence of these two events" (Evans-Pritchard, 1937, p. 70).

Although magical thinking can be seen to be present at times in every human group, in "western" cultures it is considered as superstitious and is generally denigrated, as among the German students in our case. It is however construed as a legitimate cause for illness and certain other outcomes among the Yucatec Mayas, for instance. Results from our task show that intentionality alone was not a sufficient criterion for participants of any of the groups to attribute causality. Nonetheless, for the agency and counterfactual questions intentionality played a slightly more important role for the Yucatec, and even more for the Tseltal, than for the German and Mexican Spanish participants.

These results taken together imply that, although magical thinking can be taken to be a legitimate operating principle in certain cultures, it is not applicable to all domains or situations: it might be a legitimate sole cause to explain illness or death, but not in more everyday situations like the ones presented in our scenarios. In other words, thinking of an outcome is not always considered sufficient to determine causality, or more precisely, thinking is not always performative (Austin, 1975).

CONCLUSION

Anthropologists as well as other social scientists often report that the way causality is inferred and interpreted is to some degree culturally shaped. Although it is not difficult to imagine how culture can influence the construal of causal relations between social actions and their effects (social causality), it is not always easy to demonstrate it through the collection of systematic data. Recent attempts to do so cross-culturally have shown that culture can influence attributions of causality even in sequences of physical events (physical causality; Bender and Beller, 2011a). Our cross-cultural study among four different groups is a comparable approach. Our results reveal a similar recognition of causality, showing that in all groups the Action-to-Outcome link was the most important for construing causality, more so than the Intention-to-Outcome or the Intention-to-Action links.

However, aside from these similarities there are very different interpretations cross-culturally of the relation between a cause and an outcome. What is striking from our study is the divergence in interpretation of exceptional (causal) relations across groups. While German and Mexican Spanish speakers have linguistic and cultural non-law-like concepts like *Zufall* or *casualidad* "chance, coincidence," the two Mayan groups do not. In the Tseltal case, events are often seen as intermediary causes having "their own volition" (*y-oloj*) while Yucatec Mayas reject coincidences and attribute everything ultimately to "fate" (*sweerte*) and God's will. The interpretation of non-law-like relationship explanations and hence the distinction between causal relations and accidental sequences thus strongly depends on the cultural setting.

SUPPLEMENTARY MATERIAL

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Moral asymmetries in judgments of agency withstand ludicrous causal deviance

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Americans have been shown to attribute greater intentionality to immoral than to amoral actions in cases of causal deviance, that is, cases where a goal is satisfied in a way that deviates from initially planned means (e.g., a gunman wants to hit a target and his hand slips, but the bullet ricochets off a rock into the target). However, past research has yet to assess whether this asymmetry persists in cases of extreme causal deviance. Here, we manipulated the level of mild to extreme causal deviance of an immoral versus amoral act. The asymmetry in attributions of intentionality was observed at all but the most extreme level of causal deviance, and, as we hypothesized, was mediated by attributions of blame/credit and judgments of action performance. These findings are discussed as they support a multiple-concepts interpretation of the asymmetry, wherein blame renders a naïve concept of intentional action (the outcome matches the intention) more salient than a composite concept (the outcome matches the intention *and* was brought about by planned means), and in terms of their implications for cross-cultural research on judgments of agency.

Keywords: blame, credit, action, intentional action, causal deviance, moral judgments

Introduction

Reasoning about causes is a fundamental aspect of human cognition. It is unlikely that causal cognition is a homogeneous phenomenon; the human mind is likely to have different causal competencies, which draw on different causal concepts or deploy similar causal concepts differently depending on context (see, e.g., Sperber et al., 1995; Danks et al., 2014). Here, we focus on the causal competencies deployed in the understanding of agency, both in terms of judging that an event is an intentional action, and judging that an event is an action at all. Reasoning about causes is fundamental to such judgments because they require an understanding of the causal links between mental states, bodily movements and succeeding events in the world, as well as an understanding of various interfering factors. In this article, we investigate how causal cognition drives judgments of agency, and how this varies depending on moral context.

We investigate judgments of agency in relation to events involving causal deviance, that is, events involving causal chains that are initiated by an agent, that lead to the satisfaction of the agent's intention, but that do not follow the agent's plan. For example, an agent intends to hit a target with his rifle, and indeed does hit the target, but not in the planned manner—instead of the bullet going directly into the target, it ricochets off a rock and into the target.

Our investigation relates to current work on asymmetries in judgments of intentionality indicating that people (primarily westerners) tend to judge the same type of action to be intentional

in moral contexts but unintentional in other contexts (for a review, see Cova, 2015). In our previous work with an American sample, we demonstrated this asymmetry in cases of mild causal deviance, and we argued for a multiple-concepts explanation in which distinct concepts of intentional action are selected in different contexts depending on considerations of blame and credit (see Sousa and Holbrook, 2010; for similar approaches, see Mele and Cushman, 2007; Nichols and Ulatowski, 2007; Cushman and Mele, 2008; Cova et al., 2012; Lanteri, 2013). Here, we extend our investigation to cases of more extreme causal deviance in order to explore further issues concerning judgments of action performance (i.e., judgments of whether an event is the action of an agent). With this extension, we shall explore the potential boundary conditions of the asymmetry in judgments of intentionality by experimentally probing the extent to which the asymmetry persists in conditions of extreme causal deviance.

In the first section, we characterize our multiple-concepts approach to the asymmetry in judgments of intentionality in cases of mild causal deviance and its relation to attributions of blame and credit. In the second section, drawing from our approach, we characterize our main hypotheses regarding cases of greater causal deviance. In the third section, we report an exploratory study of the extent to which judgments of intentionality and action performance occur at different levels of mild to extreme causal deviance and across amoral versus immoral contexts, and discuss its results in terms of our multiple-concepts approach and alternative explanatory models. We then point out some of the limitations of our current results and delineate some future avenues of research, before concluding with a general remark on pursuing cross-cultural research on the topic of causal cognition and judgments of agency.

Polysemy Masks Competing Concepts of Intentional Action

To illustrate the asymmetry in judgments of intentionality in cases of mild causal deviance, consider the following parallel scenarios involving amoral versus immoral shooting:

> John desperately wants to win the rifle contest [wants to have more money]. He knows that he will only win the contest if he hits the bull's-eye [that he will inherit a lot of money when his aunt Mary dies]. To win the contest [to kill his aunt], John raises his brand-new rifle and aims at the bull's-eye [Mary's heart], which is 150 feet away. John has never fired a gun before, and he has no natural talent for this type of thing. His hand slips on the barrel of the gun, and the shot goes wild... The bullet hits a rock situated 80 feet in front of John. He assumes he has completely missed the target. But what a surprise: the bullet actually bounces off the rock and goes directly into the bull's-eye [Mary's heart].

When asked whether the amoral action *hitting the bull's eye* is intentional, the majority of participants say that it is not intentional; when asked whether the immoral action *hitting the*

aunt's heart is intentional, the great majority of participants affirm that it is intentional[1].

Our multiple-concepts approach to the asymmetry in judgments of intentionality claims that the expression "intentional action" (or "acting intentionally") is polysemous: there are stable associations in people's minds between such phrases and distinct concepts of intentional action, although there may be substantial individual variation in terms of the relative strength of each association[2]. In particular, we claim that two distinct concepts of intentional action play a role in people's answers to the intentionality question in the above scenarios. In the first concept, which we call the *composite* concept, an action A of an agent S is considered intentional *only if* S had the intention to A and the causal chain constituting A follows S's plan to A, using "plan" in the specific sense of S's representation of the intended steps to satisfy S's intention to A (for a more complete characterization of this concept, see Sousa and Holbrook, 2010). With this concept in mind, in both amoral and immoral contexts, the action *hitting the target* is to be considered *not* intentional, since it does not follow S's plan to hit the target with the bullet going directly into the target (i.e., without the ricochet). In the second concept, which we call the *naïve* concept, an action A of an agent S is considered intentional *if and only if* S had the intention to A. With this concept in mind, in both amoral and immoral contexts, the action *hitting the target* is to be considered intentional, since it satisfies S's intention to hit the target.

Consistent with the psychological reality of this polysemy, when participants judge the action in question to be unintentional, they justify their judgment by emphasizing that plan-following is a necessary condition, in accord with our postulated composite concept. For example (see Sousa and Holbrook, 2010), they say:

> "...the means by which he hit the bull's-eye wasn't planned, and so the unintentional means of hitting the bull's-eye qualifies the hit as unintentional."

> "It is unintentional that the bullet bounced from the rock to the heart."

Moreover, in accord with our postulated naïve concept, when participants judge the action in question to be intentional, they justify their answer by emphasizing that plan-following is not a

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[1]This type of case was discussed initially in terms of the relevance of a skill component to the folk concept of intentional action (see Knobe, 2003; Malle, 2006; see also Malle and Knobe, 1997). However, we have shown that, in these types of scenarios, what people see as relevant for judging that the action of hitting the target is unintentional is the presence of causal deviance rather than the absence of skill qua a dispositional property of the agent (see Sousa and Holbrook, 2010).

[2]We have construed the polysemy of "intentional action" in terms of the expression of different concepts—a pluralist perspective. However, one could easily reinterpret our discussion of the polysemy at stake here in terms of the expression of different senses that are aspects of the *same* concept—a hybridist perspective. To decide between these two perspectives in relation to our topic, one would need a consensual criterion to individuate concepts, an issue without a clear resolution in the psychology of concepts (see Machery, 2009; Vicente and Manrique, 2014; see also Pustejovsky, 1995; Wilson and Carston, 2007). Thus, although we are phrasing our approach in pluralistic terms, we are open to a hybridist interpretation.

necessary condition and suggesting that intention satisfaction is a sufficient one. For example (see Sousa and Holbrook, 2010), they say:

> "John's goal was to hit the bull's-eye. He did not hit it in the manner in which he intended, but his intention to hit the bull's-eye never changed."

> "... because the effect of hitting his aunt's heart was still there. He accomplished his goal, even if it was indirectly."

Crucially, the relative salience of whether the intention was satisfied (the naïve concept) as opposed to whether the intention was satisfied by planned means (the composite concept) tracks the relative importance of these factors to concepts of blame/credit across immoral and amoral contexts. For the attribution of blame in an immoral context such as the killing of the aunt, the immoral intentions (i.e., the intentions closely connected with immoral motivations), rather than the manner in which they are satisfied, are the most relevant factor, since the type of decision that the agent makes (e.g., to commit murder) determines the moral evaluation of the agent. Thus, for the great majority, the naïve concept is more salient in the immoral context, leading them to respond to the intentionality question in terms of whether the intention was satisfied—and accordingly to judge the action to be intentional. By contrast, for the attribution of credit in an amoral context such as the rifle contest, people respond as if they are divided between the two competing naïve and composite concepts (for more details, see Sousa and Holbrook, 2010). Many take the manner in which the intention is satisfied as fundamental, since for them whether the goal is achieved in a planned and skillful (rather than merely lucky) manner determines the merit of the agent. For these individuals, the composite concept is the most relevant. However, many people also discount the manner in which the amoral intention is satisfied, and therefore favor the naïve concept. Thus, overall, fewer people in the amoral context will interpret the intentionality question in terms of the naïve concept and judge the action to be intentional—hence, the asymmetry in judgments of intentionality.

Extreme Causal Deviance

With the composite concept of intentional action in mind, any deviance from the planned means of achieving the goal should lead one to judge an agent's action to be unintentional. In cases where the naïve concept is in mind, however, it is less clear what effect different levels of causal deviance might exert on judgments of intentionality. For example, returning to John's killing of his aunt Mary as an example, suppose that John's bullet misses Mary by a mile, but the report of the rifle stampedes a herd of wild pigs that tramples Mary to death (cf. Davidson, 1980). Insofar as such extreme deviance precludes the categorization of the events leading to Mary's death as an action of John, let alone as an intentional action of John, most people may deny that John killed Mary intentionally—even with the naive concept in mind. In other words, the denial of intentionality in this case would be due to a problem with the superordinate folk concept of action; presumably, if not *S's A*, then not *S's intentional A*. Thus, it is possible that in extreme cases of causal deviance the asymmetry in

judgments of intentionality would vanish, since, in both immoral and amoral contexts, most people would deny intentionality.

A few remarks about the complementary folk concepts of action and agent (i.e., the doer of the action) are in order to explicate the above hypothesis. According to the folk concept of action, an action A is an event (i) whose description fits the scheme "what agent S did was ..." and (ii) whose agent S is interpreted as the causal producer of the causal chain constituting the action A[3]. Consider whether the following sentences encode action concepts in this sense:

(a) The door is open (− event; − action)

(b) The door closed (+ event; − action)

(c) The wind closed the door (+ event; + action; − animate agent)

(d) John opened the door (+ event; + action; + animate agent)

Sentence (a) describes a state, which by definition cannot be an event; therefore it does not encode an action concept. Sentence (b) describes something that happened to the door (i.e., the closing of the door was not something that the door did), and therefore does not encode an action concept either. Sentences (c) and (d) describe what the wind and John did (i.e., close or open the door) and these entities can be interpreted as causal producers of the door closing or opening; therefore, these sentences encode two different action concepts.

Sentences encoding action concepts are often neutral with regards to the intentionality of the action[4], although they preclude intentionality features when they involve an inanimate agent, and they encode intentionality when its verb encodes intentionality. Consider the following sentences:

(e) John killed Mary (+ animate agent; ± intentionality)

(f) The wind closed the door (− animate agent)

(g) John murdered Mary (+ animate agent; + intentionality)

Sentence (e) is neutral with regards to the intentionality of the action—a sentence like "John killed Mary intentionally (or unintentionally)" would be intelligible. Sentence (f) precludes intentionality features because in involves an inanimate agent—strictly speaking, a sentence like "the wind closed the door intentionally (or unintentionally)" is not intelligible. Finally, sentence (g) encodes intentionality because the verb "to murder" encodes intentionality—strictly speaking, a sentence like "John murdered Mary unintentionally" is not intelligible, and a sentence like "John murdered Mary intentionally" is redundant.

Ordinary action descriptions in the sense of action we characterized may incorporate an unfolding causal chain of

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[3]Our characterization here is inspired by work on thematic relations and semantic macroroles in Semantics (in particular, see Jackendoff, 1990, chapter 7; Jackendoff, 2007, chapters 6 and 8; see also Van Valin and Wilkins, 1996). For discussions of cross-linguistic differences concerning constraints on the type of entity that may be understood as a causal producer, see Wolff et al. (2009) and Kanero et al. (2015).

[4]For some cross-linguistic differences in this regard, see Fausey et al. (2010) and Fausey and Boroditsky (2011).

events[5]. Consider the following sequence of events: John opens the door; Mary, who is inside the room, startles; Mary suffers a heart attack; Mary dies. One can describe this sequence of events by saying simply, "John killed Mary." This description refers to only one action (John's killing of Mary), an action incorporating all the events of the sequence (John's opening the door, Mary's startle, her heart attack, and her death)[6]. Also, consider the following sequence of events: John pulls the trigger; the gun discharges; the bullet goes directly into Mary's heart; Mary dies. One can describe this sequence of events by saying simply, "John killed Mary." This description refers to only one action (John's killing Mary), an action incorporating all the events of the sequence (John's pulling the trigger, the gun's discharge, the bullet going into Mary's heart, and Mary's death). Finally, consider the exact same sequence of events as the last one, except that the bullet ricochets off the rock and directly into Mary's heart. Again, one can describe this sequence of events by saying simply, "John killed Mary." This description refers to only one action (John's killing Mary), an action incorporating all the events of the sequence (John's pulling the trigger, the gun's discharge, the bullet bouncing off the rock and going into Mary's heart, and Mary's death).

The folk concept of action may imply constraints on the amount and types of constitutive events an agent's action can incorporate. Plausibly, the longer the unfolding causal chain, the less one may envisage the original agent as the causal producer of the final effect of the chain, and hence the less one may think that the final effect could be part of an action of the original agent. For instance, in relation to the startle example above, suppose an extended sequence of events were to transpire: Mary suffers a heart attack; still alive, Mary is sent to the hospital; the ambulance suffers a flat tire and crashes due to a nail in the road, further injuring Mary; Mary dies due to the crash injuries. Can Mary's death still be described as part of an action "John killed Mary," or is it rather more appropriate to say that the crash injuries killed Mary? Further, it may be the case that events in the unfolding causal chain that involve animate agents may make one think less of the original animate agent as the causal producer of the final effect of the chain. For instance, returning to the shooting examples above, suppose that the bullet misses Mary by a mile; the shot stampedes a herd of wild pigs; the wild pigs trample Mary; Mary dies. Would Mary's death still be described as part of "John killed Mary," or would people be more inclined to say that the pigs killed Mary?

Returning to our hypothesis and the issue of causal deviance, the startle scenarios described above do not qualify as instances of causal deviance, since John did not intend or have a plan to bring about Mary's death. By contrast, the ricochet death scenario constitutes a case of mild causal deviance, and the stampede death scenario constitutes a case of extreme causal deviance. We propose that the naïve concept of intentionality should not be invoked in

cases of extreme causal deviance to the extent that constraints on the amount and/or types of events that an action of an agent could incorporate deter participants from viewing the event as an action of the agent[7]. Accordingly, in cases of extreme causal deviance, the asymmetry in judgments of intentionality may disappear along with the perception that the agent performed the action.

On the other hand, it is possible that the effect of causal deviance on judgments of action performance might differ by moral context, with more people judging the event as an action of the agent in immoral contexts than in amoral ones. It is plausible that, in the immoral context, the attribution of blame renders the agent more salient as the causal producer of the intended outcome, making deviant causal chains more tolerable and judgments of action performance more resilient. If this were the case, we might expect the asymmetry in ratings of intentionality to persist even at high levels of causal deviance, in parallel with an asymmetry in judgments of action performance.

Whether or not extreme causal deviance negates the asymmetry in intentionality judgments, our key point is that these judgments should closely track judgments of action performance. Similarly, to the extent that blame attributions inherently attract participants to the naïve concept of intentionality by highlighting the salience of the actor's immoral intentions, we claim that the asymmetry in intentionality judgments should persist despite extreme causal deviance only to the extent that high attributions of blame persist.

Study

To explore the aforementioned hypotheses, we presented people with scenarios describing five levels of causal deviance, from mild to quite extreme, and asked them to make judgments of blame/credit, action performance, and intentionality.

Method

Participants

Three hundred and ten participants were recruited via Craigslist.org to volunteer for an unpaid online study advertised as a "10-minute Action Survey" from regions across the United States. Four participants were removed prior to analysis for having provided incomplete responses, leaving a sample of 306 participants (48% female). Participation took place online.

Design, Materials, and Procedures

All participants gave their informed consent to participate in the study. The protocol of the study was approved by the ethics committee of the School of History and Anthropology, Queen's University, Belfast. The study was carried out following the guidelines and recommendations of the same committee. In a 2 (immoral versus amoral context) × 5 (deviance level) between-subjects design, each participant was presented with one of 10 vignettes (∼30 participants per vignette). The five immoral and amoral vignettes started with the following scenarios, respectively.

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[5]For related discussions, see Feinberg's (1970a) remarks about the accordion effect of action descriptions, work on lexical and periphrastic causatives (e.g., Fodor, 1970; Wolff and Gentner, 1997; Dixon, 2000; Wolff et al., 2009), and work on event segmentation (e.g., Bohnemeyer et al., 2010).

[6]It is important to note that while Mary's death is a causal consequence of the action *opening the door*, it is an effect internal to the action *killing Mary*. In other words, while one could say, "John caused Mary's death by opening the door," one could not say, "John caused Mary's death by killing Mary" (cf. Goldman, 1970).

[7]A similar issue arises in the legal system when, in cases where the (intended) causation of death involves extreme causal deviance, one tries to argue that the crime is one of attempted murder instead of murder (for a related discussion, see Sousa, 2009).

Immoral

For no particular reason, Sam wants to upset his neighbor. In order to so, he plans to break the neighbor's beloved vase inherited from his grandmother. The vase is positioned in the neighbor's front yard, 100 m away from Sam. He raises his rifle and aims at the center of the vase. Sam is completely sure about his decision, but he is not skilled with rifles. He pulls the trigger, but the shot goes wild.

Amoral

Fred wants to win a game. In order to do so, a vase has to be broken. The vase is positioned in a field, 100 m away from Fred. He raises his rifle and aims at the center of the vase. Fred wants to win the game, but he is not skilled with rifles. He pulls the trigger, but the shot goes wild.

All vignettes ended with, "The vase is broken." *The neighbor is devastated* (or *Fred wins the game*). In between, one of the following five levels of causal deviance was described.

Level 1

However, the bullet bounces off a rock and hits the vase.

Level 2

However, the bullet bounces off a rock and hits the tire of a passing car. The car veers out of control into the *front yard* (or *field*) and strikes a post. The post falls onto a tree, breaking off a branch. The branch falls onto the vase.

Level 3

However, the bullet bounces off a rock and hits the tire of a passing car. The car veers out of control into the *front yard* (or *field*) and strikes a post. The post falls onto a tree, breaking off a branch. The branch falls onto an unsteady log, setting it in motion. The rolling log hits an old, forgotten mousetrap. The spring-loaded trap is launched into the air, landing right next to a squirrel. The squirrel is startled and runs. The squirrel accidentally bumps into the vase. The vase falls over and rolls several feet. The vase hits a pointy rock.

Level 4

However, the bullet bounces off a rock and hits the tire of a passing car. The car veers out of control into the *front yard* (or *field*) and strikes a post. The post falls onto a tree, breaking off a branch. The branch falls onto an unsteady log, setting it in motion. The rolling log hits an old, forgotten mousetrap. The spring-loaded trap is launched into the air, landing right next to a squirrel. The squirrel is startled and runs. The squirrel runs past a dog and the dog begins to chase the squirrel. The dog chases the squirrel around the *yard* (or *field*) for several minutes. While running, the dog slips and accidentally bumps into the vase. The vase falls over and rolls several feet. The vase hits a pointy rock.

Level 5

However, the bullet bounces off a rock and hits the tire of a passing car. The car veers out of control into the *front yard* (or *field*) and strikes a post. The post falls onto a tree, breaking off a branch.

The branch falls onto an unsteady log, setting it in motion. The rolling log hits an old, forgotten mousetrap. The spring-loaded trap is launched into the air, landing right next to a squirrel. The squirrel is startled and runs. The squirrel runs toward a young boy and his father who are walking around the *neighborhood* (or *field*). The young boy begins to chase the squirrel back into the *yard* (or *field*). The squirrel soon runs out of sight. In frustration, the boy mindlessly picks up the vase and throws it in the direction of the squirrel.

For each scenario, three questions were asked in fixed order: (i) How much credit [blame] does Fred [Sam] deserve? (ii) Does it sound right to say that "Fred [Sam] broke the vase"? (iii) Does it sound right to say that "Fred [Sam] broke the vase intentionally"? As is usually done in the literature (see Knobe, 2003), the credit/blame question appeared first to offer participants a way of explicitly communicating their (moral) evaluation separately and to free them to pursue a literal answer to the subsequent questions. Otherwise, given the prototypical association between intentionality and blame, many participants may avoid saying that the immoral act is unintentional just because, if they were to say that, they would give the idea that they do not blame the immoral agent. Because we wanted to allow participants to clearly envisage the logical relation between the action performance and the intentionality questions, we positioned the former question before the latter.

All questions were answered on a 7-point Likert scale anchored as "0 = *None*; 3 = *Medium*; 6 = *Full*" for the credit/blame question, and as "0 = *Totally wrong*; 3 = *In between*; 6 = *Totally right*" for the action performance and intentional action questions. Participants were asked to justify their answer to each of the three questions, which they did by writing down their justifications in open response boxes.

Results

Judgments

Mean ratings of blame/credit, action performance, and intentionality by moral context and deviance level can be found in **Table 1**. Preliminary analyses showed that all three ratings of credit/blame, action, and intentionality were positively intercorrelated, rs ranging from 0.55 to 0.65, ps < 0.001.

A multivariate two-way between-subjects ANOVA revealed a significant main effect of moral context on all three ratings, $F_{(3,294)} = 44.52$, $p < 0.001$, $\eta_p^2 = 0.31$. In line with previous findings, participants in the immoral condition provided higher ratings of both blame/credit and intentionality for the action of breaking the vase; ratings of action performance were also higher in the immoral condition (see **Table 2**)[8]. The model also revealed a significant main effect of deviance condition, with ratings of all three measures diminishing with successive increases in the level of causal deviance, $F_{(4,296)} = 27.47$, $p < 0.001$, $\eta_p^2 = 0.27$ (see **Figure 1**). However, the drop was least sizable in

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[8]The distributions for all three ratings significantly differed between the amoral and immoral context condition due to the right-skewed pattern of judgments produced in the immoral condition. Accordingly, non-parametric Mann–Whitney U tests were conducted as well, confirming that the effects of moral condition were highly significant for all three ratings, ps < 0.001.

TABLE 1 | Mean Ratings of Credit/Blame, Action, and Intentionality by Moral Context and Deviance Condition.

	Level 1 Mean (SD)	Level 2 Mean (SD)	Level 3 Mean (SD)	Level 4 Mean (SD)	Level 5 Mean (SD)
Immoral Context					
Blame	5.87 (0.43)[a]	5.89 (0.32)[a]	5.23 (1.25)[a,b]	5.10 (1.60)[b,c]	4.73 (1.95)[b,c]
Action	5.77 (0.67)[a]	4.43 (1.87)[b]	4.30 (1.84)[b,c]	3.52 (1.88)[c]	2.53 (2.16)[d]
Intentionality	5.71 (1.19)[a]	5.14 (1.33)[a,b]	4.67 (2.06)[b]	4.26 (2.37)[b]	2.80 (2.37)[c]
Amoral context					
Credit	3.93 (2.13)[a]	3.06 (2.50)[a,b]	2.59 (2.47)[b]	2.08 (2.49)[b]	2.55 (2.34)[b]
Action	4.87 (1.57)[a]	2.81 (2.35)[b]	2.90 (2.21)[b]	1.53 (1.89)[c]	1.72 (2.00)[c]
Intentionality	4.30 (1.97)[a]	3.00 (2.40)[b]	2.90 (2.61)[b,c]	1.86 (2.27)[c,d]	1.93 (2.33)[b,c]

N = 306. Row means that do not share a superscript letter are significantly different with alpha at 0.05.

TABLE 2 | Mean Ratings of Credit/Blame, Action, and Intentionality by Moral Context.

	Immoral Mean (SD)	Amoral Mean (SD)	F	p	η_p^2	95% CI
Blame/credit	5.36 (1.35)	2.82 (2.45)	124.98	<0.001	0.29	−2.99, −2.09
Action	4.11 (2.05)	2.72 (2.32)	30.76	<0.001	0.09	−1.88, −0.90
Intentionality	4.51 (2.51)	2.77 (2.46)	43.51	<0.001	0.13	−2.26, −1.22

N = 306. These means pool across the deviance conditions of the entire sample.
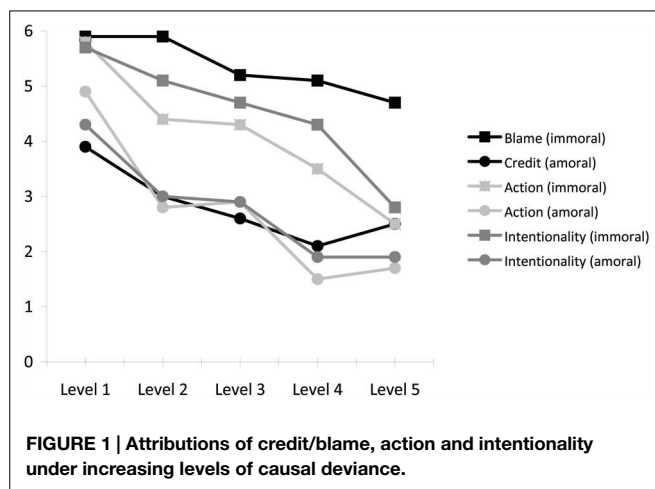
FIGURE 1 | Attributions of credit/blame, action and intentionality under increasing levels of causal deviance.

the blame measure. There was no significant Context × Deviance interaction, $p = 0.186$.

Follow-up analyses confirmed that, in the first four causal deviance conditions, all three ratings significantly differed between the amoral versus immoral conditions, with ps ranging from 0.01 to −0.000001, η_p^2 values from 0.11 to −0.38, and confidence intervals never crossing 0. However, there was no significant difference between the amoral and immoral conditions at the fifth and most extreme level of causal deviation with respect to ratings of action performance, $p = 0.14$, $\eta_p^2 = 0.04$, 95% CI = (−1.90, 0.28), or intentionality, $p = 0.16$, $\eta_p^2 = 0.03$, 95% CI = (−2.09, 0.36). In the case of credit/blame judgments, the effect of moral condition remained robust at the most extreme level of causal deviance, $p < 0.001$, $\eta_p^2 = 0.21$, 95% CI = (−3.30, −1.06).

Next, we conducted a series of mediation tests to assess the contributions of attributions of credit/blame and of action

performance to the heightened ratings of intentionality. We utilized the bias-corrected bootstrapping procedure (5,000 samples) found in the INDIRECT macro for SPSS (Preacher Hayes, 2008).

We first assessed the influence of attributions of credit/blame on intentionality ratings by entering moral context as the independent variable, ratings of credit/blame as the potential mediator, and intentionality ratings as the outcome variable, controlling for action performance attributions as a covariate. In the model, attributions of credit/blame fully mediated the effects of the morality manipulation on ratings of intentionality. The direct effect of moral context on intentionality ($b = 0.85$, SE $= 0.22$, $p < 0.001$) was no longer significant with ratings of credit/blame included in the model ($b = 0.24$, SE $= 0.24$, $p = 0.31$), whereas the indirect effect of credit/blame on rated intentionality was significant ($b = 0.31$, SE $= 0.06$, $p < 0.001$), and the confidence intervals did not overlap with 0 [95% CI $=$ (0.34, 0.93)].

Then, we assessed the contribution of attributions of action performance to intentionality ratings by entering action performance attribution as the potential mediator. In this model, the direct effect of moral context on intentionality ($b = 1.74$, SE $= 0.26$, $p < 0.001$) was approximately halved, yet remained highly significant ($b = 0.85$, SE $= 0.22$, $p < 0.001$). The indirect effect of action attribution on rated intentionality was significant ($b = 0.65$, SE $= 0.05$, $p < 0.001$), and the confidence intervals did not overlap with 0 [95% CI $=$ (0.58, 1.25)]. Thus, judgments of action performance partially mediated the effects of moral context on intentionality ratings.

Justifications

Consistent with the existence of the naïve concept of intentional action postulated by our multiple-concepts approach, the great majority of justifications for high ratings of intentionality, across

contexts and levels of deviance, emphasized the fact that the agent satisfied his intention. For example, in relation to the immoral context characterized by higher intentionality ratings, participants said:

"He intended to break the vase and succeeded. The alternate circumstances are irrelevant." (Deviance level 1)

"Sam's intention was fulfilled." (Deviance level 2)

"That was his intention from the beginning." (Deviance level 3)

"Sam intended to do this and the events lead to that result." (Deviance level 4)

"Sam intended to break the vase, and the vase was broken as a result of his actions." (Deviance level 5)

Likewise, consistent with the existence of the composite concept of intentional action postulated by our multiple-concepts approach, participants across contexts and levels of deviance emphasized the fact that the causal chain did not follow the agent's plan. For example, within the amoral context characterized by lower ratings of intentionality, participants said:

"He didn't mean to break the vase with a ricochet. He meant to hit it directly and break it." (Deviance level 1)

"Fred's intention was to break the vase but there was no way that he could have intended for all those random things to happen in order the break the vase." (Deviance level 2)

"He was aiming straight at it and missed—his intention would not have been to break a vase by crashing a car and so forth." (Deviance level 3)

"While he had the intention of breaking the vase, the means by which it happened was totally random and accidental." (Deviance level 4)

"Although he did intentionally mean to break the vase, the vase did not break in the way that he had initially and intentionally meant it to." (Deviance level 5)

In accord with the premise that perceptions of the agent as not having brought about the outcome would lower attributions of intentional action, participants with lower ratings of intentionality often emphasized the fact that the outcome was not an action attributable to the agent by explicitly observing that the agent did not break the vase. These justifications were predominant at higher levels of causal deviance, particularly at the fifth level where, given the causal intervention of the young boy, the breaking of the vase could be easily attributed to another agent. For example, in justifying their low ratings of *intentionality* at the fifth and most extreme level of causal deviance, participants said:

"Again he caused the events, [but] he did not break the vase." (Amoral context)

"Fred was not the one who broke the vase." (Amoral context)

"He didn't do the breaking the little boy did." (Immoral context)

"Sam intended to break the vase, but ultimately, he did not break it. The young boy broke the vase." (Immoral context)

"Sam had intention to break the vase, yes, but he didn't break it." (Immoral context)

As with the asymmetry in judgments of intentionality, we observed a parallel asymmetry in judgments of action performance in the first four levels of causal deviance.

Consistent with our explanation, participants produced higher ratings of action performance in the immoral context, and often emphasized the fact that the agent had caused the outcome. For example, they said:

"Because yes he did break the vase, just not with the bullet, he was the one that made the car hit the pole and knock the branch down." (Deviance level 2)

"Yes because no matter how it was done, it got broken because of his actions." (Deviance level 2)

"He was the root cause." (Deviance level 3)

"He caused it to happen by shooting the gun." (Deviance level 3)

"Sam created a chain of events that ended in breaking of the vase." (Deviance level 4)

"Sam did break the Vase. He was the one who pulled the trigger that broke the vase." (Deviance level 4)

Discussion

We have advocated a multiple-concepts approach to the asymmetry in judgments of intentionality observed in mild cases of causal deviance (Sousa and Holbrook, 2010). Here, we experimentally manipulated the degree of mild-to-extreme causal deviance across immoral and amoral contexts. As we predicted, the asymmetry in judgments of intentional action was reduced by the causal deviance manipulation in proportion to the diminution in attributions of blame/credit and of action performance, both of which contribute to the selection of the naïve concept of intentional action[9]. Further highlighting the intrinsic connection between the intentionality asymmetry and perceptions of the actor as to blame/credit and as the performer of the action, the effect of moral context on intentionality attributions was mediated by both blame/credit ratings and (partially) by action performance ratings. Finally, participants' justifications for their ratings of intentionality and action performance were largely consistent with our overall approach. In sum, the present results show that the asymmetry in intentionality ratings persists in more dramatic extremes of causal deviance, and accord with our multiple-concepts interpretation of the asymmetry.

As well as being consistent with our multiple-concepts approach, the evidence is also a better fit with our approach than with other prominent models.

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[9]Although blame ratings shifted downward with increasing degrees of causal deviance, they remained quite high even at the most extreme level. This is consistent with our hypothesis that attributions of moral blame focus primarily on immoral intentions (see also Sousa, 2009).

Modulations of judgments by moral context are typically explained in two basic ways. Some claim that moral considerations *distort* the application of otherwise non-evaluative concepts, making the related judgments depart from some normative standard. For example, Alicke (1992, 2000, 2008) argues that participants' judgments of agency in immoral contexts are the result of a blame validation mode of processing characterized by the desire to blame the agent, which supposes that their judgments depart from the way one *ought to* judge. Alternatively, Knobe and colleagues claim that moral considerations are *constitutive* of the conceptual competence related to judgments of agency and other closely related judgments (Knobe and Fraser, 2008; Hitchcock and Knobe, 2009; Pettit and Knobe, 2009; Knobe, 2010; but see Knobe's previous approaches in Knobe, 2003, 2006; Knobe and Burra, 2006). According to this perspective, there is no distortion involved in participants' judgments of agency in the immoral context—these judgments simply reflect how our conceptual competence normally works, as it is constituted by moral considerations.

Our approach differs from both of these perspectives in several respects. First, our multiple-concepts approach provides an alternative explanation of the asymmetry in judgments of intentionality. In contrast with Alicke's explanation, the multiple-concepts account does not entail distortion in the judgments of intentionality of our participants, let alone a distortion driven by moral considerations. Rather, participants tend to bring to bear the naïve concept in immoral contexts because it is most salient given the importance of the immoral intentions to considerations of moral blameworthiness. This probabilistic bias in concept selection should not be conflated with the purported distortion of the application of a single concept of intentional action (Note that our point here stands even if our approach is interpreted in terms of hybridism—see text footnote 2). Given that there is no convincing normative standard from which participants' answers in the immoral context depart (see also Sousa and Holbrook, 2010), we believe the multiple-concepts approach provides a better explanation than Alicke's. Moreover, in our current results the effect of moral context on intentionality attributions was partially mediated by action performance ratings, suggesting that participants are deploying their conceptual competence in a logically coherent way, not in a way that departs from some normative standard.

Now, while our explanation of the asymmetry gives prominence to blame considerations, Knobe's current account of the constitutive influence of moral considerations excludes any reference to blame: "... the account makes no mention at all of blame" (Knobe, 2010, p. 328). Thus, while our account predicts our current results showing that the effect of moral context on intentionality attributions was fully mediated by blame/credit ratings, Knobe's account is not consistent with these results. Also, although Knobe has specified how his account could explain the intentionality asymmetry in the context of side-effects, it is doubtful that his account can explain the intentionality asymmetry in the types of lucky contexts related to our results (see Cova, 2015). Finally, Knobe has criticized those who postulate a polysemy to explain the asymmetry in judgments of intentionality by saying that this type of approach could not lead to a unified explanation of the range of moral asymmetries found in the current literature, as one would have to postulate an *ad hoc* polysemy for each of the asymmetries, which seems quite implausible. However, we do not see any good reason for pursuing a unified explanation for all the moral asymmetries found in the literature (Hindriks, 2014; see also Sousa and Mauro, 2015).

The second important difference between our approach and the accounts offered by Alike and Knobe relates to our explanation of the asymmetry in attributions of action performance. Both of the alternative perspectives suggest that, akin to their accounts of the asymmetry in judgments of intentionality, blame motivations or constitutive moral considerations would explain the asymmetry in attributions of action performance (see also related discussion in Reuter et al., 2014). Our explanation for the inflated ratings of action performance in the immoral context as owing to increased causal salience due to blame considerations does not seem consistent with either Alicke's or Knobe's perspective, as our explanation entails simply that the general concept of action is highly underspecified and hence susceptible to a variety of contextual specifications driven by different factors (Note that we are not postulating polysemy in relation to the folk concept of action). Contrary to Alicke's approach, there are no evident normative standards that judgments of action performance would be violating in the immoral context. Contrary to Knobe's approach, moral considerations do not seem plausibly built into the general concept of action. However, further research on the structure of the general concept of action, and of the determinants of whether event sequences are categorized as coherent actions, is required to understand the asymmetry documented here, and the plausibility or compatibility of these different explanations.

Falkenstien (2013) replicated the asymmetry in intentionality judgments dealing with cases of luck due to lack of skill and provided a different type of explanation that, as her model suggests, could be potentially extended to both of our agency asymmetries. Falkenstien utilized a version of Knobe's (2003) original skill scenarios, which are quite similar to the scenarios we described initially, except that they do not include the ricochet aspect:

> Jake desperately wants to win the rifle contest [to have more money]. He knows that he will only win the contest if he hits the bulls-eye. [He knows that he will inherit a lot of money when his aunt dies. One day, he sees his aunt walking by the window.] He raises the rifle, gets the bull's-eye [her] in the sights, and presses the trigger. But Jake isn't very good at using his rifle. His hand slips on the barrel of the gun, and the shot goes wild... Nonetheless, the bullet lands directly on the bull's-eye [hits her directly in the heart]. Jake wins the contest [She dies instantly].

The explanation proposed by Falkenstien to the asymmetry in intentionality judgments related to the above scenarios is based on the idea that these scenarios lead participants to raise different types of questions, and that these questions influence their ratings of intentionality. According to her, the scenarios influence the questions that participants consider in the following way:

When the sharp-shooter shoots at a target [the bull's-eye], it seems irrelevant to ask, "Why did he want to hit it?" After all, wouldn't anyone in his position have done the same thing? It seems much more interesting to ask, "How did he manage to succeed?" since it is rather surprising that he won, given his lack of skill. But when the sharp-shooter shoots at his aunt, a question like "Why did he want to shoot her?" suddenly seems very relevant; in addition to wondering how he succeeded, a reader also probably wonders what made him do such an awful thing. (Falkenstien, 2013, p. 298)

According to Falkenstien, these divergent questions have the following downstream effects on participants' perceptions of intentionality:

(...) when observers focus on questions that draw attention to the actor's mental states, they are more likely to be aware of the actor's intentions and thus find the action intentional. For example, when the relevant question is, "How did the actor manage to succeed?," the answer doesn't invoke the actor's intentions at all. He succeeded because he was lucky. The circumstances, not his intentions, answer the question. However, when the relevant question is "Why did he shoot at his aunt?," it draws attention to the actor's choice to act the way he did. That kind of question forces the observer to notice the importance of the actor's decision (above and beyond his circumstances): the event hinged on the decision of the actor. That subconscious consideration of the actor's intent, drawn out through consideration of certain questions, makes people judge the action to be intentional. (Falkenstien, 2013, p. 298)

This explanation does not seem plausible. First, Falkenstien does not provide any evidence that participants consider the why-question in the context of the immoral scenario and the how-question in the context of the amoral scenario, and, at least in relation to the immoral scenario, it appears doubtful that the why-question would be raised in the minds of participants, since the scenario explicitly states about the motivation of the agent. Given that the immoral scenario is fairly explicit about the intention to kill the aunt for inheritance money, why would a participant raise a why-question concerning the motive of the shooting?

Moreover, Falkenstien does not provide any evidence for her claim that participants who rate the action as unintentional do not take into account the mental states of the protagonist, focusing only on a type of luck that is independent of considerations of mental states and/or on the lack of skill qua a dispositional property of the agent. Actually, in our previous research, we also probed scenarios similar to Knobe's original scenarios (i.e., scenarios without a ricochet), and most participants justified their answer that the action was unintentional in terms of causal deviance, which includes considerations of mental states (Sousa and Holbrook, 2010; see also text footnote 1). For example, they said:

Jake may have been intending to hit the bull's-eye, but instead he slipped and got lucky. The slip was

unintentional, and therefore the shot resulting from it was also unintentionally aimed.

...because his hand slipped and he didn't mean to fire the gun at that point in time.

In other words, most participants interpreted these skill scenarios in terms of a departure from the *plan* of the agent—the goal was satisfied but not *in the way intended*.

Finally, our multiple-concepts approach furnishes an arguably better explanation of Falkenstien's own results, which undermines the plausibility of extending her model to explain our results. In her first two studies, she found that when participants were explicitly asked which question, the why- or how-question, seemed more relevant to the immoral versus amoral scenarios, they tended to pick the why-question in the immoral scenario and the how-question in the amoral one. However, this can be easily explained in terms of participants' concerns with immoral blame and amoral praise, as we have discussed. More importantly, in her last study, she manipulated the questions by priming participants with the why- or how-question in relation to the immoral and amoral scenarios (i.e., by making participants think about either the why- or how-question in relation to each of the scenarios), finding that this manipulation *only* influenced ratings of intentionality in the amoral scenario. While this result conflicts with her explanation, it can be readily explained by our model. Only the naïve concept is relevant for most participants in the immoral context—hence, the null effect of question priming—whereas both concepts are salient to participants in the amoral context—hence, the effect of question priming (For more detailed evidence on the fact that both concepts are salient in the amoral context, see Sousa and Holbrook, 2010). In sum, our approach appears to accommodate both the present data and Falkenstien's own results.

Limitations and Future Directions
Our data provide clear grounds to conclude that the asymmetry in judgments of intentionality is robust to manipulations of all but the most extreme degrees of causal deviance, and that the asymmetry is contingent on attributions of blame/credit and action performance. These findings can be explained by our multiple-concepts approach. However, the results must be considered preliminary pending further research that addresses limitations of the present work.

Building on the present "proof-of-concept," future studies should examine more precisely the different variables that may influence perceptions of action performance. For example, investigators should manipulate both the number and temporal duration of the causal steps intervening between the initial action of the agent and the final effect of the causal chain. Plausibly, the most determinative variable will be that of the involvement of other agents. Our findings suggest that the voluntary interference of another human agent (as in our most extreme causal deviance condition) constitutes a clear boundary condition with regards to the perception of the outcome as stemming from the initial agent. Follow-up studies might interpose the involvement of an agent earlier in the sequence of events—both asymmetries may well have been eliminated had we depicted the boy as having broken

the vase much earlier in the unfolding causal chain. Indeed, the voluntary interference of another human agent may cancel the understanding of the event as an action of the original agent quite independent of other variables, for, at least under certain circumstances, people may accord a very special causal role to voluntary actions (for related discussions, see Hart and Honore, 1959; Feinberg, 1970b; Hilton et al., 2009).

We have highlighted the role of moral context, empirically contrasting immoral and amoral scenarios. Future extensions of this research should assess asymmetries with regard to actions that are morally praiseworthy, such as a condition in which the agent's motivation to win the contest was to use the prize money to save an orphanage. Our multiple-concepts account produces the same predictions with regard to immoral and to positive moral contexts: to the extent that moral intentions are more relevant in the appraisal of morally praiseworthy acts than are the means by which they are carried out, such contexts should make salient the naïve concept of intentionality, driving an asymmetry in judgments of intentionality (cf. Knobe, 2003).

Finally, our participant sample was drawn from the United States, one of the most non-representative societies in the world concerning many fundamental psychological dimensions (Henrich et al., 2010). Moreover, it is plausible to suppose that competencies involving causal cognition are susceptible to cultural elaborations, and that there is a significant degree of cultural diversity in their deployment (see, e.g., Morris and Peng, 1994; Bender and Beller, 2011). Replication with other samples and languages is therefore required before drawing more general conclusions concerning the issues at stake here.

Although we presume that in every human society people will have concepts of action, acting intentionally, and blame/credit, there may indeed be different cultural elaborations of these concepts and their interrelations. Anthropologists have claimed that, in many cultural contexts, people adhere to an opacity-of-other-minds folk doctrine that proscribes the ascription of intentions either in itself or as a factor in blame attribution (Rumsey and Robbins, 2008; see also Wassmann et al., 2013). We are skeptical about strong relativist interpretations of this opacity doctrine. For example, we are skeptical about the idea that in some of these contexts people do not read other minds (see Astuti, 2012), or in no way take into account intentionality or its absence when attributing culpability and liability, adhering therefore to

a doctrine of strict or absolute liability (see Goldman, 1993; Astuti and Bloch, 2015; Sousa and Manoharan, forthcoming). However, the existence of cultural norms downplaying ascriptions of intentionality may indeed lead to important cultural differences in relation to our topic. Thus, one interesting direction of investigation would be to probe whether people use distinct concepts of intentional action in these "opacity" contexts in connection with different sorts of blame/credit attributions, and whether the asymmetries we found in our results would be replicated.

There is also the related issue of variation concerning the relationship between language and concepts. Although we accept that many concepts are not linguistically encoded (see Sperber and Wilson, 1998), we expect that, given their relevance to human interaction, concepts of action, acting intentionally, and blame/credit will be encoded, by lexical or other grammatical means, in most, if not all, languages. Thus, another interesting line of research would be to probe whether one would find linguistic structures in other languages that evince a polysemy similar to that of "acting intentionally" in English, although, as one of the reviewers correctly pointed out, there are real translation challenges when one moves to more distant languages, like polysynthetic languages.

Conclusion

In this article, we focused on causal cognition as deployed in judgments of agency, dealing with a familiar Western context. Our investigation indicates a complex picture. The language of action is vague in that it expresses a concept that is underspecified, while the language of intentional action is polysemous in that it expresses different concepts (for additional concepts not discussed in this article, see Nichols and Ulatowski, 2007; Sousa and Holbrook, 2010, footnote 10; Cova, 2015). The relevance of different concepts is connected to moral considerations.

Many anthropologists have argued that a necessary condition for a good understanding of the extent of cultural variation in relation to any aspect of human cognition is a fine-grained understanding of the aspect in one's own culture. We take this article as a contribution in this direction, and we hope that our findings are taken into account in pursuing cross-cultural research on the topic of causal cognition and agency.

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The causal cognition of wrong doing: incest, intentionality, and morality

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The paper concerns the role of intentionality in reasoning about wrong doing. Anthropologists have claimed that, in certain non-Western societies, people ignore whether an act of wrong doing is committed intentionally or accidentally. To examine this proposition, we look at the case of Madagascar. We start by analyzing how Malagasy people respond to incest, and we find that in this case they do not seem to take intentionality into account: catastrophic consequences follow even if those who commit incest are not aware that they are related as kin; punishment befalls on innocent people; and the whole community is responsible for repairing the damage. However, by looking at how people reason about other types of wrong doing, we show that the role of intentionality is well understood, and that in fact this is so even in the case of incest. We therefore argue that, when people contemplate incest and its consequences, they simultaneously consider two quite different issues: the issue of intentionality and blame, and the much more troubling and dumbfounding issue of what society would be like if incest were to be permitted. This entails such a fundamental attack on kinship and on the very basis of society that issues of intentionality and blame become irrelevant. Using the insights we derive from this Malagasy case study, we re-examine the results of Haidt's psychological experiment on moral dumbfoundedness, which uses a story about incest between siblings as one of its test scenarios. We suggest that the dumbfoundedness that was documented among North American students may be explained by the same kind of complexity that we found in Madagascar. In light of this, we discuss the methodological limitations of experimental protocols, which are unable to grasp multiple levels of response. We also note the limitations of anthropological methods and the benefits of closer cross-disciplinary collaboration.

Keywords: intentionality, incest, morality, causal cognition, anthropology, Madagascar

INTRODUCTION

This paper is about the role that intentionality plays in causal reasoning and, more particularly, in reasoning about, and responding to, acts of wrong doing. In the modern Western legal tradition and in Western folk thinking more generally, a sharp distinction is drawn between doing wrong intentionally and doing wrong through negligence or accident. For example, the English legal code considers murder and man-slaughter to be quite different and to merit an altogether different punishment. Although this distinction is often taken to be universal, some recent anthropological findings have challenged this assumption, showing that in some cultural contexts people only care about the effects of an action, not about the intentions behind it (or lack thereof; e.g., Danziger, 2006; Walker, 2015).

In this paper, we shall explore the proposition that considerations of intentionality are not a universal component of causal reasoning about wrong doing, by looking at an ethnographic case we are familiar with: the case of Madagascar. In the last part of the paper, we use our ethnographically specific conclusions

on intentionality to reconsider some classic work in the social psychology of morality.

Before proceeding, a few clarifications about terminology and methodology are in order. By *intentionality* we mean "having the intention to act in a certain way or to cause a certain outcome," as opposed to accidentally doing so. By *causal cognition* we mean the folk understandings of what causes certain events to take place. In the case of actions understood to be brought about by people, causal cognition concerns the understanding of the link between the actor and her acts. By *reasoning about wrong doing* we mean the assessment by members of a community of what caused the wrongdoing and what to do about it.

Regarding the methodology, what follows is based on our long-term ethnographic fieldwork in three different regions of Madagascar: Astuti, among the Vezo on the Western coast; Bloch, among the Merina and the Zafimaniry of the central highlands. Although there are significant differences between these populations with regards to their livelihoods, their relation to the state, their kinship system, and much more, in this paper we draw on ethnographic evidence that is equally valid across our

field sites and, for ease of exposition, we refer to Madagascar and the Malagasy people in an undifferentiated manner (for the purpose of the present discussion, "people" refers to adults, men and women alike). Ethnographic fieldwork is based on the long-term engagement with communities of people who allow the anthropologist into their lives; the evidence it generates is gleaned through the gradual transformative process by which the anthropologist learns to move, speak, eat, sleep, dance, trade, fish, plant, tend animals, attend births and funerals, and so on, competently, as if she was a member of that community (for more details, see, e.g., Bloch, 1992; Astuti, 1995). This apprenticeship is aided by observation, participation, and by asking questions. With reference to the specific topic of this paper, we derive our conclusions from having learnt ourselves how to live morally in these communities, from having witnessed moral outrage or anxiety, from having asked explanations for decisions already made or for predictions of future behavior, and from having engaged people informally in counterfactual reasoning and other thought experiments in the course of our everyday interactions with them. This methodology yields in-depth and diffused knowledge, which cannot be quantified or statistically analyzed.

INCEST

For reasons that will become clear, we start with the case of incest.

The definition of what counts as incest varies across Madagascar. In some parts of the island, the children of two brothers can marry, while this would be regarded as an incestuous union elsewhere. People are aware of these differences; but they are also aware that all Malagasy people, in so far as they are "people" and not "animals," have a taboo against at least some sexual unions among kinspeople. Breaching this taboo causes terrible things to happen: crops fail, canoes overturn at sea, children die, women's fertility dries up, infants are born with horns on their heads or humps on their backs.

Such catastrophic consequences unfold irrespective of whether the people who committed incest did so knowingly and intentionally. In cases of distant incest (for example, when the genealogical relation goes back three or four generations), the people involved may have no idea that they are related, hence that they are committing incest. In such cases, it is the misfortune that follows which reveals that, in fact, the incest taboo has been breached. Indeed, the severity of the breach is not calculated *a priori* by strict genealogical reckoning, but *post facto* by observing the extent of the harm that befalls the community and the significance of the atonement that is needed to put things right.

Similarly, in the course of informal conversations about incest, we told a couple of our Malagasy interlocutors a story about two siblings who get separated at birth and, later in life, meet and end up liking and having sex with each other. The judgment was that the two people are not at fault because they do not know that they are brother and sister; nonetheless, their act will cause terrible misfortune on their children and on their families. Notably, the fact that a large number of innocent people are expected to be affected by the wrongdoing of the culprits, underscores the conclusion that intentionality does not mediate between the cause (incest) and its effects (harm). Correspondingly, a large number of innocent people are responsible for undertaking the difficult

(expensive, dangerous, stressful) ritual work that is required to repair the damage and put things right again.

All in all, it seems that when the Malagasy people we know reason about incest, predict and act upon its consequences, considerations of intentionality are simply beside the point. This is shown in three ways: first, harm follows irrespective of whether people are aware that they are breaching the incest taboo; second, harm befalls on people who have not themselves committed incest; third, the costs of ritual reparation befall on large numbers of innocent people. Incest, therefore, is prima facie a perfect endorsement of the claim that considerations of intentionality are not a universal component of causal reasoning about wrong doing.

MUNDANE ACTS OF WRONG DOING

One might be tempted to conclude that Malagasy adults do not distinguish between intentional and accidental acts of wrong doing. This conclusion, however, is unsupported by evidence that comes from other contexts of social life, where the distinction between wrong doing that is committed intentionally and wrong doing that happens accidentally is clearly drawn and taken into account.

To tease out this distinction, we asked a few of our informants whether the punishment that follows an intentional act of mild aggression (kicking over somebody's bucket of water) as opposed to an accidental one (stumbling over somebody's bucket of water) is equivalent or different. In the discussions that were sparked by this hypothetical scenario, people reasoned that if the bucket gets broken, the person will have to replace it in both cases. But the process by which this happens will be very different: if it was an accident, the person will say sorry and will volunteer to replace the bucket, explaining that she did not see it; if it was an intentional act, a fight will ensue and the victim will take the perpetrator to the village assembly, where a more serious punishment might be dispensed (e.g., a monetary compensation in addition to the replaced bucket). In a different conversation, the following scenarios were presented: two neighbors own two identical chickens. In one scenario, one of them accidentally kills the chicken that belongs to the other person, while in the other scenario, the killing of the other person's chicken happens knowingly and intentionally. When asked what would happen if the two cases were brought to the village assembly, our interlocutors said that in the case of the first (unintentional) killing, there would be no reason to go to the village assembly and that there would be no punishment either. The person who made the mistake would say sorry and give her chicken to the other and that would be the end of the story.

In such mundane cases, intentionality thus matters a great deal. This does not mean that the distinction between intentional and accidental wrongdoing can always be drawn with clarity: people can say that they did not see the bucket they stumbled over or that they did not know that the chicken they killed was not theirs, while in reality they saw the bucket and knew that the chicken was their neighbor's. In other words, people can lie about their state of knowledge and about their intentions. But this uncertainty does not invalidate the distinction between intentional and accidental causality.

ANCESTRAL TABOOS

Somewhere in between the case of incest—where intentionality seems to be beside the point—and the case of mundane acts of wrongdoing—where the distinction between intentional and accidental acts is paramount—there is the case of the breach of ancestral taboos.

Across Madagascar, people inherit a host of taboos from their ancestors, which determine which food they cannot eat, which animals they cannot kill, which words they cannot speak, which trees they cannot cut down, which color they cannot wear, and so on. As discussed at length elsewhere (Astuti, 2007a), adults are aware that the only, but fundamentally moral, reason people follow ancestral taboos is to show respect to their ancestors, who are the true source of their being. There is nothing inherently wrong in eating chicken or pork (whereas there is something inherently wrong in committing incest); what is wrong is to disobey one's ancestors who have stipulated—for whatever reason—that chicken or pork is forbidden.

Against this background, what difference does it make whether people breach a taboo intentionally or accidentally? The evidence on this is ambiguous, and interestingly so. On the one hand, some taboos work in a mechanistic fashion that seems to by-pass the intentions of the taboo violator. Take the following example: there are ancestral taboos that proscribe certain behaviors at sea, especially in the pursuit of the highly prized sea-turtle. The consequence of breaching one of these taboos is the failure to catch a sea-turtle ever again. This punishment, however, does not befall on the individual who breached the taboo, but on the canoe that carried that individual to sea (whether or not he is the owner of the canoe). The fact that the punishment is dispatched to the canoe (an artifact which is said to "breathe," as it gently and rhythmically responds to the pressure of the waves, but which is not attributed a mind/spirit) suggests that the intentions, the knowledge or the ignorance of the wrongdoer is simply irrelevant.

But this conclusion does not go unchallenged. Consider the fact that young children do not suffer any consequence if they breach an ancestral taboo. This is because, being still "unwise" and lacking any understanding (this is how adults describe them), they do not know what taboos are, why it is important to follow them, how disrespectful it is to disobey the ancestors, and so on. As a result, because of the immature state of their minds, it is as if their taboos did not yet exist. This does not mean that children are never victims of ancestral punishment; they are, but as a result of their parents' and elders' wrongdoing.

The same point—that breaching a taboo is of consequence only if it is done knowingly and intentionally—emerges from the result of the following study (described in Astuti, unpublished). Fifteen adult participants were told a story in which an infant is found abandoned in the forest and is raised by people who know nothing about his birth origins; they were then asked: will the taboos of this child's birth parents (specifically, the taboo against eating pork or chicken) affect the child when he grows up or not? The overwhelming majority of adults (80%) responded that the child will not be affected by the taboo. They explained that the birth father's taboo has been lost and that it will not work on the child because he does not know about it. Only the remaining handful of participants reasoned otherwise and suggested that when the child will eventually, if unknowingly, eat the food that was taboo for his birth father, he will become ill or crazy. The existence of the taboo will then "come out" and will be seen and explained by a diviner. In other words, the unintentional breach of a food taboo caused something like an allergic reaction—mechanically and irrespective of anyone's intentions. But this was a minority view.

ANOTHER LOOK AT INCEST

We have established that, when reasoning about acts of wrong doing and when considering what actions might follow (e.g., reparation, punishment, mediation), the Malagasy people we have worked with take into account whether such acts were undertaken intentionally or not. This finding forces us to ask why, then, intentionality does not seem to be taken into account in the case of incest. We will explore this question through two complementary moves: first ethnographically and then by way of a more theoretical reflection, which generates a testable hypothesis.

The word that Malagasy adults will almost certainly always use when discussing incest and contemplating its effects, is *loza*. The dictionary definition of this term is "calamity" or "disaster"; the verb for committing incest (*mandoza*) thus literally translates as causing a calamity or a disaster. This terminology expresses quite starkly the horror of incest: that incest causes everything to go wrong; that, in Hamlet's words, when incest occurs "the time is out of joint" (see Wolf, 2014, p. 77 ff. for a range of ethnographic examples that express a similar sentiment).

As mentioned earlier, the consequences of incest are indeed understood as catastrophic: people's livelihood, health, and reproduction are threatened. And yet, when asked why this is so, our Malagasy interlocutors are stumped—or dumbfounded, to use a term used in the psychological literature on moral reasoning (e.g., Haidt et al., unpublished; Haidt, 2001). In other words, they are unable to give a single and sufficient account of the relationship between cause (the breach of the taboo) and effect (*loza*). Instead, they come up with a multitude of answers that restate the necessity of the taboo and which do not satisfactorily explain (either for them or for us) the enormity of what incest brings about.

To try to understand the source of our informants' dumbfoundedness, we turn to a theoretical discussion of the nature of human sociality. As argued elsewhere by Bloch (2008), among humans the social is fundamentally different from what it is among other primates. In the case of the latter, social roles are only perceived as existing in the here and now, and only so long as the individuals who fill them are capable of maintaining their position. Among humans, by contrast, social roles have a kind of imaginary existence that extends beyond the here and now: roles survive their incumbents; they extend beyond the life cycle, the frailty, the shortcomings of any one individual that inhabits them. In other words, they are experienced as having transcendental permanence. This, Bloch argues, is the result of the uniquely human capacity for imagination (see also Rakoczy, 2008; Wyman and Rakoczy, 2011, for a cognate point).

In the kind of Malagasy communities where we work, kinship and its roles—ancestor, elder, father, mother, mother's brother,

wife, husband, father- and mother in-law, son- and daughter-in-law, son, daughter, grandchild, and so on—are experienced as this form of transcendental sociality. Kinship is transcendental because it extends back in time and is projected into the future, thus seeming to involve a kind of unquestionable permanence beyond the biological lives of those who fill specific kinship roles at any one time; it is transcendental because its extension and temporal reach negate the experience of the fluidity of life in the here and now, even though such extension and temporal reach can only be experienced in the imagination and during circumscribed ritual acts that produce vivid snapshots of the transcendental order; and it is transcendental because, irrespective of who he might be as an individual (poor, weak, unsuccessful, mean-spirited) a father-in-law is a father-in-law, who deserves respect and deference from his son-in-law (who might be wealthier, stronger, more successful and deeply resentful).

Ordinary life in Malagasy villages is not experienced only through this transcendental sociality. The now-on-now-off temporality of human life is fully recognized: how could it not be when people see babies turn into adults and adults turn into lifeless bodies; people's non-transcendental personalities matter: they please and annoy in the same measure; the fickleness of kinship relations is an ever ending topic of conversation: despite being a kin, she did not behave in kin-like fashion. And yet, even though kinship in its transcendental form appears to negate one's daily experience, it also appears to be essential to people's very existence—"if people are people," as our Malagasy informants would put it, they have to have a permanent system of kinship that extends through time and that slots people into roles that have permanence and fixity. By transcending the fluid, largely unpredictable interactions that make up everyday life, transcendental kinship provides an image, however vague, of a stable and lasting order and seems to afford certainty about what people ought to do and how they should behave—as mothers and fathers, as children and grandchildren.

This is why incest leaves people dumbfounded: it is because incest is felt to attack the foundational principles of kinship and, by attacking kinship at its foundation, it is felt to threaten the transcendental in its entirety. In ethnographic terms, as we have seen, incest is said to cause *loza*: calamity and disaster. In more abstract and theoretical terms, we now propose, incest is perceived as a threat to the very fabric of human sociality. This is because the possibility of incest evokes a world where everything and anything is allowed; a world where there are no rules, no respect for elders or for ancestors, who are the source of one's own existence. Note the difference between the breach of the incest taboo and the breach of ancestral taboos: as we noted above, ancestral taboos are the result of decisions made by one's ancestors (e.g., that we should not eat pork). There is nothing dumbfounding about the prospect of breaching one of these taboos, because doing so amounts to a single act of disobedience (indeed, if one manages to get away with it, such disobedience can be experienced as enjoyable and liberating). What would be dumbfounding for our informants is the prospect of breaching all ancestral taboos in an act of collective defiance, thus defying the fundamental principle of age hierarchy. As with incest, such a scenario would amount to a wholesale attack on kinship, which would cause

generalized *loza* and would question the very humanity of those concerned.

Returning to incest: at issue is not so much who can and cannot have sex with whom, or how incest should be punished; at issue is the much more fundamental question of whether any rule at all is legitimate. The very fact that incest can occur seems to invite the thought that the rules we live by may be just flimsy fictions; that, perhaps, the incest taboo and the marriage rules that ensure its avoidance are just a convention. Indeed, the possibility of such a challenge seems to be implicit in the recognition that people in different parts of Madagascar have different definitions of what counts as incest. This line of reasoning is dumbfounding because, if one starts to ask these kinds of questions, social life begins to unravel and nothing is safe.[1]

From this perspective—that of the possibility of incest as a total attack on the social—we can understand (and could have predicted) all the three ways we mentioned earlier in which intentionality is bypassed: it makes sense that, if incest occurs, harm will follow irrespective of whether it was committed intentionally or not; it makes sense that the catastrophic consequences of incest will affect everyone; and it makes sense that everyone is responsible for trying to put the world back together again. From this perspective, we can expect intentionality to become irrelevant because the breach is too enormous, the consequences too shattering, the repair work too essential.[2]

ANOTHER LOOK AT INTENTIONALITY

We have argued that, although our Malagasy informants take intentionality into account when considering acts of wrong doing, its relevance seems to fade away when incest is concerned, because of incest's cosmic consequences.

We now need to qualify our argument, by recognizing that intentionality can play a role in people's reasoning about incest. Across Madagascar, it is the elders' responsibility to make young people aware of the individuals they are in a taboo relationship with. As soon as children reach the age when they are deemed to be interested in sex, they will be told: those people, they are taboo to you. What, then, if these young people intentionally disregard what they have been told and start up an incestuous relationship? When people envisage this possibility, they pass strong judgment on the irresponsibility of those youngsters who knowingly disregard the warnings of their elders to indulge the attraction they feel for one another. Somewhat predictably, today's youths are deemed to be more selfish and immoral than those of the past; they are accused of breaching basic taboos that would

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[1]There is an obvious similarity between our analysis and Lévi-Strauss's argument about incest—that the incest prohibition is the foundation of human society, which marked the transition from nature to culture. We need not follow him in the evolutionary dimension of his argument. But we note that in societies where kinship provides the overwhelming experience of the transcendental, people do feel that if incest were allowed to occur, then human society would collapse. Life would not be human life any longer.

[2]Note that our analysis does not exclude the possibility that humans have evolved a natural aversion toward incest: see Wolf (2014) for a recent elaboration of this argument; in and of itself, such a natural aversion does not explain what we are trying to explain, that is, why the intentionality of the wrong-doer is not relevant when reasoning about incest.

ensure that brothers and sisters (anyone who is referred by these terms in the expansive web of classificatory kinship) do not come into any kind of sexually inflected association with one another. For example, it is bad enough that girls nowadays wear trousers, which expose their groin to their male kin, but it is shocking that a brother and a sister should share the very same garment. When people discuss such cases, they express a sense of outrage, along the lines: "what do they think they are doing, behaving like that?" As people express these worries, they focus on the deliberate, intentional disregard for the rules that are meant to protect people, young and old.

Another common trope is that, if a couple is found to have committed incest, whether knowingly or unknowingly, they will be asked to immediately separate and bring their relationship to an end. But what do youngsters do nowadays? They will retort that, if forced to separate, they will commit suicide. Their stubbornness is deemed unreasonable and particularly wicked, because they selfishly and intentionally force on their families an impossible choice: to cause their children to take their own life or to condone their incestuous relationship.

Whether wrong doing is done intentionally or not can thus be taken into account even in the case of incest. But the point is that attributing blame is a quite different concern than imagining a world without any incest rule, where what is experienced as necessary for one's collective existence as human beings is under threat. Attributing blame, in other words, is a quite different matter than dealing with *loza*.

CAUSAL COGNITION AND INTENTIONALITY

Through the analysis of our data from Madagascar, we have made the following arguments: that the way people reason about, and respond to, incest is, prima facie, an example of causal reasoning being decoupled from intentionality; nonetheless, this does not warrant the conclusion that Malagasy people have a radically different form of causal cognition that is blind to intentionality; evidence that intentionality is taken into account comes from the way people handle mundane forms of wrong doing as well as the breach of a host of ancestral taboos; indeed, we have also shown that considerations of intentionality are present in the way people assess culpability even in the case of incest.

What the discussion above shows is that, when talking about, and taking actions in response to incest, our informants may be thinking about two quite different kinds of thing: they may be deliberating about who did what and who should be blamed, and they may be evoking the catastrophic image of a world where incest is permitted. In the first instance intentionality is relevant, whereas in the second instance it is not. Our hypothesis—which can be tested cross-culturally—is that both of these responses are going to be present whenever people respond to incest: on the one hand, they will engage their everyday causal reasoning, while on the other hand they will be dumbfounded by the attack on the transcendental that incest instantiates.

Anthropologists, who study talk and action within lived contexts, are in a position, if they are so minded, to distinguish between these two responses. Because, at the back of their minds, they have a myriad of practices and discourses from their long term experience of sharing the life of the people they study,

they can recognize when people switch, from instant to instant, from one type of discourse to the other. They might be able to distinguish between the two even when people, as they often do, draw on the two simultaneously. This is what we have shown in this paper, demonstrating the kind of understanding that anthropologists are positioned to contribute, as they observe and participate in the contexts where people reflect, talk and act jointly with others.

This kind of understanding, by contrast, is not easily generated by the methods typically used by psychologists. Such methods proceed by deliberately isolating subjects in controlled experimental settings, placing them outside any actual lived social context. Without the wider social context in which their experimental subjects think and act, psychologists are at risk of not actually understanding what their subjects say and do in the conduct of the experiment. In the next and final section, we illustrate this point with reference to a most famous case of moral dumbfoundedness.

MORAL DUMFOUNDEDNESS RE-EXAMINED

In an influential paper, Haidt and two of his co-researchers (Haidt et al., unpublished manuscript) reported the results of an experiment with undergraduates from the University of Virginia, which became the cornerstone of Haidt's (2001) "social intuitionist model of moral judgment."

Briefly, students were told three different stories that called for a moral judgment (on whether the action depicted in the story was wrong) and they were presented with two situations that called for an action (which they could accept or refuse to undertake). One of the stories was the so called Heinz dilemma, which pitted the wrongness of theft against the necessity to save the life of one's loved one. The expectation was that, in this case, participants would engage in dispassionate moral reasoning, evaluating the pros and cons of the two possible courses of action. By contrast, in the case of the other two stories—one about incest between brother and sister and the other about cannibalism—and in the case of the two actions—drinking from a glass of juice after a perfectly sterilized cockroach was dipped into it and signing off to the experimenter one's soul after one's death—the expectation was that participants would have a strong moral intuition that the action was wrong (which they did) and a strong rejection of the proposed actions (which they had), but that they would be unable to explain why. In other words, the prediction was that they would be morally dumbfounded.

The stories about incest and cannibalism were written to pre-empt and counteract the usual objections to such acts. For example, the story about incest said that the siblings took absolutely reliable precautions against the possibility of pregnancy; that they had sex in secret and that they never mentioned it to anyone else; that after the act, which they enjoyed, they decide not to do it again and that they went on to live very happy lives, feeling even closer to one another. Having judged that it was wrong for the brother and sister to have sex, the students proved unable to explain why this was so. They offered all the predicted standard arguments: the fact that the brother and sister might give birth to a deformed child; the fact that their act might offend the sensibilities of other people; the fact that the act would be detrimental to their long term relationship and their

psychological well-being. Of course, all of these reasons had been ruled out by the story, and the experimenter, playing his scripted role as "devil's advocate," told them so. And yet, the students came back, again and again, trying to find new arguments, exploring what they soon recognized were "dead ends," admitting that they did not know, that they could not explain (i.e., that they were dumbfounded), all the while growing increasingly frustrated, as evidenced by their facial expressions, their fidgeting behavior, nervous laughter and the like.

The interpretation of the students' dumbfoundedness (which was also in evidence in the case of cannibalism and in the response to the two proposed actions, but which was absent in the case of the Heinz dilemma) was that, in responding to these specific scenarios, the students were guided by their emotions, their "gut feeling" that certain behaviors and actions were just wrong. Having made an intuitive, emotional judgment, they later searched, unsuccessfully, for some rational justification. Following Hume's non-rationalist tradition, Haidt's "social intuitionist model" thus posits that "moral judgment is caused by quick moral intuitions and is followed (when needed) by slow, ex post facto moral reasoning" (Haidt, 2001, p. 817).

We want to propose an alternative to this conclusion and to Haidt's explanation of dumbfoundedness—an unquestionably real phenomenon—on the basis of our experience as anthropologists. Often enough, in the course of fieldwork, we witness our informants' dumbfoundedness: they are unable to produce answers to our questions concerning why something is right or wrong, why they do what they do, or why they believe what they assert. It is thus very easy for us to imagine that our Malagasy informants, faced by the experimental situation that Haidt presented to his American subjects, would behave in very similar fashion. Taking the example of incest: they too would maintain that incest is very wrong, and they would continue to do so even if all the specific reasons they might come up with to explain why have been discounted one by one. They too might start fidgeting and grow frustrated, and might politely tell us that they do not know why, but that they know that it is so. However, in light of our ethnographic evidence and the analysis we have developed in this paper, we are wary of attributing their dumbfoundedness to the role of their emotional intuitions.

One thing we have learnt as anthropologists is that the first and most important step in any investigation is to interrogate whether the questions one asks are hitting the point, namely whether they address the issue one is investigating in a way that genuinely touches on the concerns of one's interlocutors—even when, apparently, everyone is using the very same words. For example, one might want to question what it would actually mean to ask our Malagasy informants whether it is wrong for Julie and Mark—the sister and brother of Haidt's experimental story—to have sex. Asked in this way, the question is about two individuals making a decision and acting in isolation. But while we are busy asking about Julie and Mark and recording the answers and the scrambling for some kind of justification, our informants might be thinking about something entirely different. They might be contemplating more profound and much more dumbfounding questions, lurking behind the question about Julie and Mark. The questions would be: what kind of society would this be where

brothers and sisters can have sex? A society, a kinship and a family system where incest is acceptable? How could one live in such a place? The way our Malagasy informants would apprehend and respond to these questions is through the readily available concept of *loza* which, as we have argued above, evokes a state of complete social catastrophe caused by an outright attack on the transcendental. In other words, we are proposing that in responding to the Julia and Mark incest scenario, our Malagasy informants would be shifting away from a focus on two isolated individuals and the emotions triggered by their action, to a consideration of what a good society must be like. Their focus (including their emotional reaction), would be on people's need for the apparent imaginary permanence of kinship, for the non-negotiable rules that protect it. In other words, their overriding concern would be to restate and reassure themselves that "for people to be people" society has to be grounded in the transcendental.

We would like to suggest that the situation is not entirely different for the students tested by Haidt and his colleagues. In the experiment, the students were put in a situation in which they had to decide, in complete isolation and away from any meaningful social context, whether Julie and Mark's action was right or wrong. The reason they grew increasingly frustrated, we suggest, is that they were forced to pretend that the moral rules and concomitant emotions by which their social world is created and lived by, are generated by the students themselves, individually and on the grounds of having a good argument to back them up.

Some might argue that bringing our ethnographic experience of working in "holistic" communities in Madagascar to bear on the interpretation of experimental results obtained in "individualistic" university campuses in North America is preposterous. We do not think so. Even if there is no doubt that the students in Haidt's experiment have grown up in a society where individualism is rhetorically hegemonic, it is nonetheless the case that they too must experience the social and its rules as originating not in their personal deliberations or private emotions, but in something that they can only grasp in the imagination. Provoked by the experiment's "devil's advocate" into finding logical reasons for their judgment, the students just gave up, since they know, or perhaps feel, that their individual and isolated opinion is really beside the point. Their dumbfoundedness signals that what they are thinking and care about is the need to align themselves, jointly with others, with what, ultimately and fundamentally, makes people people, namely, the transcendental.

CONCLUSION

In this paper, we have made a strong case for the value of the anthropological approach, showing what insights it can offer to psychologists. By way of conclusion, we want to acknowledge that the psychological approach has an important contribution to make to the work of anthropologists—the two should be brought into a fruitful dialectic relationship with each other. Specifically, anthropologists are easily tempted to use isolated bits of ethnographic evidence to reach doubtful psychological generalizations about the cognitive characteristics of the people they study. The use of psychological techniques and the awareness of psychological findings can provide a useful corrective to the

ease with which anthropologists reach conclusions about radical cognitive differences. Here as in our previous work (e.g., Astuti, 2007b, 2009; Bloch, 2007, 2011; Astuti and Bloch, 2012), we hope to have demonstrated the fruitfulness of combining concerns and insights from both disciplines.

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Agents and Patients in Physical Settings: Linguistic Cues Affect the Assignment of Causality in German and Tongan

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Linguistic cues may be considered a potent tool for focusing attention on causes or effects. In this paper, we explore how different cues affect causal assignments in German and Tongan. From a larger screening study, two parts are reported here: Part 1 dealt with syntactic variations, including word order (agent vs. patient in first/subject position) and case marking (e.g., as ergative vs. non-ergative in Tongan) depending on verb type (transitive vs. intransitive). For two physical settings (wood floating on water and a man breaking a glass), participants assigned causality to the two entities involved. In the floating setting, speakers of the two languages were sensitive to syntactic variations, but differed in the entity regarded as causative. In the breaking setting, the human agent was uniformly regarded as causative. Part 2 dealt with implicit verb causality. Participants assigned causality to subject or object of 16 verbs presented in minimal social scenarios. In German, all verbs showed a subject (agent) focus; in Tongan, the focus depended on the verb; and for nine verbs, the focus differed across languages. In conclusion, we discuss the question of domain-specificity of causal cognition, the role of the ergative as causal marker, and more general differences between languages.

Keywords: causal cognition, causal attribution, agency, language, ergative case, implicit verb causality, culture, Tongan and German

INTRODUCTION

Physical situations look the same all over the world. They follow invariable laws of nature and appear to be open to direct inspection, irrespective of the culture or language of a potential observer. But do people *represent* them and *reason* about them in the same way everywhere in the world? While causal cognition has been subject to a great deal of exploration over the last two millennia, specifically in philosophy and psychology (for an overview, see Waldmann and Hagmayer, 2013), the potential for cultural and linguistic diversity has attracted far less interest (Bender et al., 2017, for exceptions, see the contributions to Beller et al., 2014).

Previous research points to a small number of factors that—even within cultural and/or linguistic groups—may affect causal cognition, not only in the social domain but also in the physical domain: biases in assigning causality, specific causal concepts, and linguistic cues. The first group of these factors generally skews the assignment of causality a priori: The causal asymmetry bias (White, 2006), for instance, leads people to assign the roles of CAUSE and EFFECT to entities even in symmetric interactions, and to overestimate the contribution of the assumed CAUSE entity to

the overall interaction. Being a domain-general feature of causal cognition, this bias affects most of what people perceive, believe, and linguistically express with regard to causal relations, and even restrains research questions and methods (White, 2006, 2007; Bender and Beller, 2011). The second group of factors is restricted to specific settings, but is still pervasive, namely the causal theories of folk science (Keil, 2003; Lawson, 2006), including such popular misconceptions as the impetus concept in motion (McCloskey, 1983; Hubbard and Favretto, 2003), or the valve model of how a thermostat functions (Kempton, 1986). They are responsible for content effects detected, for example, with different content versions of otherwise identical tasks (Cummins, 1995; Beller and Spada, 2003; Beller and Kuhnmünch, 2007; Klauer et al., 2010; and see Le Guen et al., 2015). The third—and for the purpose of this paper most relevant—group of factors involves variations in linguistic cues that may be employed distinctively to shift attention to cause or effect. Assignment as prime cause may be affected, for instance, by a shift in what is focused on as figure and what as ground (Kuhnmünch and Beller, 2005; Beller and Bender, 2015). Conveying this focus involves language, at least as a medium, and its effectiveness thus testifies, rather non-controversially, to an impact of language on causal representations.

Besides such distinct cues from within a given language, however, diverging properties of different languages might also play a role in shifting attention in a specific manner. Cross-linguistic studies reveal that languages differ in how they encode information about causal relations and events (e.g., Ikegami, 1991; Wolff et al., 2009; Bohnemeyer et al., 2010; Fausey and Boroditsky, 2011), but the question of whether such language-specific grammatical features and phrasing preferences entail cross-linguistic differences in cognitive representations of causality has barely been investigated. We therefore attempted to address this question by exploring the influence of two types of linguistic cues on the assignment of causality in two non-related languages: German, which belongs to the Indo-European language family and serves as mother tongue to a 100 million people, and Tongan, which belongs to the Austronesian language family and is spoken by the approximately 100,000 inhabitants of the Polynesian Kingdom of Tonga in the Southwest Pacific.

Mainstream research is still guided by the wide-spread assumption that causal cognition tends to be universal, specifically in the physical domain. Given the resultant shortage in empirical evidence, we conducted a screening study with the main purpose of exploring potential cultural and linguistic impacts on causal cognition in the physical domain (Bender and Beller, 2011). The data presented here were collected as part of this screening, and address the question on whether grammatical features and phrasing preferences may affect causal representations. More specifically, we investigated within-language effects of content domain (physical setting), verbs and verb type (transitive vs. intransitive), and word order, but also between-language effects of different grammatical structures (nominative-accusative vs. absolutive-ergative). In the following, we first provide a theoretical background on the linguistic coding of information about causal relations and events, before we motivate and present the current study.

LINGUISTIC CODING OF CAUSALITY

Linguistic descriptions have long been known to affect how people represent a described event—even when they eye-witnessed it themselves (e.g., Loftus and Palmer, 1974, and see Fausey and Boroditsky, 2011). This is the very reason why particular care has to be taken with regard to how inquiries are phrased, for instance in court.

In principle, a causal relationship can be understood as an event, caused by one entity (the *causer* or *agent*) and affecting another entity (the *effect* or *patient*). Typically, if not necessarily, agents are conceived of as being animate, sentient, moving, instigating and controlling the respective action or causing the respective event (Langacker, 1987). However, according to Dowty (1991, p. 572), *agency* is a prototype rather than an either-or concept, clustered around a set of properties that include (i) volitional involvement in the event or state, (ii) sentience and/or perception, (iii) causation of an event or change of state in another participant, (iv) movement relative to the position of another participant, and (v) existence independently of the event named by the verb. While human beings combine these properties in a paradigmatic manner, the same set of properties can also be recruited for assigning agent and patient roles in non-human, entirely physical settings such as the launching of an object by another object (Mayrhofer and Waldmann, 2014).

When translating a causal relationship into language, the notion of causality can be linguistically encoded in numerous ways and across different elements of a clause, for instance in syntactic categories such as subject, in verb semantics, in morphology, in resultative constructions, or in animacy distinctions as coded in noun phrases (for examples, see Duranti and Ochs, 1990; Ikegami, 1991; Wierzbicka, 2002; Wolff and Song, 2003; Wolff, 2007; Bohnemeyer et al., 2010). Here, we are particularly interested in two types of linguistic variations: cues derived from the syntactic structuring around the verb, and causal information implicit in verb semantics.

Syntactic Structuring

The structure of a sentence is determined, at least to a considerable extent, by its core component: the verb. For our purpose, two types of verbs will be contrasted: *transitive verbs* like "kill," which entail subject and object, and *intransitive verbs* like "die," which entail a subject only. Mostly, although not necessarily, the semantic roles of agent and patient figure syntactically as *subject* and *object*, at least in active sentences. Yet, how these syntactic roles are categorized differs across languages (cf. **Figure 1**).

In *nominative-accusative languages* like German or English, subjects of intransitive and transitive verbs are treated uniformly, and are distinguished from objects of transitive verbs by their case: nominative for the subject (i.e., *der Hund* ["the_NOM dog"] in S1 and *der Junge* ["the_NOM boy"] in S2) and accusative for the direct object (i.e., *den Hund* ["the_ACC dog"] in S2). Although it is typically the agent who figures as the subject, this need not be the case: The patient can also hold the subject position

FIGURE 1 | Categorization of subject and object in nominative-accusative languages and ergative-absolutive languages, with examples from German and Tongan (adapted from Bender and Beller, 2011).

indicated by the nominative case, for instance if the verb is transformed into the passive voice (as with *der Hund* ["the$_{NOM}$ dog"] in S3).

Ergative-absolutive languages like Tongan, on the other hand, distinguish subjects of intransitive verbs from subjects of transitive verbs (Plank, 1979; Dixon, 1994; Manning, 1996). The former have the same grammatical case (i.e., absolutive) as objects of transitive verbs, whereas the latter are put in the ergative case. Therefore, *'a e kulí* ("ABS the dog") has the same grammatical form both in S4 and S5, whereas *'e he tamasi'í* ("ERG the boy") in S5 is highlighted with the ergative marker *'e*.

From a propositional point of view, S2, S3, and the respective ergative sentence S5 are equivalent. Yet, S3 is marked by the passive voice (in contrast to the unmarked active voice in S2), while its complement in an ergative-absolutive language (S5) is marked by the ergative case of the transitive subject (in contrast to the unmarked absolutive case of intransitive subjects and transitive objects). In other words, nominative-accusative languages categorize according to *focus*, whereas ergative-absolutive languages categorize according to the *entities undergoing a change of state*.

Only a small number of studies have so far examined the cognitive implications of these syntactic variations. For instance, Goldin-Meadow (2003) reports that, irrespective of their mothers' language, deaf children are more likely to spontaneously produce gestures for intransitive agents and for patients than for transitive agents, thus exhibiting an ergative pattern. For speakers of Samoan, an ergative language closely related to Tongan, a similar focus on intransitive agents and patients was observed, at least in socio-political discourse (Duranti, 1994).

Now, if speakers of ergative languages are, by default, largely content with providing and receiving information about the action and the entity affected, then introducing a transitive agent and marking him or her with the ergative case by way of exception might serve as a particularly potent tool for agency assignment. A cross-linguistic experiment (Beller et al., 2009b) explored this hypothesis by testing whether the ergative does indeed shift agency assignment in a symmetric physical setting that does not involve a "proper" semantic agent (i.e., no animate entity). The experiment contrasted the intransitive phrasing "wood floats on water" and the transitive passive phrasing "wood is carried by water" in German, with respective changes in case marking as absolutive vs. ergative in Tongan. The change from intransitive to transitive increased the assessment of water as causative (the agent marked by the ergative) in Tongan, but not in German, where wood remained in the focus (**Figure 2A**), suggesting that the ergative marking in Tongan may indeed provide a stronger tool for indicating agency than its counterpart in German.

However, due to the different structures of the languages, the two sentences were not entirely comparable. More specifically, in order to keep word order constant across languages, the transitive construction in German had to be phrased with the (marked) passive voice. Adding an (unmarked) active phrasing that allows us to disentangle their relative effects would thus be required to justify any strong conclusion.

Two further reservations may be raised with regard to this previous study: First, it used a forced-choice response format, which may have distorted responses in an unintended way. Second, and more importantly, the floating setting is purely physical and symmetric; assigning the thematic role of the agent

to either entity involved may therefore be problematic. With the data reported in this article, we aim to remedy these reservations by comparing responses assessed using the forced-choice format with responses assessed using an analog rating scale, and by comparing a purely physical setting with a setting that involves a human agent.

This latter setting also allows us to contrast agentive phrasings with a non-agentive phrasing (Hare et al., 2009; Fausey and Boroditsky, 2011). *Agentive* phrasings are typically transitive and indicate an agent in the subject position, as in "He broke the glass," whereas *non-agentive* phrasings are intransitive, with the entity affected (patient) in the subject position, as in "The glass broke." In line with related work (e.g., Ikegami, 1991), Fausey and colleagues demonstrated that speakers of different languages differ with regard to their preferences for agentive vs. non-agentive phrasings (Fausey et al., 2010; Fausey and Boroditsky, 2011), and that these preferences also affect their causal assignments: The more an event is described in an agentive way, the more likely the (personal) agent will be blamed (Fausey and Boroditsky, 2010).

Importantly, though, by virtue of its subject position, people might be willing to consider the affected entity to be the "agent" of the intransitive verb, and might thus assign more causality to it. If this tendency is further emphasized by case marking, it should be stronger in nominative-accusative languages, which shift "the glass" from (accusative) object to (nominative) subject, than in ergative-absolutive languages, in which "the glass" remains in the absolutive case.

Implicit Verb Causality

Assigning causal roles to the entities involved in a specific relation is likely the most relevant objective in identifying its causal structure. While this seems to prioritize the entities as the main source of information relevant for role assignment, the relation itself and its linguistic representation through a specific verb plays an equally important, albeit perhaps more subtle, role in this process—and again, Loftus and Palmer's (1974) classical study on motion events may serve as a striking case in point: Participants estimated the speed of two cars involved in an accident differently, depending on the verb used in the target question (e.g., "contact," "hit," or "smash").

Since Abelson and Kanouse (1966) reported the phenomenon later called "implicit verb causality," it has been demonstrated repeatedly that different verbs used to describe abstract interpersonal events may give rise to different causal assignments (for overviews, see e.g., Rudolph and Försterling, 1997; Ferstl et al., 2011). The verb "cheat," for instance, is conceived of as being primarily in the responsibility of the agent, whereas "congratulate" rather suggests that the congratulation was evoked by the person congratulated (i.e., the patient) and by something he or she has accomplished.

This difference in focus on subject vs. object can be used to establish taxonomies of interpersonal verbs, first in *state* and *action verbs*, and then further into subtypes, depending on the underlying theory. For instance, in Au's (1986) terminology, "cheat," with its subject focus, would be regarded as an *action-agent verb*, whereas "congratulate" would be considered an

action-patient verb, due to its object focus (for alternative taxonomies, see also Brown and Fish, 1983; Semin and Fiedler, 1991; Crinean and Garnham, 2006). Although this field of research has focused on implicit causality, recent studies have proven that verbs also differ with regard to whether they are more likely to trigger causal or consequential inferences (Majid et al., 2007; Pickering and Majid, 2007).

Given our primary interest in physical causality, our intention with the study reported below was not to systematically explore verb causality in German and Tongan (for respective studies on German see, e.g., Fiedler and Semin, 1988; Rudolph and Försterling, 1997), but to assess the potential for interferences with causal assignments. The main question was whether the verb itself, even in the absence of any concrete context or information on the entities involved, would already shift participants' assignments in a language-specific manner. Due to our focus on the physical domain, we selected verbs that can refer to physical settings, but had no particular expectation regarding potential cross-linguistic differences. In contrast, for a small group of verbs referring to social contexts, we did have reasons to expect such differences. Tongan culture places a strong emphasis on cooperation and sharing with others (*fetokoni'aki*), and granting other people their requests—within certain limits—is regarded as a core value (Morton, 1996; Evans, 2001; Bender, 2007). The clearer a request is articulated, the more compelling is the obligation (Beller et al., 2009a). Given this cultural evaluation, respective transaction verbs such as "giving," "offering," or "helping" may thus have a stronger object focus in Tongan than in German.

THE STUDY

The data presented in the current article were collected as part of a larger screening, which aimed at exploring the potential influences of culture on causal cognition and consisted of several sections. One section of the screening asked participants to assign causality in a range of purely physical, symmetric settings, varying content and focus (reported in Bender and Beller, 2011). Another section was concerned with potential linguistic effects on causal assignments, on both the syntactic and the semantic level (reported in this article), and a final section was concerned with causality as cognitive determinant for emotions (not considered here).

Methods

The two linguistic objectives of the screening, which are the subject of the current article, will be referred to as Part 1 (syntactic variations) and Part 2 (implicit verb causality), respectively.

The tasks in Part 1 aimed at assessing how syntactic variations affect the assignment of causality. The prime goal was to replicate a main finding of a previous study (Beller et al., 2009b)—namely that ergative case marking in Tongan shifts agency assignments, and does so more strongly than the passive transformation in German—and to broaden the empirical basis by additional variations and different response formats. More specifically, we hypothesized that re-phrasing an agentive (transitive) sentence as non-agentive (intransitive) does shift causal assignments

TABLE 1 | Syntactic variants used in Part 1 on syntactic variations (with English translations).

| | Wood floating | |
| | Word order | |
Verb type	Agent first/subject: Water (Wasser, vai)	Patient first/subject: Wood (Holz, papa)
Transitive (carrying)	(1) The fact that water carries wood, ... Ge: *Dass Wasser Holz trägt,...* To: *'Oku 'ave 'e he vai 'a e papa,...*[e]	(2) The fact that wood is carried by water, ... Ge: *Dass Holz von Wasser getragen wird ...* To: *'Oku 'ave 'a e papa 'e he vai,...*[e]
Intransitive (floating)	(3) The fact that water lets wood float, ...[a] Ge: *Dass Wasser Holz schwimmen lässt,...* To: *'Oku tukuange 'e he vai ke tētē 'a e papa,...*[e]	(4) The fact that wood floats on water, ... Ge: *Dass Holz auf Wasser schwimmt,...* To: *'Oku tētē 'a e papa 'i he vai,...*

| | A glass breaking | |
| | Word order | |
Verb type	Agent first/subject: Man (Mann, tangata)	Patient first/subject: Glass (Glas, sio'ata)
Transitive (breaking$_1$)	(5) The fact that the man breaks the glass, ... Ge: *Dass der Mann das Glas zerbricht,...* To: *'Oku fahi 'e he tangata 'a e sio'ata,...*[e]	(6) The fact that the glass is broken by the man, ... Ge: *Dass das Glas von dem Mann zerbrochen wird,...* To: *'Oku fahi 'a e sio'ata 'e he tangata,...*[e]
Intransitive (breaking$_2$); *patient shift*		(7) *The fact that the glass breaks to the man, ...[b] Ge: *Dass das Glas dem Mann zerbricht,...* To: *Ko e hoko 'a e mafahi 'a e sio'ata ki he tangata*, ...
Intransitive (breaking$_2$); *non-agentive*		(8) The fact that the glass breaks, ... Ge: *Dass das Glas zerbricht,...* To: *'Oku mafahi 'a e sio'ata,...*

Ge: German; To: Tongan.

[a] *Variant (3) somewhat strains the notion of an intransitive sentence with water as subject: Water is subject only with regard to "let," while wood still remains the subject for the (intransitive) "floating." Yet, this 'split agency' was the very reason for including this variant.*

[b] *Although this phrasing would not be used in English, it is canonical in German and feasible in Tongan.*

[e] *Ergative construction.*

toward the non-agentive subject. This effect should occur in both languages, but should be more pronounced in nominative-accusative languages than in ergative-absolutive languages due to the concurrent shift in case marking in the former but not the latter. A second goal was to explore the effect of including a full-fledged semantic (human) agent. We hypothesized that if such an agent is present, this agent should strongly attract causal assignments across other syntactic variations.

Part 2 aimed at assessing how verb semantics affect the assignment of causality. Given that implicit verb causality has never before been investigated for a Polynesian language like Tongan, we also intended to probe the potential of cross-linguistic variability in this regard. Specifically, we wanted to explore whether verbs that could be used to describe (symmetric) physical relations exhibit a subject or object focus in the first place, and do so distinctively in different languages. For verbs focusing on social events related to the Tongan obligation to help (*fetokoni'aki*) we hypothesized a more pronounced object focus than other verbs in Tongan, and more so than their German counterparts.

Materials

Part 1: Syntactic variations

In this part, two physical settings were used: Wood floating and a glass breaking. For each setting, four syntactic variants were constructed by crossing *verb type* (transitive vs. intransitive)

and *word order* (agent vs. patient in first/subject position; see **Table 1**).

For the floating setting, a purely physical setting without a human agent, the following variants were used:

Transitive, agent first/subject: "Water carries wood."   (1)
Transitive, patient first/subject: "Wood is carried by water." (2)
Intransitive, agent first/subject (split agency):
"Water lets wood float."   (3)
Intransitive, patient first/subject: "Wood floats on water."   (4)

As not all combinations of verb type and word order could be filled with a one-verb phrasing, we decided to choose a construction with "let" that splits agency for variant (3): *Wood* serves as the subject for the (intransitive) "floating" and thus, in a loose sense, as the agent in this specific activity, while part of the agency is shifted to the *water*, which is subject with regard to "let." Hence, we classified this sentence as intransitive with agent (water) in the first/subject position.

Three of the Tongan sentences required an ergative construction: The split agency phrasing (3) and the transitive phrasing (1), both of which emphasize the agent by word order and subject position, but also the transitive phrasing (2) that emphasizes the patient. The reason for this is that the passive transformation used in English and German to implement variant (2) is not possible in Tongan; the closest we can get is a phrasing as in (1), yet with reversed word order (Churchward,

1953, p. 67f.). As a consequence, the shift in word order from (1) to (2) implies a shift in case marking in German, but not in Tongan.

For the breaking setting, the following four variants were used, three of which explicated a human agent:

Transitive, agent first/subject: "The man breaks the glass." (5)
Transitive, patient first/subject:
"The glass is broken by the man." (6)
Intransitive, patient first/subject (patient shift):
"*The glass breaks to the man." (7)
Intransitive, patient first/subject (non-agentive):
"The glass breaks." (8)

One slot (intransitive verb with agent in first/subject position) was again impossible to fill. For explorative purposes, we therefore decided to include construction (7) with the patient in first/subject position for which German marks the agent by the *dativus commodi* case and thus reverses the typical causal relation, indicating the man as the entity being affected. The respective sentence was thus classified as intransitive with *patient shift*. From a linguist's point of view, the intransitive verb still does not render "the glass" the agent; speakers of German might nonetheless feel inclined to consider it to be agentive to a certain extent. Note also that variant (8) mentions the patient, but leaves the agent unnamed and is thus *non-agentive*.

Two of the Tongan sentences required an ergative construction (one, again, because the passive used in German is not possible in Tongan): The transitive phrasing (5) in which word order and subject position emphasized the agent, but also the transitive phrasing (6) in which the two factors emphasized the patient.

Assessment of causal assignments: All target items were formulated using the following sentence frame, exemplified for variant (1) (the complete list of syntactic variants is presented in **Table 1**):

"The fact that water carries wood is basically due to …
the water |————————| the wood."

German:
"Dass Wasser Holz trägt, liegt vor allem …
am Wasser |————————| am Holz."

Tongan:
"'Oku ave 'e he vai 'a e papa, ko e tupu mei …
he vai |————————| he papa."

In the floating setting, causal assignments were assessed with an analog rating scale of 10 cm length, which allowed for the allocation of relative causal effectiveness. Each side of the scale was labeled with one of the two entities "the water/the wood."

The four syntactic variants of the breaking setting were implemented each in two assessment versions: first with a forced-choice format that simply required participants to decide which of the two entities in question is the main cause for the overall event (e.g., "… □ the man; □ the glass."), and second with an analog rating scale of 10 cm length in order to assess the relative causal effectiveness of the two entities (as in the example

above). For all variants involving a person—phrasings (5), (6), and (7)—the entities were "the man/the glass" (German: *am Mann/am Glass*; Tongan: *he tangata/he sio'ata*), whereas for the non-agentive variant (8), the entities were formulated either by referring to the glass vs. an unknown person (German: *am Glas/an jemand Unbekanntem*; Tongan: *he sio'ata/he tokotaha ta'e'iloa*) or by referring to the glass vs. an unknown non-personal factor (German: *an etwas Unbekanntem*; Tongan: *he me'a ta'e'iloa*).

Part 2: Implicit verb causality

This part aimed at assessing how the verb itself—in the absence of any context information—affects causal assignments. It comprised 16 verbs, which are presented in **Table 2**. Twelve verbs can be used to describe physical relations; they were examined here to assess a baseline of verb semantics for exploring its potential influence on causal assignments. The remaining four verbs refer to social transactions of giving and helping, which are linked to the core value of *fetokoni'aki* in Tonga and are thus of particular cultural salience.

Assessment of causal assignments: All target items were presented as minimal social scenarios of the type "[S$_{(Subject)}$] verb [O$_{(Object)}$]" as shown in the following example:

"Peter carries Anna. This is surely due to
Peter |————————| Anna."

German:
"Peter trägt Anna. Das liegt sicher an
Peter |————————| Anna."

Tongan:
"Fua 'e Pita 'a 'Ana. 'Oku mahino ko e tupu mei
Pita |————————| 'Ana."

The roles [S] and [O] were replaced by proper names that are common in the respective languages. Causal assignments were assessed with an analog rating scale of 5 cm length. The subject [S] was always placed on the left side of the scale and the object [O] on the right side to ensure coherence with the word order in the sentences.

Participants

The German sample consisted of 93 students from the University of Freiburg (36 male, 56 female [1 did not indicate his or her gender]; mean age 23.7 years, $SD = 5.19$, *range*: 18–43 years). Compared to the data reported in Bender and Beller (2011), we were able to extend our Tongan sample by 76 to now 179 participants, mostly students from three different high schools (80 male, 93 female [6 did not indicate their gender]; mean age 17.5 years, $SD = 3.91$, *range*: 14–49 years). All participants were native speakers of either German or Tongan, respectively, and none had prior experience with these types of tasks.

Please note that, although the German participants are older than the Tongan ones, the two samples are roughly comparable in terms of education level, as most German participants were shortly after the exams that qualify for university entry, while the Tongan ones were shortly before these exams. Potential implications of the age difference are picked up in the discussion.

TABLE 2 | List of verbs used in Part 2 on verb semantics (with English translations).

	English	German	Tongan
1	[S] attracts [O].	[S] zieht [O] an.	Tohoaki'i 'e [S] e tokanga 'a [O].[e]
2	[S] interrupts [O].	[S] unterbricht [O].	Fakaheleleu 'a [S] kia [O].
3	[S] resembles [O].	[S] ähnelt [O].	To'onga tatau 'a [S] mo [O].
4	[S] repels [O].	[S] stößt [O] ab.	Fakafepaki 'a [S] kia [O].
5	[S] approaches [O].	[S] nähert sich [O].	Fakaofiofi 'a [S] kia [O].
6	[S] distracts [O].	[S] lenkt [O] ab.	Uesia 'e [S] e tokanga 'a [O].[e]
7	[S] pushes [O] forward.	[S] schiebt [O] nach vorne.	Teke'i 'e [S] 'a [O] ki mu'a.[e]
8	[S] lets [O] swim.	[S] läßt [O] schwimmen.	Tukuange 'e [S] ke kakau 'a [O].[e]
9	[S] carries [O].	[S] trägt [O].	Fua 'e [S] 'a [O].[e]
10	[S] stops [O].	[S] stoppt [O].	Ta'ofi 'e [S] 'a [O].[e]
11	[S] displaces [O].	[S] verdrängt [O].	Fetongi 'e [S] 'a [O].[e]
12	[S] hits [O].	[S] stößt [O] an.	Tā'i 'e [S] 'a [O].[e]
A	[S] gives [O] a book as a present.	[S] schenkt [O] ein Buch.	'Oange 'e [S] 'a e tohi ko e me'a'ofa kia [O].[e]
B	[S] gives [O] a picture.	[S] gibt [O] ein Bild.	Foaki 'e [S] 'a e fakaÄtātā'a [O].[e]
C	[S] offers [O] some cake.	[S] bietet [O] Kuchen an.	'Oange 'e [S] 'a e me'i keke 'a [O].[e]
D	[S] helps [O] with the work.	[S] hilft [O] bei der Arbeit.	Tokoni 'a [S] kia [O] ki he ngāue.[e]

S, subject; O, object.
[e]Ergative construction.

Procedure and Design

Although our university ethics board only deals with medical research, we can confirm that we follow the Frankfurt declaration of ethical conduct for anthropological research, which addresses all stages of the research project from designing to reporting the research.

The study was implemented as a paper-and-pencil questionnaire. The questionnaire always began with general instructions, followed by one task from the breaking setting in forced-choice format. This task was followed by the block of tasks on the content and focus variations reported in Bender and Beller (2011). All subsequent tasks then used the rating format: One task from the floating setting, a second task from the breaking setting, and then the 16 tasks on implicit verb causality. The final part of the questionnaire, which is not considered here, dealt with emotions.

This order of tasks was chosen for three reasons: (a) The two tasks from the breaking setting each participant had to work on were separated from one another maximally in order to minimize (trivial) transfer effects. (b) The task with the forced-choice format always preceded those with rating format, because the former used the more coarse-grained measure. (c) Finally, in the succession of tasks with rating format, the task from the floating setting was always presented before the second task from the breaking setting, because the latter introduced a human agent, and we tried to prevent possible carry-over effects from the setting richer in information to the setting with less information.

The four tasks of the breaking setting with forced-choice format varied between subjects, and the same applied for the four tasks of the floating setting and the four tasks of the breaking setting with rating format. All possible task combinations were implemented, with one constraint: When participants had received an agentive version for the first assessment of the breaking setting, that is, phrasing (5), (6), or (7), they then did not receive the non-agentive version (8) for the second assessment, in order, again, to prevent possible carry-over effects from the information-rich setting.

The order of the response options in the forced-choice format and the orientation of the rating scale in the rating format were balanced across conditions. In the non-agentive version (8), half of the participants received a personal option ("somebody unknown") and the other half a non-personal option ("something unknown") as alternative to "the glass."

The tasks of Part 2 on verb semantics (see **Table 2**) were always administered after Part 1 had been completed. Participants had to work on all 16 tasks. The physical verbs and the social verbs were presented in blocks, with the block of physical verbs (1–12) always preceding the block of social verbs (A to D). Within each block, different random orders were implemented. In total, four different sequences of tasks were used. Half of the names used were male and the other half were female. Moreover, for each verb, a female name figured as subject and a male name as object for half of the time, and vice versa for the other half. The combination of names and verbs was randomized.

Participants were randomly assigned to the different versions of the questionnaire. They were instructed to respond spontaneously and were given as much time as they needed.

Results and Discussion

The data and findings are presented and discussed in the following order: First, we analyse the data from Part 1 on the effects of the syntactic variations and possible language differences, beginning with the floating setting, followed by the breaking setting. We then turn to Part 2 and compare
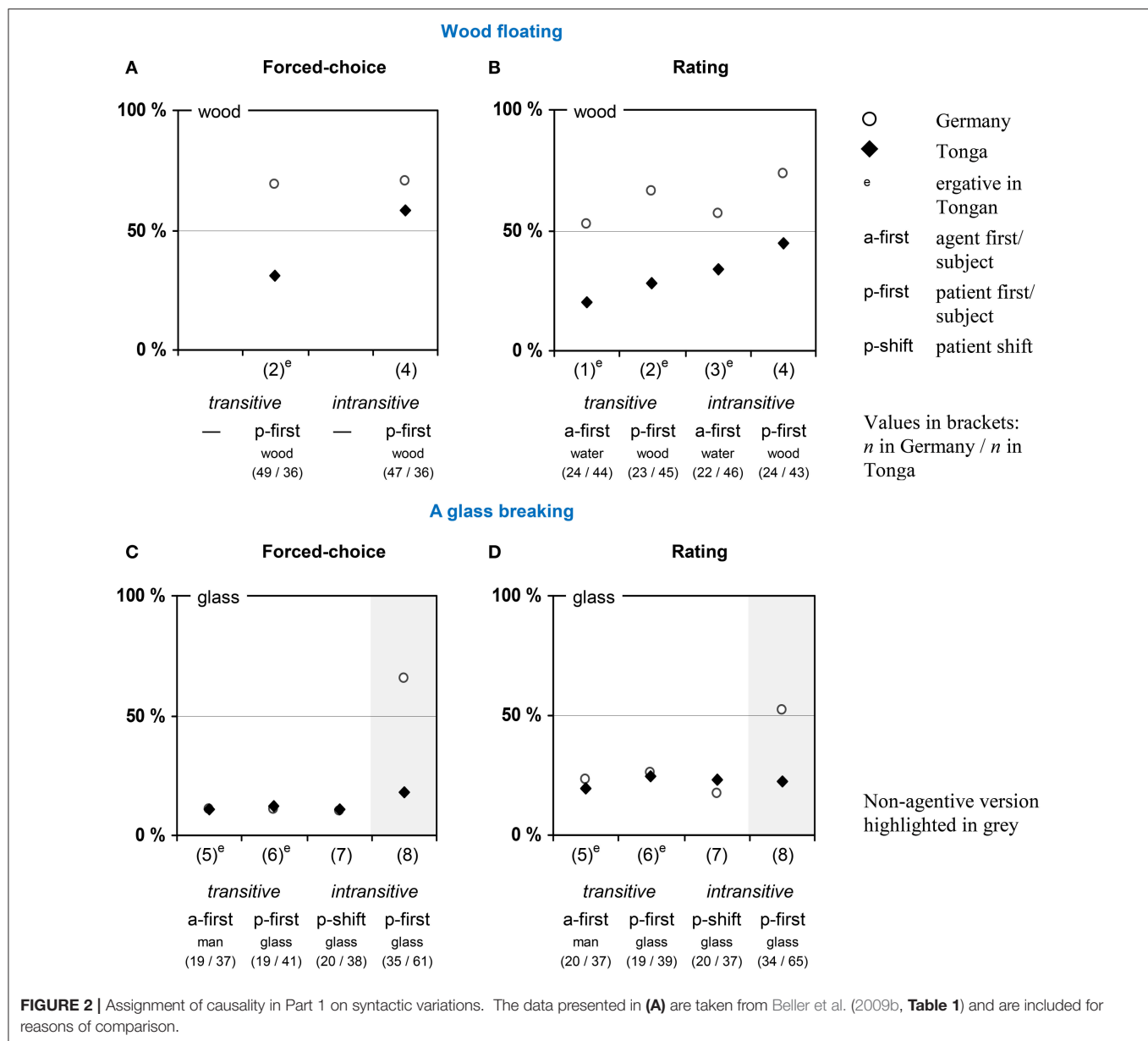
FIGURE 2 | Assignment of causality in Part 1 on syntactic variations. The data presented in **(A)** are taken from Beller et al. (2009b, **Table 1**) and are included for reasons of comparison.

implicit verb causality across languages and stimuli, before briefly addressing some possible reservations.

Causal Assignments in the Floating Setting

Participants' causal assignments were coded by measuring their marks on the rating scale accurate to 0.5 mm ranging from 0 cm (0% wood) when the mark was precisely on the endpoint labeled with "water," to 10 cm (or 100% wood) when the mark was precisely on the endpoint labeled with "wood." Accordingly, values above 50% indicate a stronger causal role of the patient (wood) and values below 50% indicate a stronger causal role of the agent (water).

With the floating setting, we aimed at assessing effects of syntactic variations on causality assignments within and across

two languages in a purely physical setting without a human agent. The descriptions used either a transitive or an intransitive verb and emphasized either the agent or the patient by word order and subject position, respectively. Across languages, we found an overall preference for the patient (wood) as causative in Germany and for the agent (water) in Tonga as well as significant effects of word order and verb type. Within languages, we found a somewhat stronger preference for the agent if emphasized by word order (in German) or in transitive phrasings (in Tongan) than in the respective complementary conditions (**Figure 2B**[1]).

An analysis of variance with *verb type* (transitive vs. intransitive), *word order* (agent vs. patient in first/subject

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[1]Please note that part of the data in Panel (B) overlaps with Figure 2B in Bender and Beller (2011).

position), and *language* (German vs. Tongan) as independent variables and the rating of wood-as-causative as dependent variable (ranging from 0 to 100%) indicated a main effect of language [$F_{(1, 263)} = 45.74$; $p < 0.001$; $\eta_p^2 = 0.148$], of word order [$F_{(1, 263)} = 7.04$; $p = 0.008$; $\eta_p^2 = 0.026$], and of verb type [$F_{(1, 263)} = 5.55$; $p = 0.019$; $\eta_p^2 = 0.021$], without any interactions.

Aggregated across conditions, the German participants preferred the patient/wood as causative for the floating with an average rating of 62.2% (95% CI: 55.0; 69.4), whereas the Tongan participants preferred the agent/water as causative with an average rating of 68.3% (corresponding to 31.7% wood [26.3; 36.9]). Given that the relation under consideration is physically symmetric, implying equal contribution of the two entities, both the Tongan and the German response patterns exhibit an asymmetry, albeit in diverging directions. This finding is largely consistent with previous results obtained using the forced-choice response format (Beller et al., 2009b; Beller and Bender, 2015).

Beyond that, the two linguistic variations probed within each language—word order and verb type—also affected causal assignments: Emphasizing the agent by word order/subject position resulted in a preference for the agent/water as causative (59.0%; corresponding to 41.0% wood [95% CI: 34.7; 47.3]), while emphasizing the patient/wood resulted in a balanced rating centered around the midpoint of the scale (53.0% wood [46.7; 59.2]). A similar preference for the agent/water was found for transitive verbs (58.3%; corresponding to 41.7% wood [35.4; 47.9]), while using an intransitive verb resulted in a balanced rating (52.3% wood [46.0; 58.6]). The impact of linguistic cues is thus not restricted to Tongan, as was observed previously (Beller et al., 2009b, reproduced in **Figure 2A**).

However, word order and verb type seem to play different roles in the two languages and to contribute differently to the overall effects, as indicated by a separate analysis of variance for each language: Word order played a significant role in German [$F_{(1, 89)} = 6.71$; $p = 0.011$; $\eta_p^2 = 0.070$], indicating a distinctive preference for the patient/wood as causative (69.6%; [61.6; 77.5]) if emphasized by word order/subject position, as compared to a balanced response (54.9% wood [46.7; 62.9]) if the agent/water was emphasized by word order/subject position. On the other hand, verb type did not make much of a difference [$F_{(1, 89)} = 0.99$; $p = 0.322$; $\eta_p^2 = 0.011$]. For Tongan, the pattern was reversed: Here, word order did not play a strong role [$F_{(1, 174)} = 2.54$; $p = 0.113$; $\eta_p^2 = 0.014$], whereas verb type made a significant difference [$F_{(1, 174)} = 7.24$; $p = 0.008$; $\eta_p^2 = 0.040$], indicating a stronger preference for the agent/water as causative (76.1%; corresponding to 23.9% wood [15.9; 32.0]) if phrased transitively (marked by the ergative case), as compared to the preference for the agent/water (60.5%; corresponding to 39.5% wood [31.4; 47.6]) if phrased intransitively (absolutive case).

The exploratory intransitive (and in Tongan partly ergative) phrasing (3) was assumed to split agency assignment, leaving parts of the agency with the wood (for floating) and assigning the remainder to the water (for enabling the wood to float). And in fact, in both languages, the causal assignment for phrasing (3) falls between the average levels reached for the intransitive

phrasing (4) with patient (wood) in first/subject position and the transitive phrasing (1) with agent (water) in first/subject position.

Finally, the two transitive ergative phrasings in Tongan (1 and 2) elicited, as expected, a strong preference for the agent (the water) as causative (76.0%; corresponding to 24.0% wood) as compared to the intransitive, non-ergative phrasing (4), which elicited a rather balanced rating [44.9% wood; $t_{(130)} = -2.934$; $p = 0.002$; one-tailed].

Causal Assignments in the Breaking Setting

The breaking setting differed from the floating setting mainly insofar as it involved a proper agent (a man) in an otherwise physical setting (a glass breaking) in three of the four linguistic variants. It aimed at testing whether the presence of such an agent affects the pattern in causal assignments found in the floating setting. The specific event was described either by using a transitive or an intransitive construction, three of these emphasizing the glass by word order and subject position— phrasings (5), (6), and (7)—and one emphasizing the man (8). Causal assignments were assessed with two different tasks per person, the first using a forced-choice format and the second a rating format. As can be seen in **Figures 2C** and **D**, we found a uniform preference for the human agent as causative for all agentive phrasings in both languages, and a difference only for the non-agentive phrasing (8), which elicited a rather balanced assessment in German and a strong focus on the unknown agent or entity.

Forced-choice data

In a preliminary step, we checked for the non-agentive variant (8) whether it made a difference how the response option that was provided as alternative to the glass was formulated: personal as "somebody unknown" or non-personal as "something unknown." This was not the case. A log-linear analysis (Kennedy, 1992) with *response type* (personal vs. non-personal) and *language* (German vs. Tongan) as independent variables and the frequency of the two response options "glass" vs. "somebody/something else" as dependent variable indicated only a main effect of language ($G^2[1] = 22.22$; $p < 0.001$), and no other effects (all $G^2[1] < 2.00$; $p > 0.156$). We therefore regarded it as justified to aggregate the data across these two types of response options for the further analysis.

Similar to the floating setting, the event was described using transitive vs. intransitive constructions, but this time, we had three versions that emphasized the glass (by word order and subject position) and only one that emphasized the man. To test the four syntactic variants for differences, we therefore performed a log-linear analysis with only the two independent variables *syntactic variation* (phrasings 5, 6, 7, vs. 8) and *language* (German vs. Tongan), and the frequency of the two response options "glass" vs. "the man/somebody else/something else" as dependent variable. The results indicated a main effect of the syntactic variation ($G^2[3] = 22.74$; $p < 0.001$), a main effect of language ($G^2[1] = 11.50$; $p < 0.001$), and an interaction of the two factors ($G^2[3] = 10.70$; $p = 0.013$).

Participants largely preferred the agent/the man and not the patient/the glass as causative albeit to a differing extent across the

four syntactic variations: phrasing (5) 10.7% glass; phrasing (6) 11.7% glass; phrasing (7) 10.3% glass; phrasing (8) 35.4% glass (see **Figure 2C**). The two main effects primarily resulted from a difference for the non-agentive phrasing (8) across samples, as indicated by the significant interaction: While most Tongan participants still regarded an (unknown) agent/factor as causative in this condition (18.0% glass; 82.0% unknown factor), the majority of the German participants now attributed the breaking of the glass to the glass itself (65.7% glass; 34.3% unknown factor).

Rating data

Participants' causal assignments were coded by measuring their marks on the scale accurate to 0.5 mm, ranging from 0 cm (0% glass), when the mark was precisely on the endpoint labeled with "the man" or "somebody/something unknown," to 10 cm (or 100% glass), when the mark was precisely on the endpoint labeled with "the glass." Accordingly, values above 50% indicate a stronger causal role of the patient/the glass and values below 50% indicate a stronger causal role of the (possible) agent/the man or somebody/something unknown.

Again, we checked in a preliminary step for the non-agentive variant (8) whether responses depended on how the alternative response option to the glass was formulated: personal or non-personal. This was not the case. An analysis of variance with *response type* (personal vs. non-personal) and *language* (German vs. Tongan) as independent variables and the rating of glass-as-causative as dependent variable indicated only a main effect of language [$F_{(1, 95)} = 17.80$; $p < 0.001$; $\eta_p^2 = 0.158$], and no other effects [all $F_{(1, 95)} < 1.0$; $p > 0.521$; $\eta_p^2 < 0.004$]. We therefore regarded it as justified to aggregate the data across these two types of response options for the further analysis.

To test the four syntactic variants for differences, we performed an analysis of variance with two independent variables, *syntactic variation* (phrasings 5, 6, 7, vs. 8) and *language* (German vs. Tongan), and the rating of glass-as-causative as dependent variable. The results indicated a main effect of syntactic variation [$F_{(1, 263)} = 4.46$; $p = 0.004$; $\eta_p^2 = 0.048$] and an interaction with language [$F_{(1, 263)} = 4.67$; $p = 0.003$; $\eta_p^2 = 0.051$], while the main effect of language did not reach significance [$F_{(1, 263)} = 3.14$; $p = 0.078$; $\eta_p^2 = 0.012$].

Similarly to the forced-choice data, yet slightly less extremely, participants mostly preferred the agent (the man) and not the patient (the glass) as causative, albeit to a differing extent across the four syntactic variations: phrasing (5) 21.6% glass [95% CI: 13.1; 30.1]; phrasing (6) 25.4% glass [16.9; 34.0]; phrasing (7) 20.4% glass [11.9; 28.9]; phrasing (8) 37.1% glass [30.7; 43.6] (see **Figure 2D**). Bonferroni-corrected comparisons between the four syntactic variations did not indicate any difference (all *ps* > 0.167). Assignment of causality to the breaking glass was again highest for the non-agentive version (8), and this effect was again due to the German participants, as indicated by the significant interaction.

Summary

With one exception, German and Tongans alike assigned prime causality to the person involved and not to the object. Similarly,

with one exception, none of the linguistic variations had any effect. The exception to both overall patterns is the non-agentive phrasing (8) which led a substantial proportion of our German participants to switch their causal assignment from the human agent to the patient, while it did not affect the response of our Tongan participants at all. This latter finding implies that ergativity had no effect in this case. The German pattern is thus consistent with findings reported by Fausey and Boroditsky (2010), in which a non-agentive phrasing also decreased causal assignment to the agent by English speakers.

At first glance, the German pattern is also consistent with our assumption put forward above that shifting the patient (i.e., the glass) to the subject position in phrasing (8), marked by the nominative case in German, may endow it with agent-like properties and hence be responsible for this switch in causal assignment. This interpretation is weakened, however, by the results of phrasing (7) with patient shift. The German version of phrasing (7) preserves the intransitive structure of (8) together with the linguistic marking of "the glass" as subject in the nominative case, but simply adds "the man" as the person affected by the breaking of the glass. This addition of (actually irrelevant) information suffices to switch the causal assignment "back to normal," hence rendering the man as the cause (for related effects of additional yet irrelevant information on causal assignments, see also Beller and Bender, 2015). In other words, mentioning a possible agent, even if not in a linguistically prominent position, appears to shift agency assignment in German toward this candidate[2].

Comparison of Verb Causality across Languages and Stimuli

Part 2 aimed at exploring language-specific effects of verb semantics on causal assignments, which would also allow us to assess possible interferences of verb semantics with the syntactic effects addressed in other parts of the survey. To this end, participants were asked to assign causality on a rating scale for minimal social scenarios based on different verbs. The first group of items consisted of 12 verbs that can be used to describe physical settings (see **Table 2**, 1–12). The second group consisted of four verbs referring to social transactions, which are highly valued in Tongan culture (**Table 2**, A to D). The goal of this task was exploratory in nature, and we assumed that the social verbs are more likely inclined toward an object focus in Tongan than in German.

The causal assignments were coded by measuring participants' marks on the rating scale accurate to 0.5 mm ranging from 0 cm (0% object) when the mark was precisely on the endpoint labeled with the name of the person in the *subject* position, to

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[2]Actually, the non-agentive phrasing (8) had also mentioned a possible agent, albeit only indirectly through the two response options given: Half of the participants were offered a choice between "the glass" and "something unknown" (two non-personal options), and the other half were offered a choice between "the glass" and "somebody unknown," with the latter providing a *personal* option. However, the different response options did not affect participants' causal assignments (as indicated by the preliminary analyses), and the option "somebody unknown" did not prime our German participants toward assuming this person to be the prime cause to the same extent as did the other phrasings.
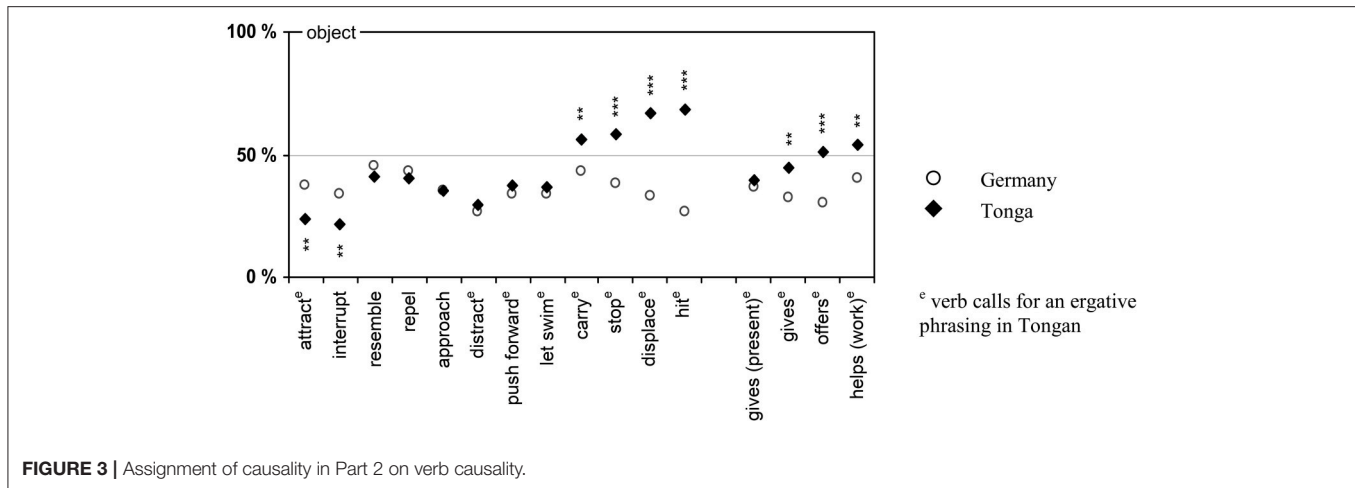
FIGURE 3 | Assignment of causality in Part 2 on verb causality.

5 cm (or 100% object) when the mark was precisely on the endpoint labeled with the name of the person in the *object* position. Accordingly, values above 50% indicate a stronger causal role of the patient/object and values below 50% indicate a stronger causal role of the agent/subject. As indicated in **Figure 3**, participants' causal assignments varied with the verb, but differently across the two languages.

To test effects of implicit verb causality, an analysis of variance was performed with the independent variable *language* (German vs. Tongan) and a repeated measurement across the ratings of the 16 verbs. The results indicated main effects of the factors language [$F_{(1, 247)} = 15.75$; $p < 0.001$; $\eta_p^2 = 0.060$] and verb [$F_{(13.5, 3337.1; Greenhouse - Geisser corrected degrees of freedom)} = 10.80$; $p < 0.001$; $\eta_p^2 = 0.042$], and an interaction of the two factors [$F_{(13.5, 3337.1)} = 11.68$; $p < 0.001$; $\eta_p^2 = 0.045$].

In general, both German and Tongan participants revealed a subject focus, albeit in different proportions: It was stronger for the German participants who assigned less responsibility to the person in the object position (35.5% [95% CI: 32.0; 39.0]) than the Tongan participants (44.3% [41.7; 47.1]). In addition, there was variation across the 16 verbs with ratings for the object as causative ranging from 28.2% ([23.8; 32.6]) for "interrupt" to 49.8% ([45.1; 54.6]) for "displace," but the causal assignments for the verbs interacted with language. In the German sample, the assignments for all verbs were significantly below 50%, thus indicating a subject focus [largest $t_{(92)} = -2.014$; $p = 0.047$; one-sample t-test; two-tailed]. In the Tongan sample, three verbs showed a significant object focus with assignments larger than 50% ["stop," "displace," and "hit"; smallest $t_{(176)} = 2.446$; $p = 0.015$], four verbs showed balanced assignments not significantly different from 50% ["carry," "gives," "offers," and "helps (work)"; largest $|t_{(174)}| = 1.901$; $p = 0.059$], whereas all other verbs showed a significant subject focus [largest $t_{(175)} = -3.102$; $p = 0.002$].

For six verbs of the first group, a subsequent *t*-test indicated cross-linguistic differences [smallest $|t_{(266)}| = 2.541$; $p = 0.012$; two-tailed]. The verbs "attract" and "interrupt" showed a stronger subject focus in Tongan than in German, whereas the verbs "carry," "stop," "displace," and "hit" showed an object focus in Tongan, but a subject focus in German. This finding is

particularly noteworthy, as each of these latter four verbs would likely be considered an *action-agent verb* according to Au's (1986) terminology. This raises the question of whether the verbs entail different connotations across languages as part of their semantic meaning, or whether culture- and/or language-specific concepts additionally affect the interpretation of (otherwise similar) words. For the remaining six verbs of this group, no linguistic differences were found [largest $|t_{(260)}| = 1.273$; $p = 0.204$; two-tailed].

Previous research in Tonga had suggested that giving and helping are considered as a response to what another person needs or requests, and may thus entail a stronger object focus in Tongan than in German. And indeed, the ratings for three out of the four respective verbs ("give," "offer," and "help") differed significantly across languages. In each case, the German verb shows a subject focus, whereas its Tongan counterpart had a tendency toward the object [smallest $|t_{(267)}| = 2.532$; $p = 0.006$; one-tailed]. The ratings for the fourth verb "gives [as a present]" did not differ [$t_{(265)} = -0.640$; $p = 0.261$; one-tailed]. Although the effects of cultural value are weaker than we expected them to be, these findings do provide good reasons to devote more attention to such effects in future research.

Finally, not all Tongan translations of transitive German verbs are transitive themselves. Roughly two thirds of the verbs scrutinized in Part 2 require the ergative for the subject (e.g., "hit": *Ta'i 'e [S] 'a [O]*), while the remainder entail a prepositional construction (e.g., with *kia*, "to/toward," as in *Fakaheleleu 'a [S] kia [O]*, "[S] interrupts [O]"). Do those verbs that require a subject in the ergative exhibit a stronger subject focus than those that do not require the ergative? While our list of verbs is neither comprehensive nor representative enough to justify broad generalizations, the results still reveal a pattern, but the trend is *contrary* to what we expected: Overall, the verbs requiring an ergative construction not only have a stronger focus on the object than their German counterparts, but also a stronger such tendency than the verbs that require a prepositional construction.

The case of "carry" is particular interesting in this regard, as it is the one verb that allows a comparison across Parts 1 and 2. While in Part 2, the abstract test of verb semantics suggests that "carry" evokes a subject focus in German and

tends to evoke an object focus in Tongan, the assignments for "water carries wood" (phrasing [1] in Part 1) exhibited the opposite pattern: Here, Tongan participants were more strongly inclined to assign causality to the subject/water and German participants to the object/wood. In other words, the causality implicit in the verb "carry" has likely dampened a cross-linguistic difference in causal assignments that otherwise may have been even more pronounced. It is thus imperative that future work on causal scenarios, and especially so cross-linguistic research, takes implicit verb causality into consideration.

Possible Limitations of the Study

As mentioned above, the data reported here was part of a larger screening study, which may have two critical implications. First due to the exploratory purpose of the study, we did not scrutinize strong hypotheses, but were interested in probing the potential for cultural influences (including influences by linguistic properties) on causal cognition in the physical domain, where previous research has almost entirely neglected such a potential. Our findings are therefore preliminary and an indication of, rather than strong evidence for, such influences in the physical domain. Second, the fact that the tasks reported here were part of a larger study also implied limitations with regard to the number of items that could be tested and the number of permutations that were possible. This constrains the generalizations we can draw form our findings. For the sake of feasibility of the whole study, for instance, we dispensed with a second version of the floating setting with a forced-choice format, as we already had partial data on it, and we dispensed with a more complete permutation of the content variations. As a consequence, only tentative inferences can be drawn from comparing the different settings on floating and breaking and their response format (**Figure 2**).

Yet, while both, the shortness in strong hypotheses and the limited comparability across conditions, prevent us from drawing straightforward inferences, the data presented here still suggest that causal cognition in the physical domain is susceptible to cultural and linguistic influences, hence justifying more thorough and in-depth investigations in this direction. Such future research should then also investigate more thoroughly the manner in which these linguistic factors are affecting causal assignment (e.g., by casing, word order, or grammatical hierarchy).

In addition, one of the reviewers raised the question of whether our tasks may reveal more about language comprehension of our participants than about their cognitive processing of the scenario. In the classical study by Loftus and Palmer (1974), for example, participants' verbally reported memories of an event could be compared to the actually observed event as an objective reference, thus allowing for a strong test of how language may bias recall. In contrast, our own study integrated event information in the task to be conducted, couching this information in terms that already contain the linguistic cues under scrutiny. In other words, participants may have simply responded to the question by reflecting the presumptive meaning of phrasings like "carries" vs. "lets float" in their ratings (for an overview on presumptive meanings, see McCawley, 1978; Levinson, 2000). Yet, even if they did simply

respond to the presumptive meaning conveyed by the linguistic cues, this would still be an interesting finding as it revealed that the underlying concept of, for instance, why wood floats on water is susceptible to such modification. Comparing across different variants of a task (for tasks of the same content) and across different content (for variants of the task) still allows us to disentangle effects of linguistic cues and of content at least to some extent. And indeed, the effects observed here did not simply reflect the linguistic cues, but additionally depended on the content of the scenario.

Another concern with the study arises from the differences in average age between the samples. For two reasons, we do not consider this critical. The first reason is that formal education does not prevent people from falling prey to the asymmetry bias (White, 2006, 2007). In the tasks we used here, the older German participants exhibited similar degrees of asymmetry as the younger Tongan participants although not always in the same direction. Second, the data on the floating setting presented in **Figure 2** were actually collected with two different samples, the rating data (**Figure 2B**) in the study reported here and the forced-choice data (**Figure 2A**) in a previous study (Beller et al., 2009b). The German participants in that previous study were as young as the Tongan ones in the current study; still, their response pattern was similar to the (older) German participants in the current study and significantly different from the Tongan participants of the same age.

A final concern revolves around the translatability of the material and raises the question of whether, for instance, the verbs used really mean the same in the two languages under scrutiny. This concern is fueled by the findings from Part 2 on implicit verb causality, which indicated substantial differences in causal assignments even in the absence of context information. If, however, a verb invites causal assignment to the agent in one language, yet to the patient in another, the two may entail different connotations as part of their semantics, and hence may not be equivalent in meaning. This implication of our findings deserves to be taken seriously in future research in this field.

GENERAL DISCUSSION

The prime objective of the study reported here was to explore whether and how language *per se* may affect causal cognition in the physical domain, and how differences between languages may come to bear on these effects. Three potentially relevant factors were targeted: (i) syntactic structure, (ii) the presence or absence of a full-fledged semantic agent, and (iii) the causality implicit in verb semantics. Despite the exploratory nature of the screening, the findings presented here still point toward intra- and cross-linguistic effects on causal assignments that are both interesting and important.

In the floating setting without agent, both speakers of German and of Tongan exhibit biases in their causal assignments, but in diverging directions, with German speakers favoring the patient and Tongan speakers favoring the agent, thus largely replicating a pattern found earlier (Beller et al., 2009a). These assignments are susceptible to syntactic cues such as transitive constructions and prior position in word order. In the breaking setting involving

an animate agent, on the other hand, speakers of German and Tongan alike assign agency primarily to the agent, and almost irrespective of linguistic cueing—except for the non-agentive phrasing (8), for which speakers of German again shift toward the non-agent. And finally, while almost half of the verbs considered here do share implicit notions of causality across languages, thereby triggering similar causal assignments, the other half differ significantly, exhibiting a stronger object or patient focus on average in Tongan than in German, and more so for the "social" than for the "physical" verbs.

In the following, we discuss these main findings with respect to three issues: the domain-specificity of causal cognition, the ambiguous role of the ergative, and more general differences between languages.

Physical vs. Social Settings: How Dependent Are Effects on Content Domain?

A popular assumption, particularly among developmental psychologists, holds that causal cognition is domain-specific (e.g., Hirschfeld and Gelman, 1994; Spelke and Kinzler, 2007; and see Morris and Peng, 1994). However, the extent to which causal assignments in the physical domain differ from those in the social domain on principle grounds is still subject to debate. For instance, while attribution biases appear to occur both in social (Gilbert and Malone, 1995; Norenzayan and Nisbett, 2000) and physical scenarios (Peng and Knowles, 2003; White, 2006, 2007; Beller et al., 2009b; Bender and Beller, 2011), it has remained unclear whether these two are in fact equivalent (Malle, 1999; Sabini et al., 2001; White, 2006). The involvement of agents complicates matters even further: Whereas physical settings typically involve inanimate objects, the occurrence of a full-fledged animate agent is normally restricted to social or at least mixed settings. This has serious implications: First, with an agent, there is typically an inherent and strong asymmetry between participants in a state of affairs (e.g., someone hits someone, someone breaks something). How these thematic roles can be applied to symmetric relations that are at stake in most physical interactions has thus remained an unresolved question until recently (Mayrhofer and Waldmann, 2014). And second, if animate beings or even social actors are involved, they might attract more responsibility ascription *per se* than inanimate objects due to their greater causal effectiveness and self-reflexiveness (Leslie, 1996). This could also explain why a comparison of verb causality for interpersonal events and physical transfer events revealed significant differences (Majid et al., 2007).

In each of the two parts of our study, the two domains were compared at least indirectly. Although both the floating setting and the breaking setting of Part 1 on syntactic variations deal with physical situations and thus do not allow for strong conclusions across domains, the introduction of a proper agent in the breaking setting adds a different quality. And although some of the differences between the two tasks may be content-specific, at least the following aspects are noteworthy: First, striking cross-linguistic differences occurred across the board in the floating setting, but not in the breaking setting, where the two groups

differed for one syntactic variation only. And second, while linguistic variations did have an effect in the floating setting, even if rather weak, this effect largely disappeared (again with one exception) in the breaking setting.

These differences can be explained in reference to the personal agent and in a related manner. The floating setting describes a symmetric physical relation, and although people tend not to perceive the symmetry (White, 2007)—with perception apparently being skewed by culture-specific concepts (Bender and Beller, 2011)—it may still trigger a sensation of ambiguity in at least some of the participants. In such a state, additional cues would be considered helpful to resolve the ambiguity and to come to a decision. The breaking setting, on the other hand, is causally more structured *a priori*, as it involves an animate agent. In this case, no ambiguity arises that would have to be resolved by linguistic cues; the social domain simply dominates the physical domain.

This may even be true for the exceptional case (8) for which the German participants assigned responsibility to the glass (rather than an unknown agent). As suggested by one of the reviewers, this specific sentence may have invoked notions related to a property of glasses, namely that they break easily, rather than notions related to a specific event. While such a property notion is more likely evoked by sentences that use the indefinite noun and a modified verb (as in "Glas bricht leicht" = *glass breaks easily*), the phrasing chosen here is still compatible with such a reading.

The findings of Part 2 on verb causality are more difficult to interpret in this respect. Our selection of verbs is somewhat skewed in comparison to the range that is typically explored in these kinds of studies because the prime goal of this part was to collect data on verb causality for verbs that can be used to describe physical relations. Furthermore, the tasks were implemented as minimal *social* scenarios, in line with the tradition in this field of research. Even if only *minimally* social, this social framing is not sufficiently abstract to prevent content effects (Majid et al., 2007), and it prevents inferences on how these verbs would have behaved in a purely physical context. Another consequence of the testing in minimal social scenarios was that some verbs shifted in meaning when transferred from the physical to the social domain. For instance, the German verb *anziehen* ("to attract")—besides inviting the meaning of "to dress"—refers to different events depending on whether the entities involved are celestial bodies like earth and moon or are human beings, where the term gains a distinctively emotional aspect. In order to be able to address questions of domain-dependence in verb semantics, better controlled experiments are clearly needed in future research.

Agent vs. Patient Focus: The Ambiguous Role of the Ergative

The main assumption behind our interest in effects of syntactic cues was that differences in the relational structure of languages may affect causality assignment; more specifically, speakers of an ergative language may pay more attention to agents that are marked by the ergative. Previous work examining speakers of an ergative language (Duranti, 1994), linguistically untrained deaf children (Goldin-Meadow, 2003), and eye movements of adult English speakers (Griffin and Bock, 2000) indicated that a patient

focus, as inherent in ergative languages, may be a default bias both in attention and language production (Goldin-Meadow, 2003, p. 517): Action or event and the entity directly affected by it attract most of the attention, while agent information is an optional add-on. If, by default, speakers of an ergative language are generally used to receiving information about the action and the entity affected, then introducing a (transitive) agent and marking him or her with the ergative case by way of exception should serve as a particularly potent tool for agency assignment. This is, in fact, what has been observed, for instance in socio-political discourse in Samoa (Duranti, 1994). The observation that, on average, our Tongan participants assigned causality largely—and more strongly so than the German participants—to the agent in each of the two settings (i.e., to the water in the floating setting, and to the man or something/somebody unknown in the breaking setting) would be in line with this hypothesis.

Further support was provided by a study on physical settings, where a change from an intransitive description (phrasing [4] "wood floats on water") to a transitive phrasing with the water in the ergative (phrasing [2] "wood is carried by water") shifted causal assignments among our Tongan participants more toward the water (**Figure 2A**; Beller et al., 2009b). This pattern could be replicated, by and large, in the current study (**Figure 2B**)—although not any longer exclusively for the Tongan speakers, but now also for the German speakers with their non-ergative language. Across the two languages, however, the same effect may also be accounted for by changes in word order, which prevents us from drawing strong conclusions on exactly which linguistic cue is responsible for the shift in assignment.

Moreover, the pattern described above could *not* be replicated in the breaking setting, where the obvious presence of an agent apparently eliminated the seductive effect of a (rather subtle) linguistic cue such as the ergative. Here, it seems as if the default focus on event and patient in ergative languages immunizes their speakers against the adding of information about the agent. Nominative-accusative languages like German, on the other hand, override the patient focus with their accusative structure and may thus sensitize their speakers to the presence or absence of agency information.

The pattern observed for implicit verb causality seems to suggest an interaction with the ergative, but in the *opposite* direction, with those verbs which afford an ergative phrasing being even more strongly object-focused on average than those which do not afford an ergative. However, the sample of items was non-representative and certainly too small to draw strong conclusions from the findings.

Given this mixed pattern of findings, it is difficult to decide whether the presence or absence of ergative case-marking in a given phrasing is actually strong enough a cue to increase or decrease the likelihood of assigning causal power to the agent. Currently, the data from the floating setting—which, with its symmetric configuration and the experimental variation of linguistic cues, can be considered the most informative task for this question—seems to support the former interpretation rather than the latter. Beyond these intra-linguistic cues, however, it seems still plausible that the relational structure of the language (e.g., whether agents of transitive constructions are singled out by

specific case marking) may increase the salience of agency as one of their relevant properties.

Across Languages (and Cultures): How Diverse Is Causal Cognition?

Teasing apart the influences of culture and language on cognition is by no means a trivial undertaking. Not only is language an essential and integral part of culture, which bedevils any attempt to conceptually distinguish the two; it is also challenging to separate them methodologically (Beller et al., 2015; Iliev and Ojalehto, 2015). With the tasks used here, for instance, it is almost impossible to assess whether the stronger object focus on average for the socially salient transactions in Tongan is caused by the cultural value linked to these transactions or whether it has become part of the semantics of the verb. The situation is somewhat clearer with regard to the causal assignments for the physical settings, were the difference between samples (cultural groups) is greater than the difference between conditions (linguistic cues). This does not, however, resolve the question of whether the differences between samples are based on linguistic encoding or cultural entrenching in the first place. In other words, while the relational structure of one's language may affect how people perceive or assign agency, we cannot currently rule out that their respective tendencies are also, or perhaps exclusively so, shaped by culture-specific concepts linked to the setting under scrutiny.

This conceptual question aside, at least some general conclusions with regard to diversity and universality in causal cognition can still be drawn (cf. Beller et al., 2014). Across the board, we found both shared and distinct patterns. The two groups *resemble* each other in that they exhibit biases when assigning causality in the symmetric floating setting, in that (and in how) they respond to linguistic cues, and in most assignments of causality in the breaking setting. They *differ* in the direction of some of these biases, for instance in the floating setting (for other scenarios, see also Bender and Beller, 2011), in how they interpret non-agentive phrasings in the breaking setting, and in how they assign agency in some of the minimal social scenarios. While the similarities seem to support assumptions on general reasoning tendencies (e.g., White, 2006, 2007), the subtle yet pervasive differences between the two groups also point toward a susceptibility of these tendencies to external influences. Given the linguistic variations in Part 1 of our study, for instance, it appears likely that culture-specific schemas of agency and causation shift the focus of attention either more toward the agent or more toward the patient.

Currently, no available theoretical approach is able to account for this. The *proto-agency theory* (Dowty, 1991; Mayrhofer and Waldmann, 2014), for instance, identifies a set of properties on which agency assignment may be based. This might account for the similar patterns in the breaking setting, where "the man" garners three of these properties (i.e., independent existence, sentience/perception, and causation of a change of state), while the scenario remains silent on the other two (volition and movement). It may even be compatible with the difference for the non-agentive scenario (phrasing [8] "the glass breaks"), namely

when assuming that participants differ in whether or not they imagine a person as part of the scenario. However, the *proto-agency theory* cannot (yet) explain the cultural differences in the floating setting, where the causal assignments of German and Tongan speakers co-vary with the manipulations in linguistic cues, but generally differ in the entity on which they focus as mainly causative. For a better understanding of such cultural influences, we thus not only require more empirical data, but also advancement in theoretical models (Beller and Bender, 2017).

CONCLUSION

Despite the relevance of causal cognition as a core topic for the cognitive sciences, previous research has paid only incidental attention to culture as a possibly constitutive factor (Bender et al., 2017)—a desideratum that is only slowly being addressed (e.g., by the contributions to Beller et al., 2014). In the two parts of the screening study reported here, we intended to explore the potential for cultural and linguistic influences by addressing two related questions: Are assignments of causal role domain-specific (by contrasting settings that do vs. do not involve a human agent), and are they affected by emphasis on the conceptual agent (by varying linguistic cues related to agency)? Our findings suggest that such linguistic cues do affect how people represent and explain causal facts and events, but that language-specific properties may also contribute to differences in people's responses. Assumptions about the mechanisms generating these differences are necessarily tentative, as the study was exploratory

and its design did not warrant conclusive inferences. One of the questions still open for future research is whether what we found primarily reflects what people perceive vs. what they express. The most important contribution of the current study to the field is therefore that it has demonstrated the susceptibility of causal cognition to cultural and linguistic influences, even in the physical domain, and that it has identified some of the factors worth investigating more thoroughly.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Ecological and cosmological coexistence thinking in a hypervariable environment: causal models of economic success and failure among farmers, foragers, and fishermen of southwestern Madagascar

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A fact of life for farmers, hunter-gatherers, and fishermen in the rural parts of the world are that crops fail, wild resources become scarce, and winds discourage fishing. In this article we approach subsistence risk from the perspective of "coexistence thinking," the simultaneous application of natural and supernatural causal models to explain subsistence success and failure. In southwestern Madagascar, the ecological world is characterized by extreme variability and unpredictability, and the cosmological world is characterized by anxiety about supernatural dangers. Ecological and cosmological causes seem to point to different risk minimizing strategies: to avoid losses from drought, flood, or heavy winds, one should diversify activities and be flexible; but to avoid losses caused by disrespected spirits one should narrow one's range of behaviors to follow the code of taboos and offerings. We address this paradox by investigating whether southwestern Malagasy understand natural and supernatural causes as occupying separate, contradictory explanatory systems (target dependence), whether they make no categorical distinction between natural and supernatural forces and combine them within a single explanatory system (synthetic thinking), or whether they have separate natural and supernatural categories of causes that are integrated into one explanatory system so that supernatural forces drive natural forces (integrative thinking). Results from three field studies suggest that (a) informants explain why crops, prey, and market activities succeed or fail with reference to natural causal forces like rainfall and pests, (b) they explain why individual persons experience success or failure primarily with supernatural factors like God and ancestors, and (c) they understand supernatural forces as driving natural forces, so that ecology and cosmology represent distinct sets of causes within a single explanatory framework. We expect that future cross-cultural analyses may find that this form of "integrative thinking" is common in unpredictable environments and is a cognitive strategy that accompanies economic diversification.

Keywords: culture, risk, causal cognition, unpredictability, traditional knowledge, cosmology, Madagascar

Introduction

The subsistence farmer, forager, and fisherman contemplating choice of crops, livestock, and prey inevitably faces the reality that crops fail, livestock sicken and die, foragers and fishermen come home empty handed, and selling prices in the marketplace drop. Sometimes the causes of economic failures are easily observable. Crops may fail because of drought or pests or because the farmer did not spend enough time weeding, and a fisherman may return to shore with low catch due to unfavorable winds. In other cases the reasons for failure may be less apparent. A farmer may lose a bountiful crop the night before she intends to harvest due to a sudden windstorm or grasshopper swarm. A fisher may unexpectedly find that a batch of fish prepared for smoking have turned rotten.

Human minds in their social contexts search for patterns and meaning behind the causes of success and failure. People search for covariations between environmental cues and subsistence outcomes, in order to better predict, and thus seek to control, their harvests of crops and wild resources. When unexpected failure happens, people ask deeper questions such as why *my* field was destroyed and not my neighbor's. Covariation theories (Nisbett and Ross, 1980, p. 90–112), knowledge of the base rate frequencies with which things happen (Cheng, 1997; Griffiths and Tenenbaum, 2005), and learned mechanisms for causality (Ahn et al., 1995) are the building blocks composing cultural models of causality (Waldmann et al., 2006) that people use to make important subsistence choices and understand their fortunes.

Subsistence risk is exactly the type of domain where one would expect what Legare et al. (2012) call "coexistence thinking," the simultaneous application of natural and supernatural models of causality to explain why things happen. The ethnographic record is replete with examples of farmers, hunter-gatherers, and fishermen using a mix of ecological knowledge and cosmological knowledge when making important decisions (Rappaport, 1968; Poggie and Pollnac, 1988; Lansing, 1991; Malinowski, 1992[1948]; Dove, 1993; Birkes et al., 2000; Orlove et al., 2000; Hunn et al., 2003). Contrary to Victorian and modernist notions that supernatural causality constitutes primitive thought (Tylor, 1958[1871]) or childish thought (Piaget, 1928) that is eventually replaced by a more sophisticated understanding of the clockwork of the natural world, a recent review of experimental studies demonstrates that coexistence thinking is pervasive in modern, urban, educated contexts, and that adults often endorse supernatural causes *more frequently* than children (Legare et al., 2012).

How and when one may explain fortune and failure with wind and rain versus angels and ancestors is an open question, one that we pursue in this article. In a recent review by Legare et al. (2012) they present a typology of coexistence thinking. In "target-dependent thinking," reasoners pick and choose natural and supernatural causes to explain different components of a phenomena or in different contexts. For example, in a study of AIDS etiology in South Africa, Legare and Gelman (2008) quoted one informant as saying that "witchcraft may cause a disease that looks like AIDS." In the context of people's understanding of the

origins and diversity of life, a reasoner may justify divine creation for humans because of a belief in the eternal soul but endorse natural selection for a purportedly soulless animal (Evans et al., 2011). Target dependence suggests that natural and supernatural causal systems are separate and sometimes in conflict with one another.

In "synthetic thinking," natural and supernatural causes are alike and co-exist within a single causal system, so that unsafe sex and witches both cause AIDS, and natural selection and God both influence life's diversity. Synthetic thinking implies that natural and supernatural forces are unified into a single explanatory system. Ethnographic descriptions of some indigenous South American cosmologies suggest that some people understand persons, animals, and spirits to be commensurate anthropomorphic agents (Descola, 1996; Viveiros de Castro, 2000; but see Ramos, 2012), thus eschewing the natural/supernatural dichotomy.

"Integrative thinking" refers to causal models where supernatural forces drive natural forces; witchcraft causes people to have unsafe sex and get AIDS, and God created the diversity of life by means of natural selection. The best-known ethnographic example of integrative thinking is probably Evans-Pritchard's (1937) description of Zande witchcraft in southwestern Sudan. Zande understand that the cause of a granary collapsing is that termites have eaten the wooden supports. But the ultimate cause, the reason why termites attacked *that* particular granary so that it fell when someone happened to be resting in its shadow, is witchcraft, an evil power unleashed by a neighbor's secret, jealous thoughts. In integrative thinking, natural and supernatural causes are categorically differentiated but occupy the same explanatory system.

Although a population may apply all three modes of coexistence thinking to the same causal problem, in the studies reviewed by Legare et al. (2012, p. 790) subjects do not apply each mode with the same frequency. For example integrative explanations are the least common in studies of people's understanding of death as biological cessation versus continuity into an afterlife (Harris and Giménez, 2005; Astuti and Harris, 2008), presumably because biological death and ancestral continuity are contradictory (although Astuti and Harris insist that Vezo fishermen have no problem accepting both).

This demands the question whether the frequency with which people use target-dependent, synthetic, or integrative thinking is the result of differences in the causal problems being solved versus differences in the populations, or both. Variability across causal problems is likely to be the results of the ecology of risk associated with each problem. The causal problems involved in rural subsistence strategies, such as forecasting rainfall, harvests, or fishing returns, are influenced by ecological factors such as climatic variability, predictability and the visibility of cues and covariations foreshadowing future events. Inter-population variability would likely be due to different culturally learned causal models that compose what anthropologists have called traditional ecological knowledge (Dove, 1993; Birkes et al., 2000; Orlove et al., 2000; Hunn et al., 2003) and cosmology (Descola, 1996; Viveiros de Castro, 2000; Howell, 2012).

The case study from southwestern Madagascar presented in this paper is intriguing because characteristics of the ecology and culture seem to favor contradictory strategies to minimize risk. The ecology (specifically, the climate) is characterized by extremely high variability and unpredictability, so that the best way to avoid risk is diversification and behavioral flexibility. The culture (specifically, the cosmology) explains risk as caused by disgruntled spiritual agents, so that people live in a state of spiritual insecurity, "the sense of danger, doubt, and fear arising from an awareness of exposure to invisible forces acting to cause misfortune" (Ashforth, 2010, p. 43). The best way to avoid risk associated with spiritual insecurity is to restrict the range of one's behaviors.

Antarctic winds, cyclones, and el Niño events conspire to give Madagascar one of the most variable and unpredictable climates in the world (Wright, 1999), what Dewar and Richard (2007) call "a hypervariable environment." In a comparison of monthly rainfall data, Dewar and Richard (2007) found that rainfall is less predictable across 15 Malagasy weather stations contrasted to 15 stations in continental Africa, where predictability was evaluated after Colwell (1974) as variability that does not covary with month or season (low contingency). Toliara, in southwestern Madagascar near where our study is set, had the second lowest predictability score with a Colwell's P of 0.281. This means that even with exceptional ecological knowledge a subsistence decision-maker can only ever have 28% confidence in monthly rainfall forecasts. Farmers, foragers, and fishermen throughout the world often cope with ecological unpredictability by diversifying their portfolios of crops, prey, and market activities (Winterhalder et al., 1999), and this is a common strategy in southwestern Madagascar (Tucker, 2001, 2006, 2007a,b; Tucker et al., 2010, 2013).

Ancestors, spirits, and a distant creator God observe the living and reward and punish people according to how well their behavior demonstrates respect. Crops fail and foragers and fishers come home empty handed because people transgress the behavioral code of taboos, offerings, other "cosmo-rules" (to borrow a phrase from Howell, 2012), either mindfully or accidentally.

A southwestern Malagasy person who wishes to avoid misfortunes caused by disrespected spiritual agents should observe dietary taboos, follow the astrological calendar of good and bad days for subsistence labor, respect elders and traditional magico-religious specialists, and not travel too far from the houses of the protective spiritual agents, in tombs, enchanted trees and rocks, and in the miniature houses that spirit mediums construct behind their homes. But reducing the risks caused by extreme weather conditions requires tracking a changing environment and planning for multiple contingencies. It may require exploiting a range of resources including those that are taboo; scheduling labor flexibly, even when the astrological calendar indicates that the day is not propitious for working; and traveling far from one's homeland to exploit distant fields and patches and traffic goods to market, distant from the terrain of protecting spirits.

In this paper we consider the question of how southwestern Malagasy people combine causal models involving wind and rain which seem to advise flexibility with causal models involving God and spirits that seem to prescribe conformity. Legare et al.'s (2012) modes of coexistence thinking suggest three possibilities. One possibility is that our informants use target-dependent thinking; they carry contradictory models around in their heads simultaneously without justifying one with the other. As they apply each model in different circumstances they bounce between conforming and flexible strategies. A second possibility is that they consider rain, wind, God, and spirits to belong to a single category of causes, composing a synthetic causal model with a consistent internal logic. A synthetic model could prescribe both conformity and flexibility in different circumstances, for example, providing ritual ways to permit diversification, for example, to excuse exploitation of taboo resources or permit distant travel. A third, integrative possibility is that natural and supernatural forces belong to separate categories but a single causal model, where supernatural forces drive natural outcomes. Using an integrative model, farmers, foragers, and fishers may make subsistence choices using ecological knowledge, but then apply cosmological knowledge after the fact to explain the successes and failures of their forecasts and strategies. Our previous ethnographic observations suggest that all three possibilities are plausible.

We examine these possibilities in light of the findings from three field studies conducted in southwestern Madagascar. In the first study we asked groups of informants to rate and explain the risk associated with different crops, prey, and market activities. We predicted that the groups would rate risks concordantly with each other, indicating a shared body of cultural knowledge. A second prediction, following Malinowski (1992[1948]), was that people would cite more supernatural causes for riskier activities. The first prediction is confirmed for the sample at large with the exception of Vezo coastal fishers. In contrast to our second prediction, informants listed almost entirely natural causes of risk such as rainfall and pests.

In the second study we asked individuals to explain the reasons why a hypothetical man in a vignette harvested more than his friend. We conducted an economic and a religious version of the vignette to see whether subjects would provide more natural causes in the former and more supernatural causes in the latter, consistent with target-dependent thinking. Instead, in both versions of the vignette informants provided primarily supernatural causes like God and ancestors. When taken together with the findings of Study 1, this suggests that our informants understand activities as responding to natural causes while personal successes and failures result from supernatural forces, consistent with integrative thinking.

The third study used a card sorting activity to examine the causal flow of natural and supernatural factors, including God, ancestors, weather, and harvest (similar to Lynch and Medin, 2006). A target-dependent thinker with competing causal epistemologies might depict independent natural and supernatural chains of causes. A synthetic thinker who treats natural and supernatural factors as coinfluential would likely depict bilateral causal interactions among natural and supernatural factors. Instead, results support a hierarchy of causal factors with supernatural forces driving natural forces

(integrative thinking). The specific form of the causal flow involves humans begging ancestors to beg God for good weather resulting in a good harvest.

We propose that when reasoning about activity risk divorced of personal context southwestern Malagasy reason within a natural causal submodel or level represented by the last two links in this chain (weather → harvest), but when reasoning about people they employ the whole chain, (humans → ancestors → God → weather → harvest). Thus in southwestern Madagascar, natural and supernatural forces are categorically distinct but occupy a single causal model rather than forming competing epistemologies. We conclude with a discussion of the significance of these findings for understanding the influences of culture and ecology on coexistence thinking, and by considering whether "natural" and "supernatural" mean the same thing in rural Madagascar as they seem to mean in Western scholarly discourse.

Research into the effects of culture and ecology on how people understand the causal influence of natural and supernatural factors on economic outcomes is significant for several reasons. Decision-making under risk is a classic topic within economics where it is modeled using probability theory (Bernstein, 1996), despite a growing body of evidence that people do not think in terms of probability distributions (Kahneman and Tversky, 1979; Gigerenzer and Selten, 2001). This article offers a cognitive perspective on subsistence risk, and explores how culture and ecology co-influence people's understanding of risk. More generally, it is significant to understand how human minds in their social contexts understand and organize causal knowledge because this forms shared concepts of reality (ontology) and ways for understanding this reality (epistemology). Studies of the cultural and ecological determinants of coexistence thinking may help us address the classic question whether all humans basically understand the world as working in the same general way (psychic unity of humankind) or whether thought is an infinitely variable cultural construction (cultural relativism; Stocking, 1987; see discussion in Bender and Beller, 2011; Bender et al., 2012).

The Cultural Context

Southwestern Malagasy

The people of Madagascar are unified by a single language and a similar set of traditional cosmological beliefs and practices, yet there is significant inter-regional variation in dialects, customs, habits, beliefs, norms, and social institutions. This article pertains specifically to Malagasy people living in the arid southwest between the provincial capital of Toliara and the port of Morombe. We refer to these people collectively as "southwestern Malagasy," although they refer to themselves as Masikoro, Mikea, and Vezo. These are not ethnic groups in a traditional sense, for "ethnic" implies that identity is inherited from parents and is perceived to be intrinsic and essential, whereas identity in southwestern Madagascar is more flexible than this (Astuti, 1995, 2001; Astuti et al., 2004).

Southwestern Malagasy commonly claim that to be a Masikoro means that one is a farmer, a herder, and savanna dweller, while

a Mikea is a forest-based hunter-gatherer, and a Vezo is a coastal gatherer, fisher, and sailor. Mikea informants have often told us that "Mikea" is a livelihood (*velomampò*) and not a "kind of person" (*karazan'olo*) and that all hunter-gatherers in the world are Mikea. Astuti (1995) reports similar statements from Vezo about fishing and fishermen.

In practice this simple classification meets with perpetual exceptions. There are savanna farmers who call themselves Mikea, coastal Vezo who farm, and Masikoro fishermen. Households also tend to be diversified, with different members practicing a range of farming, foraging, fishing, herding, and marketing activities, with activity portfolios changing over time. We have argued that most of the contradictions are resolved if we recognize that people also cite family, clan, and community histories as reasons for claiming Masikoro, Mikea, or Vezo identity. These histories trace back to the precolonial Andrevola kingdom. People identify as Masikoro in part because their ancestors were vassals to the Andrevola kings, while Mikea and Vezo recall ancestors who resisted royal domination by hiding in the forest or sailing away to sea (Yount et al., 2001; Tucker, 2003). In this article we assume that Masikoro, Mikea, and Vezo constitute a single cultural group where members move in and out of multiple subsistence options.

Risk and Ecology

Southwestern Madagascar is a semi-arid limestone shelf bordered by the Onilahy and Mangoky Rivers. The landscape is diverse. Within the span of a 100 km east–west transect one may traverse grassy savanna and savanna woodlands; the dense, dry, deciduous Mikea Forest (*Alamikea*); the lakebeds, dunes, and thorn forests of the Namonte Basin; followed by coastal mudflats, mangroves, the shallow Bay of Fagnemotse; then white sandy beaches and a barrier reef. Farmers plant crops like maize (*Zea mays*), manioc (*Manihot esculenta*), and rice (*Oryza sativa*) in rainfed and irrigated savanna fields, in forest swiddens, and in gardens in the Namonte lakebeds on the coast. Foragers dig wild *ovy* tubers (*Dioscorea acuminata*) in the deciduous forest, gather estivating tenrecs (African hedgehogs, *Echinops telfairi*), and fish in the fresh waters of the Namonte Basin and lake Ihotre. On the coast people gather mud crabs (*Scylla serrata*) in the mangroves, collect octopus (*Octopus cyanea*) and sea cucumbers (*Holothuria* and *Scabra* sp.) in the shallows before the reef, and fish for finfish, shark, and sea turtles with lines and nets. Masikoro and Mikea sell an average of 45% of their production in local markets and to exporters, while Vezo sell an average of 87% (Tucker et al., 2010, 2013).

Our previous research into subsistence risk in the region finds that agriculture produces more food by quantity but at considerably greater risk than foraging or fishing (Tucker et al., 2010). A useful way to illustrate this is with a thought experiment. Imagine that an individual will spend 90 days on just one subsistence activity. 90 days of labor spent cultivating maize would result in a two-hectare field that would produce an average of 1862 kg maize, or roughly 6.8 M calories. By contrast, 90 days spent digging wild ovy tubers yields an average of 864 kg or 1.0 M calories. However, the maize farmer invests all her hopes on a single harvest, one that is highly dependent on good rainfall

and sparse pests. The wild tuber forager harvests every day, distributing her risk over 90 foraging trips. If a tuber forager has a string of bad days she can move to a part of the forest that received more rain or switch prey, options that are not available to the farmer. In a set of simulations following this logic, we found that agriculture tends to be an order of magnitude more risky than foraging and fishing (Tucker et al., 2010). When asked to rate the risk of their subsistence activities, Masikoro, Mikea, and Vezo in 24 focus groups generally agreed that agriculture is riskier than foraging and fishing (Tucker et al., 2013).

Previous Evidence for Covariation Theories

In a previous study we tested whether southwestern Malagasy have consistent covariation theories linking rainfall and the outcomes of farming, foraging, and fishing activities using an historical matrix exercise in fourteen communities (10 Mikea, two Vezo-Mikea, and two Masikoro) in 1999 (Tucker, 2007a). The method involved creating a tabular grid of playing cards on the ground in which rows represent the past 5 years, the first column represents rainfall, and subsequent columns represent crops and prey. A group of informants was instructed to work together to pour sand on to each card representing the quantity rainfall or harvest in each year. Working as a group engendered conversation. Of 95 comments that we recorded, 22 were statements of quantity (e.g., "a lot"), 28 were statements of events ("the year of the big cyclone"), and 45 were statements of rules ("when there is a lot of rain, there is no honey"). Rule statements and rank-order correlations between the sand piles in the rainfall and harvest columns were quite consistent. Groups agreed that, "when there is no rain, there is no maize," "manioc hates rain," "rain destroys rice irrigation schemes," and "fish drink water, too" (meaning, there are more fish in rainy years). This evidence suggests that southwestern Malagasy have shared ecological knowledge of the causal interactions between rainfall and economic outcomes.

Cosmology

In the traditional cosmology of southwestern Madagascar the creator God *Ndragnahare* (called *Zanahary* or *Andriamanitra* elsewhere in Madagascar) is distant and people interact most commonly with ancestors (*raza*) and spirits that possess mediums in trance ceremonies (*doane*). These invisible forces observe the personal lives of human beings and their judgment results in triumphs or failures.

Recent theories about the evolution of religion have proposed that rewards and punishments by omniscient "high moralizing gods" (Norenzayan, 2013) or by a "broad spectrum" of moralizing supernatural agents (as Watts et al., 2015 argue is more appropriate to Austronesian cultures) function to reinforce cooperative norms by rewarding niceness and punishing selfishness. Malagasy cosmology fits imperfectly within this scheme. In Madagascar, the ancestors and other spirits are not omniscient, they may deceive and be deceived, and the moral code they reinforce is primarily one of respect, for God, for the universe, and especially, for the spiritual agents themselves and their earthly representatives, elders, spirit mediums, and diviners

(Ruud, 1960; Feeley-Harnik, 1991; Sharp, 1993; Graeber, 2007; Astuti and Bloch, 2015).

For example, a man may commit a selfish act like killing his neighbor's livestock out of jealously. Ancestors and other spirits are unlikely to punish this offense. The livestock owner may consult a diviner who may, through divination with grains (*sikily*), learn from the spirits that the neighbor is guilty and that the neighbor has "bad ideas" (*raty hevitse*) or "a bad soul" (*raty say*). Still, spirits issue no punishment. But had the bad person killed cattle that had been allocated for sacrifice to the ancestors, this would have been a clear offense that the ancestors would have punished forthwith.

Although ancestors, spirits, and God rarely directly reward interpersonal niceness and punish meanness, the code of respect that they enforce is prosocial, for it creates the traditional social structure. Ancestors may be capricious and selfish but they are essentially good because they connect the living to tombs (*lolo*), to the land (*tanindraza*), to one's clan (*firazagna*), and one's community (*filongoa*), securing one's social identity, right to material and social resources, and membership in a larger intergenerational corporate program (Bloch, 1971, 2008; Feeley-Harnik, 1991; Graeber, 2007). Participating in clan activities and maintaining community sentiment requires interpersonal niceness (and sometimes meanness to enemies or criminals), even though interpersonal acts are not the major concern of supernatural agents[1].

People consult with the spirit world by performing clan ceremonies and livestock sacrifice to honor ancestors under the direction of the clan head (*mpitokazomanga*), through trance ceremonies with mediums (*tromba*), through divination under the guidance of the diviner (*ambiasa,* called *ombiasy* elsewhere in Madagascar), and, for a rare few, through knowledge of astrology (*andro, vinta*). People demonstrate respect for the supernatural primarily by respecting a code of dangers or taboos called *faly* (*fady* elsewhere in Madagascar) that limits dietary choices, sexual behavior, clothing, mobility, permissible speech, and other behaviors (Ruud, 1960). Each individual has her own personal set of *faly* associated with place, clan, astrological destiny (*vinta*), and magical charms (*aoly*). People acknowledge a common calendar of good and bad days for different activities (*andro*). Most people know that one should refrain from work on Mondays and Thursdays; some also know the taboos associated with particular month-day combinations, and the correspondence of dates with stellar positions.

In a survey of 550 Masikoro, Mikea, and Vezo in the study region we found that 17% claimed to be Lutheran (mostly Masikoro) and 17% claimed to be Catholic (mostly Vezo). While some Christians publicly eschew traditional religion,

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[1]Interpersonal magical attacks (sorcery) compose a parallel moral system. Returning to the example of the man who discovers though divination that his jealous neighbor has killed his livestock, the man could ask the diviner to encourage the spirits to cause harm to the wrongdoing neighbor. Only a minority of sorcerers are capable of attack magic (*vorike*), for it requires "dirty" magical substances (*volohazomaloto*) and is generally considered to be immoral. The moral code enforced by sorcery may encourage niceness (to avoid attacks by neighbors) as Evans-Pritchard (1937) argued for Zande witchcraft; but, judging by the amount of gossip we hear on the topic and the ubiquity of the protective magic that people wear, sorcery seems to encourage suspicion, envy, enmity, and discord.

many self-identifying Christians in the region host and attend traditional ceremonies, consult with clan heads, spirit mediums, and diviners, and show every other sign of conforming to traditional Malagasy cosmological expectations.

Study 1: Popular Concepts of Risk for Subsistence Activities

The first study has been published elsewhere framed in pursuit of a different set of questions (Tucker et al., 2013); the study is reviewed here in light of its contributions to the topic of coexistence thinking. Study 1 explored shared concepts of risk for different crops, prey, and market activities, and the causes for activity risk. In the context of group interviews we asked people to define risk, list their subsistence activities, provide reasons why each activity is risky, and then rate the risk of each activity on a four-point scale. If our informants use coexistence thinking when reasoning about subsistence risk then the groups should cite a combination of natural and supernatural causes for activity risk. A second prediction, inspired by Malinowski (1992[1948]), was that people would cite more supernatural causes for higher risk activities. Our third prediction was that if informants have a consistent body of knowledge about risk, groups should rate risks concordantly.

Sample

We interviewed groups rather than individuals because we were interested in shared, public knowledge, and group interview settings encourage individuals to provide "normal" answers (Smithson, 2000). We convened 24 sex-segregated focus groups in 12 villages in 2008. The villages were a mix of Masikoro farmers ($N = 3$ sites), Mikea forager-farmers ($N = 6$ sites), Vezo coastal fishers ($N = 2$ sites), and Tandroy farmers ($N = 1$ site; Tandroy migrated to the region from southern Madagascar in the 1930s). Group interviews occurred after a meeting with the townspeople (*fokon'olo*) in which we explained our research objectives and sought community consent. We divided the pool of willing adults into male and female groups of 6–10 each and sought oral consent to conduct the research. Two Malagasy researchers of the same sex as the informants posed the questions.

First we asked people to define risk. Two words for risk had come to our attention in previous research: *risike*, from the French *risque*, and *kitahitahy*, which literally means "little blessing" but could also mean potential fortune. We did not seek to distinguish one term from the other but simply asked the informant to explain *risike* or *kitahitahy* and let them choose which word to use[2]. Then we asked the assembly to list their most significant subsistence activities and to rate each subsistence activity on a four-point scale: not risky (*tsy misy risike*), low risk (*risidrisike avao*), risky (*misy risike*), or very risky (*risike mare*). As the groups discussed their ratings we asked them to provide reasons (causes) for why each activity is potentially risky.

Research participants were served cookies and coffee, and no other compensation was provided. This method was approved by the Institutional Review Board at the University of Georgia (2007-10358-0).

Results

From the 24 focus groups we received 31 definitions of risk, which fall roughly into four categories: risk is something you must face in order to gain something ($N = 19$), risk means you might win or you might not ($N = 12$), risk is something that requires courage to face ($N = 12$), and risk is what happens when many factors predict an outcome ($N = 4$). Of the 31 definitions, only three, belonging this final category, mentioned supernatural causes.

The groups listed 53 unique crops, prey, and other economic activities. Average activity risk ratings are calculated over different Ns because some activities were listed by only one group while others were listed by all 14. **Table 1** summarizes the risk ratings for activities listed by four or more groups. The seven agricultural activities are all listed among the top 12 riskiest activities alongside collecting sea cucumbers and marine line fishing and big game hunting (bushpig, shark). Across all 53 activities the average ratings were, for agriculture, $M = 1.96$, $SD = 0.80$; for forest foraging, $M = 0.98$, $SD = 1.05$; for marine foraging, $M = 1.94$, $SD = 0.91$, and for marketing activities, $M = 1.09$, $SD = 1.12$. For those activities listed by at least four groups, the ratings were, for agriculture, $M = 2.09$, $SD = 0.69$; for forest foraging, $M = 1.03$, $SD = 1.05$; for marine foraging, $M = 2.00$, $SD = 0.80$, and for marketing activities, $M = 1.13$, $SD = 1.07$.

Table 2 summarizes inter-group agreement as measured by Cohen's Kappa. This analysis was conduced on a dataset of all unique combinations of paired ratings for each product ($N = 606$). On average there was a 42.74% agreement across all pairs of ratings, which is significantly greater than the 29.72% agreement expected by chance $\kappa = 0.18(606)$, $p \leq 0.001$. Landis and Koch (1977, p. 165) label this "moderate" consensus. Inter-group agreement was moderate for men $\kappa = 0.32(135)$, $p \leq 0.001$, just above traditional 0.05 alpha levels for women $\kappa = 0.08(139)$, $p = 0.066$, and significant for Masikoro $k = 0.22(48)$, $p = 0.005$, Mikea $\kappa = 0.16(168)$, $p \leq 0.001$ and Tandroy $\kappa = 0.80(9)$, $p \leq 0.001$, but not Vezo $\kappa = 0.10(43)$, $p = 0.153$.

In total, informants offered 239 causes for risk. Nearly all were natural causes, including pests ($N = 79$), rainfall ($N = 35$), dangerous encounters with animals, bandits, or gendarmes ($N = 26$), and risk of injury ($N = 18$). Only two of the 239 causes were supernatural. A Mikea woman said success fishing for snakehead fish depends on the astrological significance of the day (*andro*). Another Mikea woman said that honey foraging is risky because one might encounter a *tsiboko*, an undead creature with glowing red eyes.

Discussion

Our first prediction was that groups would supply a mix of natural and supernatural causes for activity risk, consistent with coexistence thinking. Much to our surprise, both risk definitions and causes of risk were almost entirely earthly and secular. This could suggest that our informants preferentially rely on ecological

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[2]In the risk definitions, seven responses used the term *risike*, including at least one Masikoro, one Mikea, and one Vezo speaker. Two responses used *kitahitahy*, both Mikea (although two other Mikea used *risike*). One speaker, a Masikoro woman, used both terms.

TABLE 1 | A rank ordered summary of groups' average risk ratings for activities listed by four or more groups.

Activity	Crop/prey scientific name	Subsistence mode	N (focus groups who rated)	Average risk (0 = not risky–3 = very risky)	Standard deviation (disagreement)
Lesser hedgehog tencec	*Echinops telfairi*	Forest foraging	7	0.14	0.38
Trapping birds	Various *sp.*	Forest foraging	4	0.25	0.50
Wage labor replanting rice		Market	7	0.43	0.79
Digging *ovy* tubers	*Dioscorea acuminata*	Forest foraging	8	0.50	0.76
Freshwater fishing, line	*Tilapia* sp.	Forest foraging	4	0.75	0.96
Gathering and selling fuelwood		Market	9	0.78	0.97
Wage labor, rice tilling		Market	6	0.83	0.98
Hunting mouse lemur	*Microcebus murinus*	Forest foraging	4	1.00	0.82
Tobacco retailing		Market	4	1.00	0.82
Coffee vending		Market	9	1.56	1.01
Marine finfish, with net	Various sp.	Marine fishing	6	1.67	0.81
Shop keeping		Market	11	1.73	1.19
Honey gathering	*Apis mellifera*	Forest foraging	8	1.75	0.89
Sea cucumber gathering, night	*Holothuria* sp.; *Scabra* sp.	Marine fishing	4	1.75	1.26
Pumpkin	*Cucurbita pepo*	Agriculture	6	1.83	0.41
Sea cucumber gathering, day	*Holothuria* sp.; *Scabra* sp.	Marine fishing	6	1.83	0.98
Gathering octopus	*Octopus cyanea*	Agriculture	7	1.86	0.38
Vohem beans	*Phaseolus* sp.	Agriculture	7	1.86	0.38
Sweet potato	*Ipomoea batatas*	Agriculture	9	1.89	0.60
Onion	*Allium cepa*	Agriculture	5	2.00	0.71
Maize	*Zea mays*	Agriculture	12	2.08	0.90
Marine finfish, line	Various sp.	Marine fishing	5	2.20	0.45
Manioc	*Manihot esculenta*	Agriculture	14	2.21	0.70
Rice	*Oryza sativa*	Agriculture	9	2.56	0.73
Bushpig hunting	*Potamocorus larvatus*	Forest foraging	5	2.80	0.45
Shark netting	Unidentified sp.	Marine fishing	4	3.00	0.00

Adapted from Tucker et al. (2013, p. 401–402).

knowledge when reasoning about activities, or that the domain of subsistence is immune from coexistence thinking. It is also possible that the public nature of group methods discouraged discussion of supernatural causes. Our second prediction, that southwestern Malagasy would provide more supernatural causes for riskier activities, is not supported given that almost no supernatural causes were provided.

Our third prediction, that our informants would largely agree about the riskiness of their activities, received partial support, for

TABLE 2 | Summary of analysis of agreement between all pairs of risk ratings for the same activity, using Cohen's Kappa.

Sample	N (pairs rating activity)	Agreement (%)	Agreement expected by chance (%)	Kappa	z	p
All	606	42.74	29.72	0.18	7.70	0.000
Women	139	30.94	25.52	0.08	1.50	0.066
Men	135	58.52	39.03	0.32	5.14	0.000
Masikoro	48	45.83	30.73	0.22	2.59	0.005
Mikea	168	38.10	26.53	0.16	3.48	0.000
Vezo	43	44.19	37.75	0.10	1.02	0.153
Tandroy	9	88.89	44.44	0.80	3.34	0.000

Adapted from Tucker et al. (2013, p. 402).

there was moderate agreement in risk ratings across the whole sample, excluding Vezo. The low agreement in the Vezo sample is likely due to the fact that Vezo are the most specialized on one mode of subsistence, marine foraging, and listed exclusively fishing and market activities. The ordered list of perceived risk in **Table 1** shows that activities roughly cluster by mode, so that forest foraging activities are lowest risk, marine fishing is moderately risky, and agriculture is the most risky. Southwestern Malagasy may agree more on the order of risk among these modes rather than among individual activities within these modes. We do not have a satisfactory explanation for why there was less agreement among the female focus groups than the male groups. We would expect men and women to have similar experience with most of these crops and prey, for men and women work in the same fields and forage for the same terrestrial resources (excluding bushpig, which are exclusively hunted by men), although the division of labor is clearer for marine fishing, where men exploit deeper waters.

Study 2: Differential Economic Success Vignette

The purpose of the next study is to get a clearer picture of when and how southwestern Malagasy employ coexistence thinking.

While study 1 asked about *activity* risk, in this study we asked individuals to discuss why *persons* succeed or fail. The method involved a vignette about two men, Reolo and Tsiato[3], who are good friends but not close kin, who discover one day that Reolo consistently harvests more than Tsiato. Informants were asked to provide possible causes for Reolo's greater success. We conducted two versions of the vignette, one framed around a market scene and the other around a funeral. If the domain of subsistence is immune to coexistence thinking, then we would predict that informants would provide primarily natural causes, as they did in the previous study. Target dependence would be demonstrated if our informants primarily provided ecological causes when the vignette was framed around a market scene and supernatural causes when framed around a funeral scene. Synthetic thinking should lead to informants providing a mix of natural and supernatural causes as if these were commensurate kinds of influencing factors. If participants favor supernatural causes (in contrast to Study 1), then a few interpretations are possible. They may be using a kind of target-dependent thinking with which they explain activity risk (Study 1) and personal risk (Study 2) with competing causal models. Or it could be that they understand harvests to be the result of natural forces where natural forces are ultimately influenced by supernatural forces that reward and punish individuals (integrative thinking).

Sample

These data were collected in the Mikea community of Bevondrorano and the Vezo village of Lamboara in 2014. Bevondro is a series of Masikoro and Mikea villages clustered around two small lakes on the eastern edge of the Mikea Forest, where people divide their time among forest foraging, lake fishing, and floodplain cultivation of manioc, sweet potatoes, and rice. Bevondrorano is one of the Bevondro villages, settled within the past 2 years by Mikea displaced by the new Mikea Forest National Park[4]. Bevondrorano is home to Mikea we have

known since the 1990s from forest camps and the villages of the Namonte Basin. The Vezo village of Lamboara, located on a small island in the mouth of the Bay of Fagnemotse, is among the older settlements on the Vezo coast, having been established in the 19th century.

The samples for Studies 2 and 3 are described in **Table 3**. For Study 2 we recruited 12 adult participants in Bevondrorano (nine women, three men) and 24 in Lamboara (14 women, 10 men). Nine Lamboara people also participated in Study 3. Due to time constraints we did not attempt random sampling. These samples represent roughly a quarter of the total population in both communities.

Method

We interviewed individuals in the shade of our camp or near their homes. We attempted to talk to people in private, but participants were sometimes accompanied by a spouse or friend, and by young children in their care. After obtaining oral consent we began with a series of questions about the individual's household size, education, frequency of church attendance, and ownership of a set of productive and luxury assets, from which we calculated a wealth score[5]. The instrument is presented in its original Malagasy form and in English in supplemental materials.

We administered an economic and a religious version of our vignette, each to half the sample. The script for the economic version of the vignette is as follows.

I am going to tell you an imaginary story about two men, Reolo and Tsiato. Reolo and Tsiato are good friends, but they come from different families, and they live in different villages that are rather far away from each other. What both men have in common is that they both work constantly to manage their household economy, particularly by frequent buying and selling in marketplaces. In fact, it is at the market that the two men often see each other, and share news over a cup of coffee.

[3] Reolo means "Mr. Person" and Tsiato means "not here." These equivalents of "John Doe" are nonetheless realistic names.

[4] Bevondrorano was a well-known subsistence environment for these Mikea families even before they were displaced by the Park, as many lived part of the year here to sharecrop manioc, do rice wage labor, dig wild *babo* tubers (*Dioscorea acuminata*) and sell game to savanna people. Bevondrorano people have many Mikea kin among the greater Bevondro community. They were not displaced by

force, but by policies by Madagascar National Parks that made forest life more complicated.

[5] The wealth score included two assets that are most commonly owned by Masikoro and Mikea (land, cattle) and two commonly owned by Vezo (ocean-going canoes, shark fishing nets). The other assets were equally likely to be owned by anyone with financial capital: oxcart, radio, generator, and telephone.

TABLE 3 | Sample characteristics for Studies 2 and 3.

Village study	Sample size		Age[1]			Mean Frequency of church attendance[2]	Mean Years of formal education	Wealth[3]	
	Total	Women	Young adult	Adult	Old adult			Low	High
Bevondrorano (Mikea)									
Study 2	12	9	4	7	1	0.4	1.2	10	2
Lamboara (Vezo)									
Study 2	24	14	3	17	4	1.3	4.3	16	8
Study 3	22	10	2	15	5	1.4	4.0	10	12

[1]Based on a visual estimate by the authors.
[2]Average of responses scaled as 0 = never, 1 = sometimes, 2 = frequently.
[3]Informants asked if they own eight common assets (land, cattle, oxcart, ocean-going canoe, shark fishing net, radio, generator, and telephone). Low = owns 0–3 assets; high = owns 4–6 assets. Mean = 1.8 assets, max = 6 assets.

One day when they talk together about their lives, they are surprised to learn that Reolo consistently harvests more crops than does Tsiato, whether it is maize, rice, or manioc. Tsiato harvests much less than his good friend does.

The second version of the vignette was religiously framed.

I am going to tell you an imaginary story about two men, Reolo and Tsiato. Reolo and Tsiato are good friends, but they come from different families, and they live in different villages that are rather far away from each other. What both men have in common is that they both work constantly to manage family affairs, particularly by attending many of family ceremonies, such as circumcision, rites of filiation, and funerals. They often see each other in the ceremonies, where they exchange news. One day when they talk together about their lives, they are surprised to learn that Reolo consistently harvests more crops than does Tsiato, whether it is maize, rice, or manioc. Tsiato harvests much less than his good friend does.

With Vezo research subjects, we substituted harvest of "maize, rice, manioc" with harvest of "fish, octopus, and sea cucumbers."

It is important that Reolo and Tsiato do not live close to one another so that their economic activities are not influenced by the same weather. It is important that they are not kin so that they do not share the same ancestors. The vignettes were accompanied by drawings of either two Malagasy men shaking hands in a marketplace or at a funeral.

After telling the story we first asked the informant to voluntarily *list* reasons why Reolo experienced better success than Tsiato (because participants may have different explanations for gains versus losses, we consistently emphasized Reolo's success relative to Tsiato's failure). Then we presented a list of possible causal factors and asked the informant whether she would *endorse* each cause. We provided seven natural factors (e.g., rainfall, wind, and pests), three social factors (age, poverty, jealous neighbors), and six supernatural factors (e.g., God, ancestors, taboo transgression, etc). These factors are listed, along with a summary of results, in **Table 4**. When the exercise was completed informants received a small cash gift (1000 MGA, $0.50 USD, equivalent to 10 cups of coffee). This method was approved by the University of Georgia's Institutional Review Board (MOD00001573).

TABLE 4 | Frequency that different natural and supernatural factors were listed or endorsed by Mikea and Vezo informants.

	Factors listed voluntarily by informants		Factors endorsed by informants when listed by the researcher		Factors listed and endorsed	
	Mikea	**Vezo**	**Mikea**	**Vezo**	**Mikea**	**Vezo**
N	12	24	12	24	12	24
Natural factors						
Rainfall	3	0	3	3	6	3
Hard work	5	5	3	9	8	14
Pests[M]/Wind[V]	0	0	6	3	6	3
Good land[M]/good canoe[V]	2	0	1	3	3	3
Weeds[M]/good nets[V]	0	0	1	4	1	4
Inherited land[M]/good swimmer[V]	1	0	2	1	3	1
Fertilizer[M]	0	0	0	0	0	0
Social factors						
Age	0	0	2	4	2	4
Poverty	0	0	2	4	2	4
Jealous neighbors	0	0	2	2	2	2
Didn't do bad things to others*	0	1	0	0	0	1
Good parents*	1	2	0	0	1	2
Supernatural factors						
Ancestors	7	20	2	3	9	23
Possessing spirits	2	1	7	7	9	8
God	11	23	1	1	12	24
Magic	5	4	5	4	10	8
Other people's magical attack	0	0	1	0	1	0
Transgression of taboos	0	0	8	8	8	8
Astrological destiny	3	0	5	17	8	17
Church attendance	0	0	10	9	10	9
"Anjara" (turn)*	0	10	0	0	0	10
Astrological day*	0	1	0	0	0	1

*Each informant listed 0–5 causes; when presented with the remaining causes in this list, each endorsed 2–14 additional causes. M, asked to Mikea only; V, asked to Vezo only. *Factors introduced by informants that were not part of our original list.*

Results

Informants voluntarily listed 0–5 causes ($M = 3.0$, $SD = 1.2$), and endorsed an additional 2–14 causes ($M = 7.0$, $SD = 2.7$). Because of this variation in total number of causes listed and endorsed, all analyses that follow examine the percent of supernatural causes out of the total causes the individual listed or endorsed.

There were no significant differences by version of the vignette in the percent of causes that were supernatural, listed [economic version $M = 82.9$, $SD = 28.4$; religious version $M = 75.4$, $SD = 28.5$; $t = 0.790(36)$, $p = 0.435$] or endorsed [economic version $M = 76.6$, $SD = 22.1$; religious version $M = 72.8$, $SD = 18.4$; $t = -1.035(36)$, $p = 0.308$]. We combine results from both versions in the remaining analyses.

There were also no statistical differences in the responses of women versus men, listed [women $M = 80.4$, $SD = 25.9$; men $M = 76.5$, $SD = 33.2$; $t = 0.384(36)$, $p = 0.703$] or endorsed [women $M = 76.2$, $SD = 20.3$; men $M = 71.8$, $SD = 20.0$; $t = -1.018(36)$, $p = 0.316$]; by wealth, listed [low $M = 77.1$, $SD = 31.4$; high $M = 83.8$, $SD = 18.9$; $t = -0.632(36)$, $p = 0.531$] or endorsed [low $M = 72.8$, $SD = 21.0$; high $M = 79.3$, $SD = 17.5$; $t = 1.740(36)$, $p = 0.091$]; by frequency of attendance to a Christian church, listed [never $M = 79.0$, $SD = 19.6$; sometimes $M = 80.1$, $SD = 29.9$; always $M = 76.0$, $SD = 34.3$; $F = 0.06(N = 36$, df $= 2)$, $p = 0.944$] or endorsed [never $M = 77.2$, $SD = 17.9$; sometimes $M = 74.1$, $SD = 21.7$; always $M = 73.4$, $SD = 19.8$; $F = 0.14(N = 36$, df $= 2)$, $p = 0.874$]; or by whether participants also participated in Study 3 [listed, no $M = 75.4$, $SD = 31.5$, yes $M = 88.3$, $SD = 15.3$, $t = -1.235(36)$, $p = 0.224$; endorsed, no $M = 72.3$, $SD = 20.9$, yes $M = 80.7$, $SD = 17.1$, $t = 0.721(36)$, $p = 0.476$].

Participants listed several causes that we did not anticipate: it was Reolo's *turn* to succeed (*anjara,* an idiom for luck related to astrology, $N = 10$), Reolo did not do bad things to neighbors $N = 1$, Reolo had good parents $N = 1$, and Reolo had a favorable astrological day $N = 1$ (we had asked about astrological destiny, *vinta,* but neglected to ask about the related concept of *andro,* a propitious day).

Participants primarily listed supernatural causes for Reolo's superior success: God $N = 34$ and ancestors $N = 27$, followed by an important earthly cause, working hard $N = 10$. Only three Mikea listed rainfall, and no one listed wind, pests, weeds, or fertilizer, although they were endorsed fairly frequently when listed by the researcher. Mikea listed a lesser percentage of supernatural causes than did Vezo [Vezo $M = 85.4$, $SD = 25.1$; Mikea $M = 66.1$, $SD = 31.0$; $t = 2.01(36)$, $p = 0.052$], although they endorsed a similar percentage of supernatural causes [Vezo $M = 76.9$, $SD = 20.3$; Mikea $M = 70.0$, $SD = 19.5$; $t = -0.980(36)$, $p = 0.334$].

Discussion

When asked why *individuals* succeed or fail, our informants primarily provided supernatural causes, in contrast to Study 1. Because informants cited natural and supernatural causes at similar frequencies regardless of the version of the story it does not appear that people apply competing causal models to economic versus religious problems (target-dependent thinking).

One could argue that the economic and religious versions are not really all that different because, while they present different contexts for Reolo and Tsiato's meeting (market, ceremony), they are both about economic outcomes (harvest). It is interesting, then, that informants responded to them primarily with supernatural causes; had one of the vignettes featured a supernatural outcome (e.g., angry, dishonored ancestors) rather than a harvest, it seems most likely this would also be explained with supernatural causes.

The contrast between Study 1 and Study 2 suggests either that southwestern Malagasy apply competing knowledges to activity risk and personal risk (target dependence) or that they understand activities to respond in predictable ways to natural causes while the natural causes themselves are influenced by supernatural rewards and sanctions for the farmer, forager, or fisherman (integrative thinking). Study 3 attempts to distinguish between these possibilities.

Study 3: Sorting Causes into a Flow

This study used a sorting activity to discern people's concepts of the causal flow linking natural and supernatural forces. Vezo informants chose cards to represent God, ancestors, weather, and harvest (catch of fish). They were asked how pairs of cards influence one another, and were then asked to sort the cards into a causal flow. The method is similar to one used by Lynch and Medin (2006) to examine how U.S. undergraduates, nurses, and energy healers understand the physical and psychosocial causes of heart attack and depression, and our predictions follow their example. If southwestern Malagasy apply competing knowledges to activity risk and personal risk (target dependence), then we would expect them to create two separate chains, one with God and ancestors influencing harvest and the other with weather influencing harvest. If our informants understand no real existential difference in natural and supernatural forces (synthetic thinking), we would expect them to trace multiple bilateral interactions among natural and supernatural forces, and alternate their effects within chains. Integrative thinkers would present a hierarchy of causes with supernatural forces driving natural forces; the cards would form a single chain indicating that while supernatural and natural forces are different, they occupy the same causal system.

Sample

The sample included 22 Vezo adults (9 women, 13 men) in the village of Lamboara. As with study 2, recruitment was non-random and covered approximately a quarter of the adult population in the village. Nine subjects were also participants in study 2, which they may have done before or after this study. Descriptive statistics are in **Table 3**.

Method

As with study 2, we attempted to interview individuals privately but at times they were accompanied by a spouse, friend, or children. After obtaining oral consent from the interviewee we presented her with with six colored cards (white, black,

red, yellow, blue, green) and quizzed her on the names of the colors (one man could not name the colors; the interview was terminated and he received the cash gift). We then asked the informant to choose one card to represent God (*Ndragnahare*), one to represent ancestors (*raza),* one to represent weather (*toets'andro*), and one to represent harvest of fish (*vokatse fia*). The informant was quizzed to see if she remembered what each color represented.

Then we presented each of the 12 pairwise combinations of two cards to the research participant and asked whether one force could influence the other. "Influence" was difficult to translate into the local dialect of Malagasy. We used the verb *mikomandy* (from the French verb *commander*; the French verb implies less force than the English "command," with a meaning closer to "request"), *mandily* (a synonym for *mikomandy*), or *magnina* (meaning to matter, to be the reason for). Informants switched among these terms, suggesting that their meanings are roughly equivalent in this context.

Next we asked the informant to place the four cards in rank order by power. Once this was completed we asked them how all four cards influenced one another together. We ended the exercise by adding an additional card, usually the yellow one, with the announcement that this represents spirits that possess people (*doane*). The subject was then instructed to add this card to the causal flow. When the exercise was completed each informant received a small cash gift (1000 MGA). This method was approved by the University of Georgia's Institutional Review Board (MOD00001573).

Results and Discussion

The majority of the 22 participants chose to represent God with the white card (N = 17), ancestors and weather with black or red (ancestors six black, five red; weather eight black, five red), and harvest with blue (N = 9) or green (N = 6). Informants frequently substituted "wind" (*taiky*) for weather, consistent with the importance of wind in the marine economy. As **Table 5** presents, informants were unanimous that God may influence ancestors and weather but not vice versa, and most said that God may influence harvest (N = 20) but not vice-versa (N = 22). There was disagreement as to whether ancestors influence weather (N = 3) or weather influences ancestors (N = 4), but the majority answered no to both questions. In the process of discussing the pairwise interactions, 14 of 22 volunteered that ancestors cannot influence weather directly, but must beg God to change the weather. An additional three people offered that God cannot influence harvest directly,

but can only command the weather that in turn influences harvest.

Twenty one informants sorted the cards by relative power, with much agreement. All 21 placed God as the most powerful force; 20 positioned harvest as the least powerful; and 20 ranked weather and ancestors as intermediate in power (13 favored ancestors, 6 favored weather, and 2 insisted they were of equal power).

From the pairwise interactions in **Table 5** we may infer the causal flow represented in **Figure 1**, in which God influences everything, God is influenced by nothing, and God, weather, and ancestors command the harvest of fish. When presented with all four cards and asked to arrange cards into a causal flow, the majority of research participants who completed the exercise produced the different looking diagram in **Figure 2**. The method was a challenging task, both because we had not worked out a clear procedure for instructing informants in this exercise[6], and because some informants did not consider themselves experts on such topics. Fourteen people completed the task. The arrangement in **Figure 2** was generated independently by 11 individuals.

There are two major differences between the causal flows depicted in **Figures 1** and **2**. First, in the second diagram

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[6]The procedure we eventually developed was, after asking about causal influences of pairs of cards, to graduate to combinations of three cards, then finally, the fourth.

FIGURE 1 | The causal flow among God, ancestors, weather, and harvest implied by informant's responses to pairwise questions, does X *influence* Y? See text for the Malagasy meaning of "influence."

FIGURE 2 | When asked specifically to organize the cards to a causal flow, 11 informants produced this pattern.
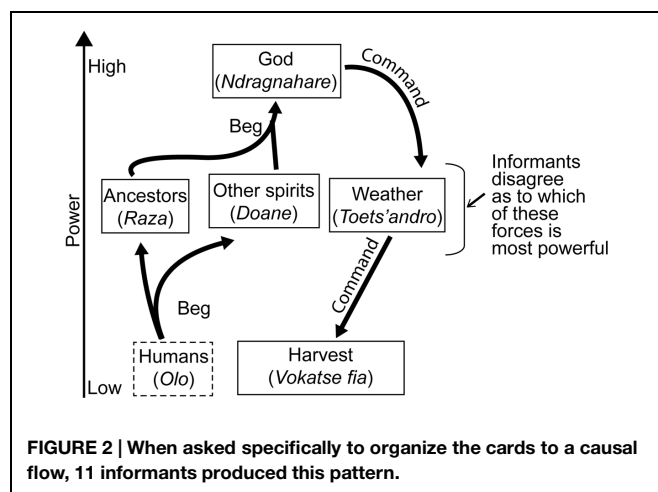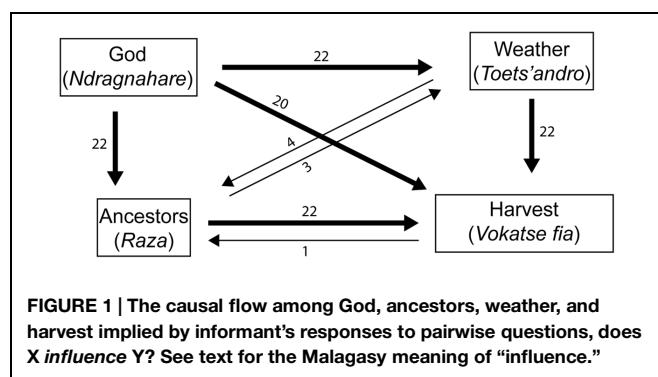
TABLE 5 | Results of 12 questions asking, does factor X influence factor Y? Does Y influence X? The table reports frequencies of yes responses.

First ->	God	Ancestors	Weather	Harvest
God		0/22	0/22	0/22
Ancestors	22/22		4/20 *	1/22
Weather	22/22	3/20*		0/22
Harvest	20/22	22/22	22/22	

*These combinations were accidentally omitted in two cases.

ancestors (and possessing spirits) may influence God. This key difference is explained by the verb our informants used to explain how ancestors influence God: by begging (*mangatake*), which is less forceful than commanding (*mikomandy, mandily*) and causing (*magnina*). Although we did not include a card to represent people, participants also indicated that people beg ancestors and spirits to beg God on their behalf, so that God may command the weather to influence the harvest. The second contrast is that in **Figure 2** there are no direct arrows linking ancestors and God to harvest. In **Figure 2** ancestors and God *do* influence harvest, consistent with **Figure 1**, but via the chain of ancestors → God → weather → harvest of fish. This is also consistent with the comments made by several informants that God cannot influence harvest directly but may only do by influencing the weather, and ancestors cannot influence the harvest directly, but must ask God to change the weather.

The causal flow represented in **Figures 1** and **2** suggests that natural and supernatural forces are arranged in a hierarchy, and that supernatural forces drive natural forces, consistent with integrative thinking.

General Discussion

The studies reviewed here support a specific form of integrative thinking in which people ascribe activity risk to natural factors (Study 1) and personal risk to supernatural factors (Study 2), and supernatural and natural forces form a hierarchy within a single explanatory system (Study 3). Natural and supernatural causal forces occupy distinct categories, in contrast to recent descriptions of indigenous American thinking (Descola, 1996; Viveiros de Castro, 2000), but do not form competing epistemologies, as seems to be the case for many Westerners when explaining life as resulting from evolution versus divine creation (Evans et al., 2011), and death as biological cessation versus afterlife (Harris and Giménez, 2005; Astuti and Harris, 2008).

We argue that when southwestern Malagasy reason about the risk of farming, foraging, or fishing activities, they reason within a natural submodel or level of explanation represented by the last two links in **Figure 2**'s causal chain, weather → harvest. In an environment where rainfall is only predictable 28% of the time, someone with good ecological knowledge may successfully forecast weather and economic outcomes one third of the time, while someone with bad knowledge leaves her fate completely to chance. In the rural economy there is often a long delay between cause (rainfall) and effect (crop yield, prey abundance) so that causality is difficult to observe. Instead, people learn natural causal models from others through cultural transmission (Boyd and Richerson, 1988). That supernatural and natural forces are categorically distinct, and the application of natural factors to activity risk, allows people to share information about drought tolerance and prey behavior while minimizing the distortions of personal and social concerns.

But even with really good ecological knowledge, the highly unpredictable climate means that people's predictions will often fail. By ascribing *personal*

successes and failures with the whole causal chain (humans → ancestors → God → weather → harvest), the Malagasy person may make sense of successes and failures without doubting the validity of the ecological knowledge. We predict that integrative thinking may be a common cognitive strategy accompanying economic diversification in risky environments.

This argument is consistent with our ethnographic observations. In our previous research in the region we have had countless discussions with farmers, foragers, and fishermen about their subsistence decisions and economic strategies, including such questions as when should one plant swidden maize, how many grains to plant, what to do if the crop does not germinate, how many times a manioc field should be weeded, how long manioc should be left in the ground to mature, what variety of rice is most pest-resistant, how to find wild *ovy* tuber patches, how to tell when *ovy* patches have been exhaustively harvest, what size gillnets are best for different fish species, etc. Almost unanimously, informants responded with the sorts of agronomic and ecological factors that an outsider without knowledge of local cosmology would expect. Meanwhile, our field notes describing the social life of Mikea, Masikoro, and Vezo communities are replete with accounts of people worrying about ancestors, navigating taboos, seeking benedictions in ceremonies, and sorcery accusations.

Southwestern Malagasy seek creative ways to diversify their income sources while also piously following their cosmo-rules. We provide two examples. First, the *doane* spirits that possess mediums typically cannot tolerate the presence of chickens, so spirit mediums have a taboo forbidding them to eat or raise chickens (*faly akoho*). When a spirit medium provides charms and other prescriptions to a client, the medium commonly insists that the client also avoid contact with chickens, lest the potency of charms be annulled. Chickens and eggs have become profitable market commodities, due to the ease with which they are produced and stable prices. Clients of spirit possession commonly request that the *doane* spirit allow a waiver of the chicken taboo, as long as chickens are only raised to convert to cash. A second example involves labor migration among Vezo fishers, many of whom, during the past decade, have undergone the long, dangerous ocean voyage to the region of Maintirano, half the island's length to the north, where, according to the rumors, fisheries offer inexhaustible plenty and vendors buy ocean products at good prices. The separation from family tombs, elders, and possessing spirits adds significant risk on top of the physical risks of a long ocean voyage to an uncertain opportunity. To balance pious conformity to cosmo-rules with behavioral flexibility, Vezo mariners consult with one or more magico-religious leaders, including spirit mediums, diviners, and clan heads, to request special dispensation from ritual duties and protective charms.

The results reported here suggest that there may be some interesting variation within our sample, among farmers, foragers, and fishermen. Vezo fishing communities had less consistent evaluations of risk than Masikoro, Mikea, or Tandroy (although, as we argued, this could be because Vezo only listed fishing and marketing activities and there may be greater

differences in risk among modes than activities). Mikea listed more natural causes for Reolo's superior success than did Vezo. Masikoro, Mikea, and Vezo, and farmers, foragers, and fishermen, may approach the world somewhat differently for both ecological and cultural reasons. Agriculture, foraging, and fishing represent different intersections of human labor to climate and environment. Farmers in the region spend much of their time hoping for more rain while fishermen often want less rain and the right kinds of wind. Even though there is fluid movement among the three subsistence modes, there are still farming, foraging, and fishing modes associated with Masikoro, Mikea, and Vezo identities, so these communities are likely to maintain somewhat different knowledge.

The results of Study 1 also suggest that there may be interesting differences in men and women's causal knowledge. As stated above, we do not have a good explanation for why male focus groups exhibited greater agreement in risk ratings than did female focus groups, especially considering that men and women grow the same crops and forage for most of the same terrestrial resources. Perhaps there are differences in women's mobility and knowledge of activities in distant subsistence modes. It is also possible that men and women communicate ecological knowledge in different ways.

Our data do not address whether southwestern Malagasy apply integrative thinking beyond the domain of subsistence, where the hypervariable climate is not a direct influence on outcomes. In a domain not so obviously connected to climate, that of death and afterlife, Astuti and Harris (2008) found that Vezo adults tended to explain death as biological cessation in the context of a story about a malaria death in a hospital while explaining death as continuity into the afterlife of ancestors in the context of a story about a funeral. Astuti and Harris (2008), like us, argue that biology and cosmology are not competing causal explanations, but they do not present evidence whether or how these causal models are integrated. Death in Madagascar is a risky venture, as the dead cannot control how or where their body will be handled or buried. It would be interesting to learn whether risk and choice in this domain mirror or intersect with subsistence decisions.

The pattern of integrative thinking that we have documented for southwestern Madagascar echoes Evans-Pritchard's (1937) classic description of Zande witchcraft as an idiom of causality. Is a hypervariable environment the reason for Zande integrative thinking? The closest weather station to Zandeland in Dewar and Richard's (2007) comparative climate study was Yei, South Sudan, which has a monthly rainfall predictability score of 0.527, nearly double that of Toliara, Madagascar 0.281. It is unclear how much unpredictability, and unpredictability of what, exactly, we would expect to be associated with integrative thinking. Evans-Pritchard argued that Zande witchcraft is a domain-general causal model, applied not only to subsistence, but health, politics, and domestic life. "There is no niche or corner of Azande culture that [witchcraft] does not twist itself" (Evans-Pritchard, 1937, p. 63). One possibility is that Zande witchcraft helps people deal with a more domain-general form of unpredictability, perhaps relating to social alliances. It may also be that integrative

thinking can be a tool to solve more than one set of ecological challenges.

The causal flow depicted in **Figure 2** is not dissimilar from what one might expect in Christianity and other Abrahamic cosmologies. Just as a southwestern Malagasy person must beg ancestors and other spirits to beg God for good fortune, so a Catholic calls upon Jesus, the Virgin Mary, and Saints to intercede on her behalf. We suspect that when southwestern Malagasy convert to Christianity they simply insert Jesus into the mediating role alongside ancestors and other spirits. Indeed, it is not uncommon to hear our informants refer to Jesus as the *razambazaha,* "the foreigners' (or white people's) ancestor." Thus "conversion" may result in minimal changes to cosmology, culture, and behavior, which is consistent with our observations that even clan heads, diviners, and spirit mediums are sometimes ardent churchgoers.

Our interpretation that for southwestern Malagasy "natural" and "supernatural" are distinct categories of causes and yet integrated into a single causal model requires further discussion and future research, given contradictory statements in the literature that natural and supernatural knowledges are either inherently different or that the natural/supernatural dichotomy is a figment of Western imagination. Boyer (2000) has argued that causal knowledge of the natural world is an extension of innate intuition while supernatural causality, by definition, involves counter-intuitive twists on natural relationships that are learned later in life. By contrast, some cultural anthropologists have warned that dichotomies like mind/body, nature/culture, and natural/supernatural are cultural artifacts of European Enlightenment philosophy that are not shared by many non-Western traditional cultures (Ingold, 1991, p. 362; Ortner, 1996; Lambek, 1998). Some anthropologists of religion argue against the utility of the natural/supernatural dichotomy, stating that many peoples see no difference in the realness of rocks and rain versus ghosts and angels, and may see all such forces as similarly animate and agentive (Lambek, 2008, pp. 5–7).

Whether non-Western peoples dichotomize natural/supernatural or other such knowledges is ultimately an empirical question. The data presented here show that different kinds of questions yield different sets of causes, suggesting that they are distinct, but they are not dichotomous or opposed categories because they do not contradict each other. Our data do not address the question of what makes a causal force like rainfall or ancestors fit into one category or the other, nor whether "natural" and "supernatural" mean the same thing to our informants as these terms generally indicate in Western discourse.

A seemingly obvious difference between natural and supernatural is that the supernatural is the domain of invisible agents, where agents, after Leslie (1995), have mechanical properties of force and energy, goal orientation, and cognition. Natural causes, by contrast, are visible agents (pests), invisible non-agents (wind), or visible non-agents (rainfall). However, it is not difficult to conjure contradictory examples. The Malagasy astrological calendar is supernatural in that it provides what Howell (2012) calls "cosmo-rules" to honor ancestors, possessing spirits, and God, but astrology is not agentive for it does not

think or pursue goals. The germ theory of disease constitutes a natural force but involves invisible agents.

Could it be that when southwestern Malagasy discuss climatic causes within their natural submodel or level of causality, they understand "rainfall" and "wind" to be personified agents with goal orientation and cognition, similar to how they think about ancestors and God? When the first author suggested this "animistic" possibility to the Malagasy co-authors, they initially found the question difficult to understand. We also found this to be a difficult question to pose to Vezo informants. Wind and rainfall, they insisted, were just natural. But to the first author's confusion, the word "natural" in Malagasy is *voajanahare,* which translates literally as, "fruit of God" (work of God). Further research is required to understand exactly what separates forces like rain, wind, pests, and germs from ancestors, spirits, God, and astrology.

Conclusion

This investigation of coexistence thinking was framed around an apparent paradox in the ecology and culture of subsistence risk in rural southwestern Madagascar. Crops fail and prey become scarce because of climatic factors, which are highly unpredictable; Masikoro, Mikea, and Vezo adapt to their hypervariable environment via diversification and behavioral flexibility. And crops fail and prey become scarce because of the judgments and moods of spiritual agents; southwestern Malagasy adapt to their high spiritual insecurity by narrowing their range of behaviors, by following a pious code of taboos, ritual prescriptions, and astrological proscriptions. One possible cognitive explanation for this paradox is that southwestern Malagasy maintain contradictory natural and supernatural causal models in their heads and employ each in certain circumstances. A second possibility is that they see no paradox, for wind, rain, God, and ancestors belong to the same category of causes that permits behavioral flexibility and pious conformity in different circumstances. We interpret the results of the three studies presented here as supporting a third, integrative model, where ecological factors explain why crops and fields fail, supernatural factors explain why persons succeed or fail, and supernatural factors influence economic outcomes via natural factors. We have argued that this permits Masikoro farmers, Mikea foragers, and Vezo fishers to effectively share ecological information undistorted by personal concerns, while simultaneously giving reason for why ecological knowledge fails without casting doubt about the validity of the ecological knowledge. This is of course a functionalist explanation; our data do not address the origins of this purported cognitive adaptation to a hypervariable environment.

It is difficult to disentangle the influences of ecology and culture on coexistence thinking with a single synchronic case study. Culturally learned causal rules are part of how people adapt to environmental challenges (Steward, 1955; Richerson and Boyd, 2005), and it could be that integrative thinking is a mental strategy developed rather recently by the ancestors of today's Masikoro, Mikea, and Vezo, or perhaps a broader geographical range of Malagasy people. Yet cultural traditions may persist that have neutral or negative effects on people's survival (Durham, 1991); it is possible that southwestern Malagasy integrative thinking is not adaptive, or did not develop here because of its adaptive value, but was simply inherited from previous generations as part of broader Austronesian and East-African culture histories. This echoes a classic debate in cultural ecology as to whether a society's religious ideas are peripheral with regards to ecological adaptation (Steward, 1955) or central to it (Rappaport, 1968). Future research could explore people's application of coexistence thinking to subsistence risk through cross-cultural comparison, by contrasting samples from places with different levels of climate unpredictability, both within Madagascar where people share similar traditional beliefs, within the broader Austronesian tradition of which Madagascar is a part, and in distantly or unrelated cultures.

Researchers studying choice under risk within the economic tradition have traditionally applied probability theory and rational actor models to decision-analyses, implicitly promoting a psychic unity of humankind by which all peoples make similar decisions for similar reasons. Our research suggests that risk-sensitive decision-making may depend on the local ecology and culture and whether people employ target-dependent, synthetic, or integrative thinking. This argument emphasizes cultural relativism while simultaneously providing a framework for the kinds of cultural-cognitive variations we may expect to find in different settings.

Acknowledgments

Supplementary Material

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg. 2015.01533

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The fundamental role of causal models in cultural models of nature

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INTRODUCTION

Cultural Models (CMs) are a way to organize mental knowledge (Holland and Quinn, 1987; Bennardo and De Munck, 2014) within communities of various sizes. Regarding their internal organization, causality plays a major role in CMs' structure/s. A widely accepted way to represent causality in a variety of domains is that of using causal models (Sloman, 2009; Rips, 2011). I propose to think about and use the concept of causal model as a fundamental aspect of CMs. I provide a tentative exemplification of this proposal by looking at causal models in CMs of nature.

CULTURAL MODELS AND CAUSAL MODELS

CMs are assemblages of mental knowledge (i.e., models/representations of the world) shared within a population. CMs function as mental lenses used in understanding, in reasoning, in planning actions, and they may motivate/generate action as well (D'Andrade and Strauss, 1992). CMs are systems, that is, they are constituted by units (e.g., concepts, events, foundational CMs, molar cultural models, etc.) and relationships among these units. Relationships among conceptual units (including CMs of same or different molarity) can be of different types. For example, they can be sequential, taxonomic (also partonomic), and causal.

Sloman affirms that the logic of causality is an invariant of and the best guide to human reasoning and knowledge organization (Sloman, 2009, p. 20). Rips successfully maintains that our ability to infer causality from co-occurrence of events depends on higher-level beliefs, i.e., causal

models, about what sort of events can cause others (Rips, 2011, p. 150). He also states that: "Identifying causes requires a healthy dose of theory to direct our search. We can't understand these abstract matters unless the appropriate schemas are already in place" (Rips, 2011, p. 123). In other words, schemas or theories (I prefer the term "model" as in Johnson-Laird, 1980, 1983, 1999) guide and/or generate our causal thinking. Causality, then, appears to be part and parcel of our knowledge of the world while at the same time it depends on knowledge being organized in CMs. This leads to my current proposal of seeing causal models embedded within CMs.

One way in which causality is described and explained is by the use of causal models. First, though, let's see how we can define a cause or a causal relation. Sloman writes that

> "A causal relation suggests a mechanism unfolding over time … so the notion of cause involves change over time … [C]ausal relations relate entities that exist in and therefore are bounded in time. I will refer to such entities as *events* or *classes of events* … Causal relations … associate events with other events" [original italics] (Sloman, 2009, pp. 21–22).

If representing the world includes fundamentally the representation of events and if events are mostly associated by causal relations, then, it is these latter that need to be an essential component of CMs.

Causal relations are typically represented by causal models. A causal model consists of (1) a Graph whose input are (2) the World and (3) the Probability

Distribution. *The World* consists of the "causal system" we want to represent, a part of the world, e.g., fire, sparks, oxygen, energy source, etc. *The Probability Distribution* consists of the likelihood that certain events (i.e., the content of the World) exist and the likelihood of them going together. For example, while the probability P of fire is typically low, it becomes high when sparks, oxygen, and energy source co-occur, and it becomes zero when there is no oxygen. *The Graph* consists of a representation of the relations among events (i.e., the content of the World) by means of boxes (standing for concepts, events, etc.) and arrows (standing for causal relations). It is the co-presence of oxygen, sparks, and an energy source (3 boxes) that causes (arrow) fire.

Causal Models have been suggested to play a role in reasoning, decision making, judgments, conceptual structure, categorical induction, language, and learning. Relevant to our discussion is the role that they play in conceptual structure since CMs represent organizations of knowledge in conceptual structure.

CAUSAL MODELS AND CATEGORIZATION

Concepts do not only represent sets of objects in the world, but also a set of possible objects. As such they are representing actual and counterfactual objects. This characteristic of concepts is very close to that of causal models insofar as they both can represent possible worlds. Causal relations then can be critical for categorization. Sloman (2009, p. 120) suggests that it would be worth using causal models in exploring relationships not only between

events but also between properties of objects.

As an exemplification of this possibility, Sloman introduces a discussion of the theory of function for artifacts proposed by Chaigneau et al. (2004). This theory suggests that the function of an object is related to the following aspects of the same object: its Historical role, the Intentions of an agent using the object, its Physical structure, and the Events that occur when it is used (that is why this theory is also known as the HYPE theory of objects). Finally it is suggested that all these pieces of information are related via a causal model (see Sloman, 2009, p. 122).

The process of categorization that includes a causal model theory of conceptual structure assumes two stages: the first stage relates to some sensory experience; the second stage uses the sensory experience as a cue to retrieve concepts from memory in the form of a causal model (Sloman, 2009, p. 125). For example, one might look at the sky and see what one would interpret to be wings and a body. Then, one also hears a roaring sound.

At first, one may retrieve a causal model in which "has wings," "has body," and "has feathers" are related causally to "can fly." This model though would not fit one's current sensory experience (especially leaving the "roaring sound" unaccounted). In an attempt to account for the roaring sound, one would access a causal model in which "has wheels," "has body," and "has engine" would be related causally to a box named "can drive," while at the same time the "has engine" would cause "makes noise." The "can drive" box would cause the "can transport people" one. While this model explains the roaring sound by the presence of a causing "engine," it introduces the concepts of "wheels" and "drive" that are not present in one's current sensory experience.

Finally, a causal model is accessed and activated in which "has wings," "has body," and "has engines" cause a box named "can fly" while the "has engines" box by itself causes "makes loud noise." The "can fly" box would also be causally related to a "can transport people" one. This last model is a good fit for one's sensory experience and provides a plausible causal explanation of all the elements one sensed (Sloman, 2009, p. 126).

Objects may be associated with a number of causal models and the one that is activated depends on people's intentions in dealing with them as well as on the context within which people and objects may be located. What remains constant though is the fact that the relevant knowledge about objects is organized as a causal model in spite of the variety of intentions that people may have in specific contexts (Sloman, 2009, p 128). In addition, categorization serves a multitude of purposes and not all of them can be served by referring to causal properties. These latter are paramount when categorization is intended to reveal the reasons why an object exists, what its use is, what its origin is, and how it works.

CULTURAL MODELS OF NATURE

I am currently heading a collaborative research project sponsored by NSF about the cross-cultural concept of nature. The project includes 15 scholars collecting data in 15 communities of primary food producers all over the world. We have prepared a methodological protocol that will be used by all of us both to collect and analyze data (Bennardo, 2012). By the end of 2014, all the data will be collected and the analyses should yield a number of preliminary concepts of nature held within the communities. These concepts will be verified by further data collection and a consensus analysis to be conducted in each community the following year.

The concept of nature is a "complex concept" (see Keller and Lehman, 1991) and I prefer to call it a CM. I have already proposed that a fundamental aspect of any CM is that it contains a causal model. In addition, Sloman's (2009) suggestion of the role of causal models in categorization (concept formation) has also convinced me that the concepts/CMs of nature do include causal models as their fundamental constituent element.

Before benefiting from the results of the mentioned project, I have prepared three "hypotheses" of CMs of nature that are structured to include causal models. In other words, the three CMs of nature I am suggesting include three slightly different types of causal models. The examples of CMs of nature I am using are personal

renditions of suggestions in Kempton et al. (1995), in Selin (2003), in Atran and Medin (2008), and in Bennardo et al. (2012).

The first CM of nature can be labeled "holistic" and it is typical of populations whose religion is Buddhism, Confucianism, Shinto, and others (see Selin, 2003). Within this model, all the major elements of the existing world are part of "one" reality which does not have privileged agents (**Figure 1A**). As such, the causal model in this CM of nature would have these constituent elements in *the World* part: humans, animals, plants, physical environment, weather, and the supernatural. In *the Probability Distribution* part, only a combination in which all the constituent elements of the CM of nature in *the World* part appear receives a high score, while whenever one of the elements is missing, the score would be zero. In *the Graph* part there would be a box with a list of all the elements and an arrow (indicating cause) leading to the concept/CM of nature.

The second CM of nature I called "supernatural" insofar as it implies a separation of a supernatural/creator being from all the other elements in *the World* part of the causal model (**Figure 1B**). In *the Probability Distribution* the presence of any elements of nature without the supernatural would receive a low or zero score, while the score becomes higher when supernatural and other elements of nature appear together. *The Graph* part of the causal model sees the box of supernatural causing all the other elements, i.e., humans, animals, plants, physical environment, and weather. This causal relationship finally leads to the causation of the concept/CM of nature.

The third CM is labeled "supernatural/humans" because these two elements of *the World* are assigned a privileged position (**Figure 1C**). The supernatural is still causing all the other elements of the world as in the previous model, but now "humans" are separated both from the "causing" supernatural and from animals, plant, physical environment, and weather. Humans do not cause these latter and they are directly caused by the supernatural.

These causal models—suggested as constituents of different CMs of nature—are only three out of other possible ones.

FIGURE 1 | Three Causal Models of Nature. (A) Holistic, **(B)** Supernatural, and **(C)** Supernatural/Humans.
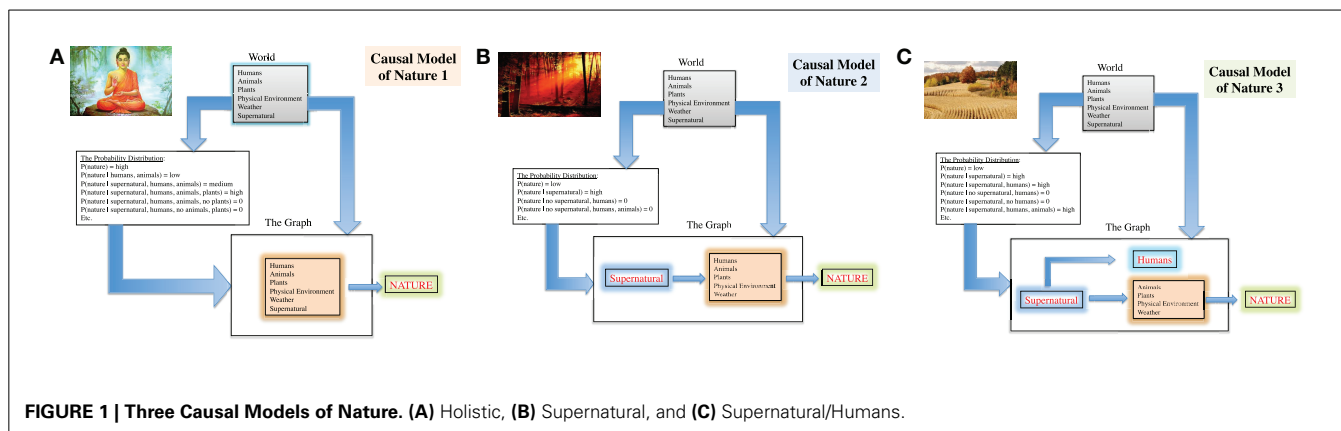
It is important to notice that at *the Probability Distribution* level/part, culture plays a very fundamental role. That is, since perception of the world depends on cultural saliency, the probability distribution of the constituent elements of the concept of nature are dependent on cultural choices. Thus, cultural saliency determines the (perceptual and probable) choices that are then represented in *the (causal) Graph*.

Once the project is completed, we are convinced that we will be able to fill in some of the missing data—especially at *the Probability Distribution* level—that will lead to a refinement of the CMs of nature we are after and their internal causal models. I believe that the introduction of causal models in CM theorizing provides a suitable way to enhance our cross-cultural understanding of the mental organization of knowledge.

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Analysis of minimal complex systems and complex problem solving require different forms of causal cognition

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In the last 20 years, a stream of research emerged under the label of "complex problem solving" (CPS; see e.g., the two editions from Frensch and Funke, 1995 and Sternberg and Frensch, 1991). This research was intended to describe the way people deal with complex, dynamic, and intransparent situations. One of the promoters of this field, Dietrich Dörner from Bamberg University, proposed to use complex computer-simulated scenarios as stimulus material in psychological experiments (see e.g., Brehmer and Dörner, 1993). This line of research lead to subtle insights into the way how people deal with complexity and uncertainty (see Dörner, 1997; Osman, 2010).

Besides knowledge-rich, realistic, intransparent, complex, dynamic scenarios with many variables, a second line of research used more simple, knowledge-lean scenarios with a low number of variables ("minimal complex systems," MCS) that have been proposed recently in problem-solving research for the purpose of educational assessment (see Greiff et al., 2012). In both cases, the idea behind the use of microworlds is to increase validity of problem solving tasks by presenting interactive environments that can be explored and controlled by participants while pursuing certain action goals.

The construction principles behind the minimal complex systems follow certain formalisms like linear structural equations or finite state automata (both described in Funke, 2001). Subjects have to first explore such systems (they have to understand the causal relations between input and output variables) and then use the acquired causal knowledge to control the given system in order to reach given goal values.

The main argument presented here is: both types of systems—CPS and MCS—can only be dealt with successfully if causal dependencies between input and output variables are identified and used for system control. System knowledge is necessary for control and intervention. But CPS and MCS differ in their way of how causal dependencies are identified and how the mental model is constructed; therefore, they cannot be compared directly to each other with respect to the cognitive processes that are necessary for solving the tasks.

The argument in more detail: In case of the more simple MCS problems, a complete causal analysis of the system under scrutiny can be done in short time (e.g., in 3 min). Typically, the acquired causal knowledge is assessed via a causal diagram that has to be drawn by the participant (Blech and Funke, 2006). In case of the more complex CPS systems, time is not enough to run a complete causal analysis of the given scenario because of its complexity. Normally, causal knowledge about the CPS system is not assessed (there are exceptions: e.g., Wittmann and Süß, 1999). Instead, the use of heuristics and the use of causal knowledge derived from previous everyday experience are necessary for constructing a causal model.

So, the role of causal cognition is different in both types of problems. In the simpler knowledge-lean systems, systematic causal analysis is the main task during exploration; no reliance upon previous knowledge (except from strategic knowledge) is recommended. A detailed point-by-point analysis is needed, domain knowledge is not important at all (instructions sometimes warn to rely on such knowledge). In the more complex knowledge-rich systems, a precise causal analysis through systematically controlled exploration is nearly impossible; instead, reliance upon previous content knowledge is highly important.

In the next section, I will contrast the two approaches by describing the role of causal analyses for a problem-solver who has to handle either the task of carefully analyzing systems from the MCS type or systems from the CPS type.

MCS: PROBLEM SITUATIONS THAT COULD BE UNDERSTOOD COMPLETELY BY PRECISE CAUSAL ANALYSES

Problems that could be understood completely by a precise causal analysis need to consist of a small set of input and output variables. Otherwise, constraints of working memory and of time for analysis would make such a complete analysis impossible. For problem-solving research within educational contexts, Greiff et al. (2012) proposed the use of MicroDYN items according to the formalisms of linear structural equations (see Funke, 2001) that could be analyzed within 5 min testing time. A typical MicroDYN example containing all possible types of effects between input and output variables is shown in **Figure 1**.

The task for the subject is twofold: first, to explore the system by manipulating the input variables and observing the effects of this manipulation on the output variables;

FIGURE 1 | A typical MicroDYN item as an example for a more simple system with different kinds of effects. For the selected sets of endogenous and exogenous variables any cover story is possible (from Greiff et al., 2012, p. 192).
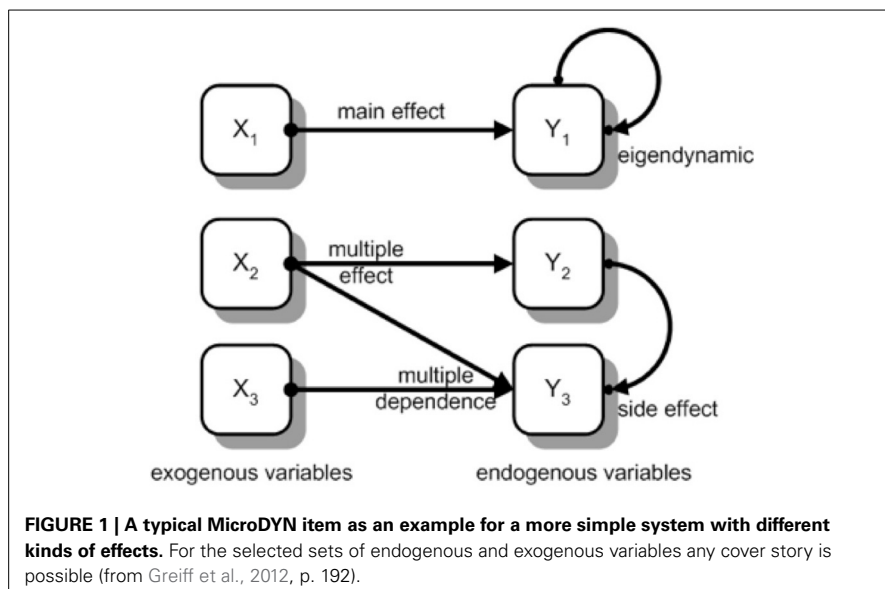
second, to control the output variables with respect to given goal values by appropriate manipulation of the input variables.

As one can easily see, this task requires nothing else than identifying causal structures by active experimentation and using the identified causal structures later for reaching goals. The task is designed so that subjects have a chance to identify all causal relations by proper variation of the inputs. No wonder that the VOTAT strategy ("Vary One Thing At a Time"; Tschirgi, 1980) is seen as most relevant for succeeding with the task (Fischer et al., 2012).

An advantage of this type of causal structure is its independence from content: There is a nearly arbitrary choice of labeling input and output variables and a nearly arbitrary choice of selection for the type of relationship (see **Figure 1**: main effects; multiple effects; multiple dependencies; side effects; eigendynamic). So, complexity of the item structure can be changed easily to construct large sets of items with different difficulties (as it is needed, e.g., in large-scale assessments like the OECD "Programme for International Student Assessment").

The disadvantage of this procedure is the unclear degree of overlap between previous knowledge about the assumed relationships between the variables (on the side of the participant who has to identify the causal structure) and the realized relationships. So, different item difficulties result not only as a consequence of

the complexity of the chosen causal structure, but also of the (unknown) degree of "surprise" to the participant. To decrease this potential disadvantage, item labeling is very unspecific ("variable A," "controller 2," etc.), loosing connection to everyday knowledge.

CPS: PROBLEMS THAT COULD NOT BE UNDERSTOOD COMPLETELY BY PRECISE CAUSAL ANALYSES

Problems that could not be understood completely by precise causal analyses consist of a larger number of variables that cannot be analyzed completely in a given time frame of about an hour in the lab that is given for (short) exploration and (longer) control of the system. As an example take the microworld "Tailorshop" (originally developed by Dietrich Dörner). The round-driven scenario simulates a small business that produces and sells shirts. The participants lead this business for 12 simulated months by manipulating several variables like the number of workers, the expenses for advertising, etc. (see Figure 2 from Danner et al., 2011, on p. 226, for the complete set of variables; this list is normally not shown to the participants).

The task for the subject is to increase the company value over the course of the simulation period. Participants have to rely on assumed causal relations but cannot check the details in this case. They have to monitor the systems' output in

a more global way than in a MCS situation. The famous VOTAT strategy that is helpful in the previously mentioned MCS example would not work in this situation because there are too many variables that could not be controlled for in short time. This is a typical situation for many everyday complex problems: we cannot use VOTAT alone to find out how to increase the quality of the relationship with our partner; policy-maker cannot systematically change the conditions of a nations' education system in order to find the most efficient one.

How can we deal with such complex situations, anyway? If one learns about the variables of the Tailorshop, a participant might hypothesize that "workers' satisfaction" is more dependent on "salary" than from "social costs" or that "price of shirts" has more influence on "demand" than "number of shops" In real life as well as in CPS simulations, general knowledge about the world and knowledge about the domain in question is guiding our problem solving activities. It is important how variables are labeled semantically: because, for sure, the "Machine 100" produces double the amount of shirts than "Machine 50"—the knowledge about these labels guides decision-making much more than any systematic identification strategy.

ON THE UNIVERSALITY OF CAUSAL COGNITION AND ON THE CULTURAL SPECIFICITY OF HEURISTICS

For influencing the world, the assumed causal mechanisms (in the case of CPS, e.g., "more salary for workers increases their satisfaction"; in the case of MCS, e.g., "increasing controller 1 by a value of 2 decreases variable C by the value of 8") remain the same but the reliability of the rule is lower in the case of CPS (How much does satisfaction increase if one increases salary from 900 to 1000 units? Is it a linear function? Has this function an upper limit? Does the relation depend on other variables?) than in the case of MCS. The mechanism for producing/activating this causal knowledge is different: in the case of MCS, it is systematic experimentation and testing, in the case of CPS it is hope that some unproved world knowledge might apply to the given case.

There is some research on cultural differences in dealing with complexity

and uncertainty. Strohschneider and Güss (1999) compared students from India and Germany while working on the complex scenario "MORO." Subjects in this scenario had to take the role of a developmental aide and to improve the living conditions of the Moro tribe sustainably over a period of 20 (simulated) years. In their conclusions about the detected cultural differences, Strohschneider and Güss (1999, p. 250) state: "We thus explain the problem-solving differences by differences in strategic (or heuristic) expertise, and we argue that these differences in expertise are due to a number of specific characteristics of the cultural learning environment."

On a more theoretical level, Medin et al. (2014; see also Medin and Atran, 2004) argue that cognition occurs in "cultural ecosystems"—it would be interesting to learn if even abstract MCS tasks would be conceptualized differently in different cultures. For CPS tasks, this happens for sure. Strohschneider and Güss (1998, p. 713), for example, observed differences in planning and problem-solving styles between German and Brazilian students with the MCS simulation "Coldstorage" that can be interpreted as "effects of different sociocultural conditions, such as accountability of the environment, value systems, and objective planning necessities."

All organisms that have intentions and follow goals will, at some point in time, face problems in reaching them. For solving these problems, the obstacles between given and goal state need to be removed, and this presupposes causal cognition. Causal cognition (in the sense of understanding of causal relationships between input and output variables of dynamic systems) lies at the heart of problem solving when dynamic problems require the manipulation of exogenous variables in order to reach certain goal values in the endogenous variables.

When it comes to complex and knowledge-rich problems the use of heuristic decision rules is necessary; more important: the role of general world knowledge and of specific domain knowledge increases strongly. Therefore, cultural differences (Güss and Robinson, 2014) and cultural ecosystems (Medin et al., 2014) will become more visible when dealing with complex problems.

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frontiers in PSYCHOLOGY

What you see is what you (don't) get: a comment on Funke's (2014) opinion paper

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In an opinion paper published in this journal, Funke (2014) argues that two different types of assessment instruments for complex problem solving (CPS), computer-simulated microworlds (CSMs), and minimal complex systems (MCSs), might require different types of causal cognition. CPS denotes the ability to successfully deal with new, intransparent, and dynamically changing problem situations (Funke, 2001) and is considered one of the most important skills of the 21st century. Given the recent attention CPS has received from both academic and educational stances, for instance, through the Programme for International Student Assessment, which tested CPS in 15-year-old students across more than 40 countries (OECD, 2014), the topic addressed by Funke (2014) is both timely and of high relevance.

In this commentary, we will elaborate on the difference between specific CPS assessment instruments used in a variety of research fields (e.g., experimental psychology, educational assessment) and CPS as the underlying attribute, and we will offer a view that diverges from Funke's (2014). We will express our hope that different CPS assessment traditions that are reflected in CSMs and MCSs will converge toward a generalizable understanding of CPS as an unobserved latent attribute (i.e., a psychological concept) that is of relevance to researchers from a number of fields including experimental psychology and individual differences research. Before alluding specifically to Funke's opinion paper, we would like to specify our terminology. Funke uses the terms CPS and MCS for the two types

of assessment. However, CPS denotes a psychological attribute and not a specific set of assessment instruments. Thus, we will use the established terms *computer-simulated microworlds (CSMs)* and *minimal complex systems (MCSs)* for the assessment instruments, and we will reserve the term *complex problem solving (CPS)* for the latent attribute that both types of assessments claim to tap into.

Funke (2014) argues that the usefulness of CSMs and MCSs for measuring CPS depends on the field of study. CSMs, with their realistic and highly complex setup, their many interrelated variables, and their knowledge-rich semantic embedding, are best applied in experimental settings, whereas MCSs, with an analytical approach that is geared toward reducing complexity and a high level of standardization, are best suited for (educational) assessment purposes. This position is reflected in the predominant use of CSMs in experimental and cognitive research (e.g., Dörner, 1980) and of MCSs in (educational) assessment (e.g., Wüstenberg et al., 2012). On the basis of task analyses, Funke claims that the type of causal cognition, the heuristics, and the strategies required in CSMs and MCSs differ substantially and, thus, do not allow for direct comparisons between the two.

For any study, it is of crucial importance that the employed measures—be they CSMs or MCSs—tap into the construct they claim to capture even though the measures may differ with regard to their difficulty or their surface features. Admittedly, CSMs and MCSs look quite different at first sight. CSMs are knowledge-rich and simulate complex

real-world scenarios such as business companies (e.g., the Tailorshop) or entire cities (e.g., Lohhausen), whereas MCSs are knowledge-lean and less complex. But can we really conclude, on the basis of purely conceptual task analyses, that they tap into different types of causal cognition? And if so, what is it that they tap into? 15 years ago, Süß (1999) had already provided important empirical guidance on this question with regard to the construct validity of CSMs. He showed that the performances in three different CSMs were moderately correlated—which was to be expected given that they supposedly all measured CPS. More importantly, when controlling for fluid intelligence and specific prior knowledge, the correlation dropped to non-significance. In the terms of contemporary theories on the human intellect (McGrew, 2009), the shared variance of three CSMs originated from fluid intelligence and (specific) prior knowledge. That is, the type of causal cognition required to successfully master CSMs is empirically identical to the causal cognition required for standard tests of fluid intelligence. Provocatively, one could state that the Tailorshop, probably the best-known microworld included in Süß's study, requires nothing but fluid intelligence and inductive reasoning as well as specialized knowledge about how companies work. Following this, the strong impact of context in CSMs and the substantial advantages for participants who possess this specific knowledge are not only assets of CSMs that make them more realistic but also disadvantages that distort the measurement of the underlying attribute and the cognitive processes

associated with it. In addition, the high complexity of CSMs (sometimes up to 1,000 variables) does not allow for a complete causal analysis—an asset according to Funke. However, this may also lead to unsystematic variance created by the fact that subjects have to deal with an environment that is basically unpredictable for them. That is, CSMs may produce unsystematic variance because they are just *too* complex and leave participants with no choice but to either guess or apply some general reasoning skills that are also found in classical intelligence and reasoning tests. And neither guessing nor abstract reasoning are distinctive features that are found in contemporary definitions of CPS as unique characteristics. Thus, despite their high face validity, empirical evidence suggests that CSMs may fall short of tapping into the type of causal cognition unique to CPS or causal cognition at all—a point not mentioned in Funke's (2014) paper.

Indeed, reports such as the one by Süß (1999) have led to a notable decline in the number of studies on CPS using CSMs in the late 1990s and the early 2000s because they questioned the empirical usefulness of CSMs and the existence of CPS as a latent attribute. It was argued that CSMs were unable to provide any evidence suggesting that they tapped into other than already well-known and established attributes such as reasoning and prior knowledge. At the same time, efforts were undertaken to solve the aforementioned issues by introducing more formalized CPS assessments that focused on the core features of CPS such as dynamics, complexity, and intransparency and that tried to minimize the impact of unsystematic and construct-unrelated variance (e.g., Funke, 2001; Kröner et al., 2005). One of these efforts cumulated in the development of MCSs (e.g., Greiff et al., 2013).

Obviously, avoiding any unnecessary ballast in favor of a focus on the core attribute of CPS comes at a cost: severe reductions in face validity. MCSs lack the appealing and attractive real-world resemblance of CSMs, which constitute a much more prosaic assessment environment. At the same time, we should ask whether the complex contextual embedding of CSMs has ever been shown to allow valid conclusions about participants'

abilities to act efficiently in the real-world context simulated by CSMs. In this regard too, results are rather mixed because experience and expertise with the real-word context do not necessarily warrant better decisions in CSMs (but see also Putz-Osterloh and Lemme, 1987; Chapman et al., 2006; Elliott et al., 2007). To this end, we do agree with Funke (2014) that MCSs lack the appeal of the complex real-world problem situations that are found in CSMs, but we respectfully disagree with his notion that MCSs capture a type of causal cognition that does not require the use of heuristics (Greiff et al., 2013) or of sophisticated strategies (Neubert et al., in press).

Interestingly, the use of strategies and heuristics relates directly to the question of cultural differences in CPS. In one of the few studies addressing this topic, Strohschneider and Güss (1999) report that different cultural backgrounds have an impact on the type of strategy and heuristics used in CSMs. It is important to understand whether such cultural differences originate from different prior knowledge (e.g., the kind of business knowledge needed in the Tailorshop might vary a great deal across cultures) or whether they constitute genuine differences in the underlying cognitive processes of CPS (e.g., it might be that culturally different conventions impact the way problems are approached). To this end, data on the processes taking place in CPS derived from computer-generated log files provide a useful tool for further penetrating the actual behavioral correlates in both CSMs and MCSs. For instance, Wittmann and Hattrup (2004) used log file analyses to show that boys tend to outperform girls in the Tailorshop because of a lower level of risk aversiveness reflected through more and stronger interventions in the system, which led, in turn, to better problem solutions.

An abundance of research questions await answers on how cultural background might influence the cognitive processes that occur when people tackle complex problems. But here again, we should ask whether these scientific challenges can be better addressed with CSMs, which are related to a real-world embedding almost necessarily bound to the cultural context of the real-world environment that is

simulated or with the more context-free and perhaps more culture-free instruments provided by MCSs. In building up further knowledge on CPS, we will need a clear distinction between face validity on the one hand and the underlying CPS attribute and its defining characteristics on the other. Valid CPS assessments that serve the purpose of researchers from different fields, whether in the form of CSMs or MCSs, should be developed along the lines suggested by Borsboom et al. (2004) who state that "a test is valid for measuring an attribute if and only if (a) the attribute exists and (b) variations in the attribute causally produce variations in the outcomes of the measurement procedure" (p. 1061). For CPS assessments, both questions remain unanswered for the time being. Empirical rigor and scrutiny are needed more than anything else so that the construct validity of CPS measurements can be guaranteed, implying a process that cannot be driven mainly by the desire for face validity, however appealing this facet might be. Herein, we do not see a dissociation between experimental- and assessment-oriented studies but a potential synthesis that jointly works toward an understanding of CPS as a latent attribute beyond its specific assessment instruments.

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Predicted causality in decision making: the role of culture

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DECISIONS AND HOW THEY ARE MADE

In the wider sense, decision making is embedded in the problem-solving process and its many stages (Davidson and Sternberg, 2003; Güss et al., 2010). In the narrow sense, decision making is understood as the ability to select one of several alternatives and to act accordingly (Güss, 2004). Previous research has often focused on decision making in relatively predictable environments with clear goals (e.g., expected utility theory of von Neumann and Morgenstern, 1944). In recent decades the focus has been on decision making heuristics, i.e., strategies or rules of thumb, applied in uncertain situations (e.g., Tversky and Kahneman, 1974; Simon, 1979; Gigerenzer and Gaissmaier, 2011).

Causality plays an important role in many cognitive processes – and causal cognition is itself influenced by culture (e.g., Norenzayan and Nisbett, 2000; Medin and Atran, 2004; Beller et al., 2009; Bender and Beller, 2011; for a controversial discussion of causal cognition, see Sperber et al., 1995). Causality is especially important during the decision-making process, because the decision maker has to predict what consequences specific decisions bring about before making a decision.

Causality refers here to the predicted decision options, that a specific planned action, when executed under specific circumstances, will have a specific predicted effect. This definition of causality refers to Aristotle's causa efficiens, i.e., an action is the origin and will cause an intended effect. Our understanding of causality is a constructivist understanding, because causality refers to the causal predictions of the actor and sometimes the actor's predicted probability of causal consequences might differ from a normative-mathematical probability of causal consequences. Predictions by actor and mathematical probability might be quite high ("As it is raining slightly, I will use the big umbrella and therefore not get wet during my walk"), but predictions by actor might be high and mathematical probability might be quite low ("when I buy a lottery ticket and use the birthdates of my family as lucky numbers, then I will win a million dollars"). Thus one could speak of predicted causality guiding the decision-making process. We are referring here to the predictions of the actor across domains.

The selection of decision alternatives is dependent on several factors such as importance, urgency, and likelihood of success (e.g., Dörner, 2008; Dörner and Güss, 2013). First, the predictions regarding decision alternatives involve the estimation of how important an alternative is. The importance is related to the human needs and the decision alternative, for example, to drink a glass of water when extremely thirsty would be more important than the decision alternative to call a friend to chat. Thus, although decision making is a cognitive process, it is related to our human needs and motivational processes.

Second, predictions regarding decision alternatives involve estimations of time and resulting urgency. If I am in my office and it is 5:30 pm, and I want to buy some groceries for the weekend and I know the store closes at 6:00 pm, and I know it takes me 15 min to get to the store, then the decision alternative "check and respond to emails" is perceived as less urgent (if the time estimation to check and respond to emails is longer than a few minutes which is usually the case).

Third, predictions regarding decision alternatives involve estimations of how likely it is that the predicted consequences actually happen. I know 15 min is the time I need to go to the store and I know I need an hour to check my emails and to respond to them. This predicted likelihood of success is dependent on one's competence: first the epistemic competence, i.e., the fact knowledge and experiential knowledge of the past; and second, the general competence, i.e., an estimation of one's ability to act successfully in the given situation (Dörner, 2008). High general competence is reflected in high predicted likelihood of success for decision alternatives ("I can do this"). In other words, one believes in oneself and that translates into one's ability to deal with situations successfully.

Judging importance, urgency, and likelihood of success for decision alternatives can occur either automatically or deliberately, i.e., unconsciously or consciously. Automatically means that based on previous experiences in similar situations, the predictions and their results are known and attributed to the current situation. Often certain cues in the current situation trigger the memory of similar situations and connected with those the successful actions in those situations which can then be applied in the current situation (e.g., recognition-primed decision making according to Klein, 2008).

If the current situation is a novel situation, then deliberations about possible

consequences of decision alternatives are more likely to take place. The novel situation requires deliberate thinking and predicting possible causal developments of decision options.

CULTURAL INFLUENCES ON THE PREDICTED CAUSALITY DURING DECISION-MAKING

The brief discussion of decision making and the variables influencing the selection of a decision alternative suggest ways in which culture influences the decision-making process and in which cultures could differ. Culture can be understood as implicit and explicit knowledge – including knowledge about how to make decisions and what decisions to make under what circumstances – shared by a specific group of people and transmitted from generation to generation (e.g., Smith et al., 2006). According to action theory and sociocultural theories, this knowledge is acquired during social interactions (Vygotsky, 1978) in a specific cultural, social, and historical context (Cole, 1996) which offers similar opportunities for learning (e.g., Lave, 1991).

IMPORTANCE – MOTIVATIONS

Previously we have stated that the estimation of decision alternatives' importance is related to needs. Although one can assume the universality of some human needs (Maslow, 1954), for example the existential needs and the needs for sexuality, affiliation, certainty, and competence (Dörner, 2008) or the needs for autonomy, competence, and relatedness as outlined in self-determination theory (Ryan and Deci, 2000), it is very likely that the importance of these needs varies across cultures. Church et al. (2013), for example, tested self-determination theory in eight cultures and found that Asian participants (Japan, China, Malaysia, and the Philippines) showed lower need satisfaction of competence and autonomy compared to American participants (United States, Mexico, and Venezuela). Additionally, research on individualism and collectivism has shown that for members of collectivist cultures, social and relational aspects of decisions might be more important compared to members from individualistic cultures (e.g., Güss, 2004).

Thus, the cultural importance of certain needs triggers different importance ratings for decision alternatives related to these needs.

URGENCY – TIME

Cultures encourage their members to develop different expectations regarding time and the future; not only the content of future developments, but also their structure (Güss, 2013). Structural differences can refer to the breadth and width of future expectations. Does the
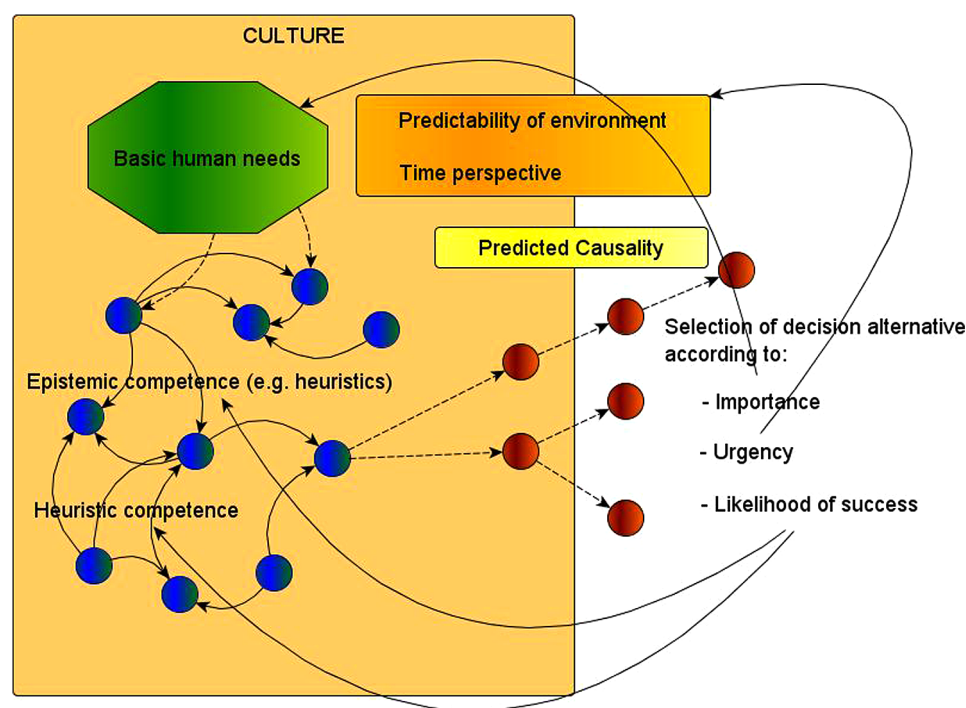
FIGURE 1 | Factors influencing predicted causality, decision making, and the role of culture. The knowledge structure is shown as a simplified neural network with interconnected neurons in blue color. From the node representing the current situation two dashed arrows go to two predicted situations (represented in brown dots). The first one predicts two further situations as probable linear consequences when certain actions take place (represented by dotted arrows). The second one predicts two different further developments when specific actions are taken. The selection of one decision alternative then depends on importance, urgency, and likelihood of success. Importance refers to the strength of a specific need. Urgency refers to predicted time needed to execute a decision. Likelihood of success refers to existing knowledge, i.e., epistemic competence, and heuristic competence, i.e., the estimation of one's abilities to deal successfully with the current situation. Cultures differ regarding importance, urgency, likelihood of success, and predicted causal developments.

development of decision alternatives and their related causal predictions concern the near future or the far future? Do decision makers develop one decision alternative or several?

Stable as opposed to unpredictable cultural environments, are those cultural environments in which social, political, economic, and/or climate-geographic changes are minimal and therefore allow their citizens long-term planning and decision making (Strohschneider and Güss, 1999). In relatively unpredictable cultural environments, it is not adaptive to develop predictions that reach far into the future. The predictions about possible likelihoods of events would be too difficult to make, for example during times of inflation. Yet, it is adaptive to develop several short-term plans. In relatively stable cultures, it is more adaptive to develop predictions and to make decisions that reach far into the future. Evidence for this argument can be found in the following cross-cultural studies on dynamic decision making and planning.

German, U.S., Indian, Filipino, and Brazilian participants were presented with the dynamic, non-transparent task Coldstore (Güss and Dörner, 2011). Participants attempted to regulate a broken thermostat which was simulated on the computer and to maintain an ideal temperature during this task. The thermostat does not react right away, but is time-delayed. When it is turned up, it takes a little while for the temperature to heat up; and when it is turned down, it takes a while for the temperature to cool down.

German and U.S. participants showed adaptor-type decision making more often than Indian, Filipino, and Brazilian participants who showed more oscillator-type decision making. Adaptor-type decision making means observing long-time intervals of changes in the system and adjusting slowly. Oscillator-type decision making means reacting to the momentary situation and regulating the temperature from one extreme to the other extreme without considering adequately what happened before and without taking possible predicted developments into consideration.

Regarding planning, researchers investigated these differences using daily life scenarios in Brazil during a time of extremely high inflation and in Germany during relatively stable economic conditions. German plans were longer and had more decision alternatives compared to Brazilian plans. Interestingly, Brazilian compared to German participants were more optimistic about the potential results of their decisions (e.g., Güss, 2000). Thus decision making was adapted to the conditions of the cultural context.

LIKELIHOOD OF SUCCESS – EPISTEMIC AND GENERAL COMPETENCE

Prediction of consequences and their likelihood of success are partly based on the epistemic competence, i.e., world knowledge in general and on specific domain knowledge in particular which the decision maker has accumulated over time. World knowledge is highly dependent on culture such as what we learn when we grow up.

Heuristics are a part of this epistemic knowledge which is acquired during socialization. Such heuristics can differ between cultures. Several experiments have shown, for example, that Chinese participants when confronted with uncertain and contradicting materials preferred a compromise. European Americans, however, tried to choose one correct position (Peng and Nisbett, 1999). Thus the Chinese learned and applied a "find a middle way" heuristic, whereas the European Americans learned and applied a "find the right way" heuristic.

Estimating the likelihood of success is also based on general competence, i.e., the estimation of one's abilities to deal successfully with the current situation. This general competence also varies across cultures (see also cross-cultural differences in self-efficacy, e.g., Scholz et al., 2002). Many studies have shown, for example, that Chinese students outperform U.S. students on international math tests (e.g., Beaton et al., 1996). One explanation for this finding is that Chinese "students perceived controllable causes, particularly effort, to play a greater role in performance outcomes than did their American peers" (Tuss et al., 1995, p. 408). Also the Chinese mothers viewed effort as the main cause for low math performance, whereas American mothers attributed low performance to other causes as well (Hess et al., 1987). Thus, the actual math performance might

be related to a higher feeling of general competence (because effort is controllable) in the Chinese compared to the American sample.

CONCLUSION

The main argument of this paper is that decision making involves causal predictions about possible future developments and that decision making involves estimation of importance, urgency, and decision alternatives' likelihood of success (see **Figure 1**). We then presented results from cross-cultural research showing that these processes differ among cultures and that culture highly influences decision making. These cross-cultural differences in decision making highlight the embeddedness of decision making within a specific eco-cultural historical context. To put it in extreme but very realistic terms, every decision is a cultural decision.

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Causal beliefs about depression in different cultural groups—what do cognitive psychological theories of causal learning and reasoning predict?

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Cognitive psychological research focuses on causal learning and reasoning while cognitive anthropological and social science research tend to focus on systems of beliefs. Our aim was to explore how these two types of research can inform each other. Cognitive psychological theories (causal model theory and causal Bayes nets) were used to derive predictions for systems of causal beliefs. These predictions were then applied to lay theories of depression as a specific test case. A systematic literature review on causal beliefs about depression was conducted, including original, quantitative research. Thirty-six studies investigating 13 non-Western and 32 Western cultural groups were analyzed by classifying assumed causes and preferred forms of treatment into common categories. Relations between beliefs and treatment preferences were assessed. Substantial agreement between cultural groups was found with respect to the impact of observable causes. Stress was generally rated as most important. Less agreement resulted for hidden, especially supernatural causes. Causal beliefs were clearly related to treatment preferences in Western groups, while evidence was mostly lacking for non-Western groups. Overall predictions were supported, but there were considerable methodological limitations. Pointers to future research, which may combine studies on causal beliefs with experimental paradigms on causal reasoning, are given.

Keywords: causal learning and reasoning, causal beliefs, causal model theory, lay theories of depression, cross-cultural differences

INTRODUCTION

Causal learning and reasoning appears to be a universal capacity. Causal learning enables us to derive knowledge about generic causal relations from observations and actions and to test hypotheses about causal relations. Causal reasoning allows us to explain events, to diagnose causes, and to predict future events and unobserved features. For example, causal learning enables us to find out which factors cause mental distress and impairment. Causal reasoning allows us to diagnose the causes of current distress, to predict its future course, and to envision interventions which may provide relief.

Causal learning, however, requires pre-existing causal knowledge. Research in cognitive science has shown that causal learning from a limited amount of data is only feasible if there is some higher order, abstract causal knowledge that constrains the number of potential causal hypotheses (Kemp et al., 2010; Tenenbaum et al., 2011). Only if a learner has some abstract theory about which of the numerous observable variables are candidate causes and which are possible effects, a small number of observations is sufficient to derive causal knowledge, that is, generic causal beliefs that have a relevant degree of certainty. For example, to find out what factors cause digestive problems, it is important to know that (i) causes precede the symptoms and that (ii) symptoms cannot be causes even when they are observed simultaneously with or even before the condition. These

abstract causal beliefs represent fundamental concepts of causality (Waldmann, 1996; White, 2006; Beller et al., 2009). In addition, higher-order, domain-specific beliefs are relevant for learning. For example, some basic medical knowledge tells us that physical injuries are not related to digestion, but nutrition and stress might be.

Like causal learning, causal reasoning is also based on causal knowledge, including higher-order theories about a domain (e.g., lay theories of illness) and specific causal beliefs about particular issues (e.g., beliefs about the causes of depression). For example, to diagnose the cause of a person's depressive symptoms, it is important to know that stress is a relevant causal factor for disease in general. When it comes to problem solving and decision making, causal knowledge may again be relevant. Sometimes purely instrumental knowledge, that is, knowledge about the consequences of actions, may be sufficient. But when no respective instrumental knowledge is available, causal knowledge may enable decision makers to choose the best course of action (Sloman and Hagmayer, 2006; Hagmayer and Meder, 2013). For example, persons with lactose intolerance usually know that taking lactase in advance prevents later digestive problems (instrumental knowledge), but only causal knowledge including at least some vague idea about the mechanism by which lactase works, allows us to infer that taking lactase after digestive problems have already occurred will give some relief.

Given that causal learning and reasoning and causal beliefs are inherently connected to each other, it may seem surprising that cognitive-psychological research often disregards people's pre-existing causal beliefs when investigating causal learning and reasoning. In order to study the underlying learning and reasoning processes, pre-existing domain-specific knowledge is usually excluded by using abstract problems or by providing participants with knowledge about new, previously unknown causal relations. These artificial scenarios ensure that participants cannot rely on pre-existing knowledge to respond to the given tasks, but have to actually engage in learning and/or reasoning based on the observed data, general notions of causality and higher-order theories. For example, in a landmark study on causal learning, Waldmann and Holyoak (1992) asked US-students to learn the relation between the disease Midosis and substances in the blood, which were either introduced as causes or as effects of the disease. Using the famous blocking paradigm, they showed participants in a first learning phase that Substance 1 was present whenever the disease was present. In a second learning phase they showed participants that Substance 2 was present whenever Substance 1 and the disease were present. In a test phase participants had to judge the likelihood of the disease given each of the substances. It turned out that participants' inferences were not only based on the observed statistical relations, but also on assumptions about the causal status of the substances. If they were assumed to be *effects* of the disease, participants considered both substances to be good predictors of the disease. By contrast, if substances were believed to be *causes* of the disease, only Substance 1 was considered to be a good predictor, while participants were unsure whether Substance 2 was a good predictor and therefore gave intermediate ratings. In other words, Substance 2 was blocked by Substance 1 only when they were assumed to be causes, but not when they were assumed to be effects.

Cognitive anthropological studies, in contrast to cognitive psychological research, often focus on studying systems of beliefs. Causal beliefs (i.e., beliefs concerning causes, consequences, interventions, and causal mechanisms) are part of the belief systems being explored. Respective research has been carried out in many cultural groups, both Western and non-Western. For example, Furnham (1988) explored people's lay theories about the causes of various medical conditions including depression, obesity, and lung cancer in the UK and elsewhere. Murdock (1980) summarized and analyzed previous anthropological work on lay medical theories in cultural groups around the globe. Despite not investigating causal reasoning *per se*, respective research showed that causal beliefs are related to other beliefs and actions. In the medical domain, for example, causal beliefs were linked to attitudes (e.g., stigma), to medical practices with respect to diagnosis and treatment, to people's expectations and predictions (e.g., prognosis of the course of an illness), and to actions (e.g., help seeking). For instance, Okello and Ekblad (2006) investigated causal beliefs about depression of the Ganda in Uganda. When witchcraft was suspected as the cause of a person's depression, the help of traditional healers was sought, while Western medicine was preferred to address somatic causes and symptoms of depression.

Thus, cognitive-psychological research on causal cognition and research on causal beliefs, which is conducted by anthropologists and other social scientists, yield important insights on causal cognition. Nevertheless, these two research traditions are still largely unconnected (cf. Beller, Bender and Waldmann's introduction to this special issue). An important and still open question is how these two types of research can best inform each other. Our aim in this paper is to provide first, tentative answers to this question. First, we will explore the predictions that can be derived from cognitive psychological theories on causal learning and reasoning for systems of causal beliefs. We will then apply these predictions to a specific test case, lay theories of depression. Expectations concerning similarities and differences between cultural groups will be laid out. In order to test these predictions, a systematic literature review of studies on causal beliefs about depression will be presented. Findings will be discussed and limitations will be pointed out. Finally, we will outline potential routes for future research, which combine studies on causal beliefs with experimental paradigms from the research on causal learning and reasoning.

PREDICTIONS FROM COGNITIVE PSYCHOLOGICAL THEORIES OF CAUSAL COGNITION FOR SYSTEMS OF CAUSAL BELIEFS

Many cognitive theories have been proposed to account for causal learning and reasoning. Some of these theories have tried to reduce causal reasoning to associative learning or probabilistic reasoning, but failed to account for the abstract notions of causality that people bring to bear when reasoning causally (Waldmann and Hagmayer, 2013). Therefore, we will focus on two classes of theories, causal model theory (Waldmann, 1996; Sloman, 2005) and Causal Bayes nets (Spirtes et al., 1993; Pearl, 2000; Glymour, 2001; Griffiths and Tenenbaum, 2009), both of which assume that people base causal reasoning on abstract notions of causality and represent causal relations in their beliefs. Causal model theory is a psychological theory, which aims to describe how people actually learn and reason. Causal Bayes nets provide a rational, computational model to formally describe causal induction, knowledge, and reasoning. It models an optimal learner and perfectly rational causal thinker (Waldmann et al., 2008). Recently causal Bayes nets have been used to formally describe mental causal models and derive predictions to be tested empirically. Empirical investigations to test these predictions with Western students using artificial scenarios yielded mostly confirmatory evidence (see Rottman and Hastie, 2014, for a comprehensive overview).

Two other theories have to be mentioned first, though, as they explain when and whereof people reason causally. Norm theory (Kahneman and Miller, 1986) predicts that people will start to search for causal explanations when observing events or instances which violate norms, that is, expectations about what normally happens. Counterfactual thinking is assumed to determine the factor that caused the deviation. The abnormal conditions focus model (Hilton and Slugoski, 1986) basically makes the same prediction. Abnormal events are assumed to trigger causal analyses. Research on counterfactual thinking has provided confirmatory evidence for these predictions (cf. Roese, 1997). It also showed that counterfactual deliberations are used to establish the cause or causal contribution of a given factor to an event. Given that successful causal inquiries result in causal beliefs, these theories

imply that people should hold more causal beliefs concerning abnormal than normal events. For example, people should hold more beliefs about the causes of ill-health than about the causes of good health. They also entail that people should hold similar beliefs across different cultural groups as long as the same events are considered abnormal in these groups.

Causal model theory (Waldmann, 1996; Sloman, 2005) and causal Bayes nets (Pearl, 2000; Glymour, 2001) assume that causal relations are represented as a set of beliefs about interconnected causal relations. In other words, causal relations in the world are represented as causal models. Causal models can be represented as graphical models, more precisely as directed acyclic graphs, which capture the asymmetry of causal relations (see **Figure 1**). Cause and effect variables are represented as nodes, while causal relations are represented by causal arrows capturing the assumption that there is a connecting causal mechanism by which the cause influences the effect. These theories assume that causal beliefs represent generic, directed causal relations and not merely associative relations. They also assume that causal relations are represented at the type level, that is, generic relations between types of events, rather than at the token level, that is, causal relations between individual instances. Hence, they entail that causal beliefs about an issue are complex and concern types of causes, mechanisms, and effects.

These theories, however, do not assume that people have specific knowledge about a causal mechanism, even when they assume that two variables are causally connected. Therefore, people should have more specific beliefs about the causes and consequences of a particular event or state than about the causal mechanisms by which these are related. This prediction was supported by research on explanation in Western cultural groups, which has shown that people often have only skeletal causal knowledge (i.e., knowledge about causes and effects), but do not know how the underlying causal mechanisms work (Rozenblit and Keil, 2002). Nevertheless, these theories also entail that assumptions about causal mechanisms should affect causal learning and reasoning whenever people hold such assumptions. When no connecting mechanism is known, for example, two variables should not be judged to be causally related even when they are statistically related. Respective research with Western adults

(e.g., Koslowski, 1996) and children (Gopnik et al., 2004) yielded confirmatory evidence.

Hierarchical Bayes nets (Tenenbaum et al., 2011) presume that causal learning and reasoning is guided by general notions of causality and higher-order causal theories of a domain. General causal notions include the assumption that causes precede their effects and that causes can influence their effects but not vice versa. Higher-order, domain-specific causal theories are, for example, the assumption that diseases cause observable symptoms and impairments. Research on computational modeling has shown that such higher-order theories are necessary to constrain the set of causal hypotheses when learning from limited amounts of data (Tenenbaum et al., 2011). Hence this theory implies that people should have a hierarchy of causal theories. It also predicts that mental causal models for particular topics (i.e., causal beliefs with respect to a particular issue) should conform to the respective higher-order theories. For example, causal models for particular maladies (e.g., depression) should align with more general lay theories of illness held in a particular cultural group. Of course, causal learning also depends on the observed data. The induced causal model needs to explain the observations. Consequently, differences in causal beliefs about particular issues should arise either due to (i) differences in observations, or due to (ii) differences in higher-order theories. When the environment is roughly the same, then differences in causal beliefs about a particular topic should only be found when there are differences in higher-order theories.

The observability of causes and the frequency with which observations can be made should affect the beliefs being held. When causes can be directly observed, then respective beliefs can be induced rather easily from a few observations (Lagnado and Sloman, 2002; Fernbach and Sloman, 2009). Therefore, people in different cultural groups should hold similar causal beliefs about observable causes, as long as the environments in which they live, and thus the observations to be made, are the same. However, when the observed factors cannot account for the events to be explained, hidden causes have to be inferred from observable clues. As the number of observations is often rather small, there is generally a large number of hypotheses about unobserved causes that may explain the data (Steyvers et al., 2003). In this
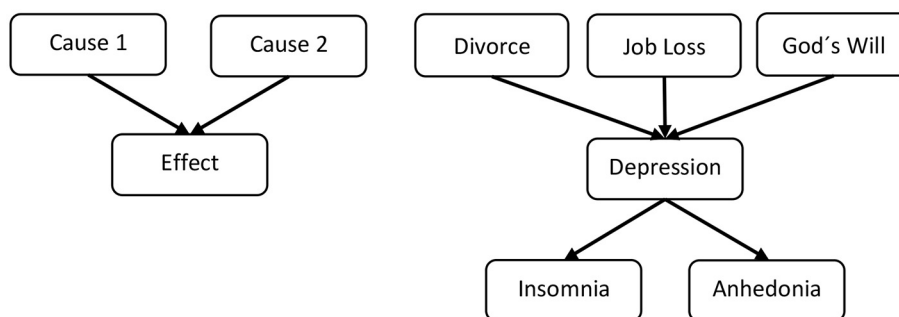
FIGURE 1 | Graphical causal models representing causal relations. On the left hand side an abstract, generic model is depicted, on the right hand side an example for a simplified causal model of depression is presented. Nodes represent variables (events, states) and arrows represent directed causal relations.

case, higher-order theories of a domain become more important, as they constrain the number of potential causal hypotheses. This entails that causal beliefs in different cultural groups should align more with respect to observable causes than with respect to unobservable causes. In addition, causal beliefs about observable causes should be less affected by higher-order theories than causal beliefs about hidden causes.

Higher-order theories, however, are not independent of the observable evidence, but they are underdetermined by the evidence (Kemp et al., 2010). Therefore, many higher order theories are compatible with a set of observations. For example, in medicine a number of highly elaborate theories of illness have been proposed (e.g., traditional Chinese medicine, Ayurvedic medicine, Western bio-medical medicine). All of these systems can account for a vast variety of observable illnesses and provide recommendations for—more or less—effective treatments. Therefore, it is not surprising that all of these systems are currently used by medical practitioners and are taught at universities. By contrast, causal models of particular issues have to directly conform to the observations made. Therefore, these models have to be revised more frequently than higher-order theories to account for new observations. This leads to the expectation that across different cultural groups, less variability should be found between causal models for particular issues than between higher-order causal theories, as long as the environment in which the groups live is roughly the same.

All theories of causal learning and reasoning assume that causal knowledge is functional. It not only allows us to explain events, but also to act and achieve goals. In other words, it not only serves epistemic, but also pragmatic goals (cf. Wellen and Danks, 2014). First, causal knowledge and reasoning can be used to make a diagnostic judgment and/or categorize a certain case. The causal model theory of categorization (Rehder and Hastie, 2001; Rehder, 2003) assumes that respective judgments are based on assumptions about the causal relations within a category. Based on the causal model of a category, the likelihood of observing a particular case can be derived. In turn, it can be inferred how likely the observed case belongs to the respective category. For example, when encountering a person showing symptoms of depression, a causal model of depression can be used to judge whether depression as an illness is present. This entails that causal assumptions and not merely observed symptoms should determine diagnostic judgments.

When it comes to decision making, people may resort to instrumental knowledge about the efficacy of certain actions, and choose the action which is most likely to yield the desired outcome. But even when people have no instrumental knowledge, causal knowledge and reasoning may prove to be very helpful as it allows us to identify the factors that are most likely to make a difference (cf. Sloman and Hagmayer, 2006). The causal model theory of choice predicts that people choose their actions based on a causal model of the given situation (Sloman and Hagmayer, 2006; Hagmayer and Sloman, 2009). To be more precise, people are assumed to first retrieve the causal model of a particular issue and instantiate it for the given case. Based on the model, simulations can be run to predict the outcomes of potential actions. By comparing the expected outcomes, the action can be selected that

has the highest likelihood of achieving the most desired goal state. For example, when deciding on what to do in a case of depression, a causal model for a particular patient can be constructed based on the decision maker's causal beliefs and the information provided by the affected person. This model can then be used to predict whether social support is sufficient for the person to cope with the condition she or he is in. If the depressive symptoms are attributed to stress, social support is likely to be considered sufficient. By contrast, when the symptoms are assumed to be caused by persistent, depressogenic thinking styles, then some form of psychotherapy is likely to be judged more effective.

To sum up, theories of causal learning and reasoning, more precisely, causal model theories and causal Bayes nets, allow us to derive predictions for systems of causal beliefs and potential differences and similarities between different cultural groups. **Table 1** provides an overview.

SYSTEMS OF CAUSAL BELIEFS—DEPRESSION AS A CASE STUDY

Lay theories of depression are an interesting case to test the predictions derived in the previous section. Depression is a mental disorder that has a substantial prevalence in every country around the globe investigated so far, with rates ranging between 7% in Japan and round about 20% in the US and Western Europe (WHO, 2013). It also creates a significant burden to patients and their relatives (WHO, 2013). Second, there are higher-order theories that may inform models of depression. These higher order theories encompass theories of illness, which have been found in all investigated cultural groups (Murdock, 1980), theories of the mind (i.e., lay theories of psychology), and/or theories of mental distress (Sheik and Furnham, 2000). Third, depression is characterized by a set of directly observable symptoms, which allow lay people to identify the illness. It presents with psychological symptoms (depressed mood, anhedonia, and reduced energy) and somatic symptoms (loss of appetite and weight, sleep problems, digestive problems). Although there are differences in how patients from different cultural groups first present themselves, the same symptoms are usually described when inquired about (Kirmayer, 2001; Bhugra and Mastrogianni, 2004). Forth, many different causes and risk factors have been established for depression, including biological, psychological, social, and economic factors (NICE, 2009). Some of these factors are directly observable (e.g., poverty, marital problems), while others are not (e.g., physiological parameters, genetic predisposition). In addition, depression sometimes seems to result from particular events (e.g., post-partum depression, depression after stroke), while in other cases there seems to be no specific causal trigger. Thus, lay people should be able to learn about the observable causes and they should infer hidden causes to account for the cases in which there is no observable cause. Fifth, different types of interventions have proved to be effective for depression, including pharmacological treatments, psychotherapy and—in cases of mild to moderate forms of depression—many types of psycho-social interventions and activities on behalf of the patient (cf. NICE, 2009). These findings entail that at least mild to moderate cases could be successfully addressed by non-Western, non-bio-medical treatments. Hence even lay people in non-Western cultural groups having difficulties to access Western forms of

Table 1 | Predictions derived from causal model theories and respective research for systems of causal beliefs in general and beliefs about depression in particular.

Assumptions of causal model theories	Predictions for systems of causal beliefs	Predictions with respect to lay theories of depression
Causal reasoning is triggered by unexpected, abnormal events (Hilton and Slugoski, 1986; Kahneman and Miller, 1986).	Causal beliefs concern abnormal conditions more often than normal events or conditions.	Depression is a frequent, but abnormal condition. Therefore, people across different cultural groups should hold causal beliefs about depression.
Causal beliefs represent directed, generic causal relations among cause and effect variables (Waldmann, 1996).	Causal relations are not only represented on the token level as relations among particular instances, but also as causal laws, i.e., generic causal relations, on a type level.	People across different cultural groups should have assumptions about causal factors that generally lead to depression.
Beliefs about individual causal relations are integrated into more complex causal models (Waldmann, 1996; Sloman, 2005).	Causal beliefs about a particular issue should form complex causal models.	People across different cultural groups should have interrelated beliefs about the causes, symptoms and consequences of depression.
Mechanisms are represented by mechanism placeholders, which represent merely the presence of an interconnecting mechanism (Pearl, 2000; Glymour, 2001).	Causal mechanisms are assumed to be present or absent. Knowledge about causal mechanisms is vague, often no details are known.	People across different cultural groups should have better knowledge about causal factors relevant for depression than knowledge about the underlying causal mechanisms.
Higher-order theories are necessary to induce causal models for a particular issue (Tenenbaum et al., 2011).	Causal models for specific issues conform to higher-order theories.	People across different cultural groups should possess higher-order theories, which inform models of depression. Causal beliefs about depression should align with these higher-order theories.
Higher-order theories are underdetermined by observable evidence (Kemp et al., 2010). Causal models of a particular issue have to directly conform to observations.	Many different higher order theories might be held and applied to a particular issue. Causal models should align whenever observations are similar.	Higher order theories may deviate between different cultural groups. Higher order theories informing causal models should deviate more strongly than causal models of depression.
Observed causal relations in the world are the basis for the induction of causal beliefs. Inferred causal relations are as simple as possible to account for the observations made (Lagnado and Sloman, 2002; Fernbach and Sloman, 2009). Hypotheses involving hidden causes are generally underdetermined by the observed data (Kemp et al., 2010).	Causal relations involving directly observable variables are easier to learn than causal models involving hidden variables that need to be inferred. Hidden causes are only inferred when observations require to do so. There is less agreement on hidden than observable causes.	Causal models with respect to directly observable causes and effects should be similar in different cultural groups given that the environments in which they live are similar. As observable causes do not fully account for depression, people across different cultural groups should have assumptions about hidden factors that contribute to depression. People from different cultural groups should agree more on observable causes than hidden causes of depression.
Assumptions concerning the usage of causal beliefs	**Predictions**	**Predictions with respect to depression**
Categorization is based on beliefs about the causal structure underlying a category (Rehder and Hastie, 2001). Diagnosis is based on assumptions about causal structure underlying an illness (Kim and Ahn, 2002).	Depending on assumptions about the underlying causal structure, the same instances may be categorized differently.	Depending on assumptions about the causes of depressive symptoms and depression as an illness, the same patient may be diagnosed as medically ill or not. Patients should be more likely to be diagnosed as ill when they present with symptoms that are causes of other symptoms (e.g., depressive thinking style) or symptoms that are caused by many other symptoms (e.g., high level of distress).
Judgments are based on causal knowledge when respective knowledge is available (Garcia-Retamero and Hoffrage, 2006; Krynski and Tenenbaum, 2007; Kahneman, 2011).	Causal beliefs may bias judgments when probabilistic instead of causal judgments are requested; causal knowledge may support probabilistic judgments by giving meaning to probabilistic information and allowing decision	Causal beliefs may contribute to the over-diagnosis of depression, when the typical symptoms and causal factors are present, despite a low base rate in the respective groups of patients. Causal beliefs may also lead to an under-diagnosis of

(Continued)

Table 1 | Continued

Assumptions concerning the usage of causal beliefs	Predictions	Predictions with respect to depression
	makers to integrate the information into a causal model representation.	depression, when depressive symptoms are explained away as normal reactions to transient conditions or specific events.
Decisions on actions are based on causal or instrumental knowledge (Hagmayer and Sloman, 2009; Hagmayer and Meder, 2013).	Decision makers use causal knowledge to infer the consequences of novel options. Choices are based on the predicted causal consequences.	Persons across different cultural groups should take their beliefs about the causes of depression into account, when rating and/or choosing a treatment for depression. Therefore, preferences should agree with causal beliefs.

treatment should be able to learn something about effective treatments for depression. Because of these reasons, depression seems to be an appropriate test case to investigate the predictions of theories of causal learning and reasoning for systems of causal beliefs across cultures.

Table 1 (right hand column) summarizes the specific predictions for the case of depression. Across different cultural groups people should hold generic beliefs about the causes of depression, and beliefs about observable causes should be similar as long as the environment in which people live is roughly the same. In consequence, treatment preferences should tend to align across different groups when depression is attributed to these observable causes. Differences between cultural groups are expected when environments differ. Differences despite similar environments are expected for: (i) Higher-order theories, which inform causal models of depression, (ii) assumptions about hidden causes of depression (which are informed by higher-order theories), and (iii) treatment preferences when hidden causes are assumed to be responsible for the observable symptoms. The literature review presented in the next section will show whether these predictions are supported empirically.

METHODS

We conducted a systematic review of the literature on lay theories of depression following the methodology used in the medical sciences (cf. Glasziou et al., 2001). It is important to note that none of the studies reviewed here were conducted to test the predictions derived in the previous sections (cf. **Table 1**). Studies in general aimed to investigate causal and non-causal beliefs about depression and to relate these beliefs to treatment preferences.

SEARCH STRATEGY

Three databases (Embase, Medline, and Psychinfo) were searched using the following search terms: Depress* AND (explanatory model OR illness perception OR caus* model OR caus* belief* OR lay theory). All publications up to September 2012 were considered. Five-hundred-eighty-six papers were found after removing duplicates. By screening titles and abstracts, papers obviously not meeting the previously specified inclusion criteria (see **Table 2**) were excluded, which reduced the number of publications to 55. These papers were read and reference lists were screened for further potentially relevant publications. Seven further publications were identified this way. Of these 62 studies, 36

met the inclusion criteria, while 26 were excluded; three papers (Patel, 1995; Lobban et al., 2003; Angermeyer and Dietrich, 2006) for being reviews, the other papers for presenting no or only incomplete statistical analyses of collected data.

We decided not to include publications presenting only qualitative results concerning causal beliefs, because participants from all investigated cultural groups tended to assume a large variety of potential causes. Hence, differences between groups could hardly be judged. Only quantitative data allowed us to rank order categories of causes and thereby assess similarities and differences between groups systematically. However, this decision favored non-anthropological over anthropological studies, which tended to be more qualitative in nature (e.g., Kleinman, 1977). This issue is further discussed in section Limitations.

ANALYSIS OF SELECTED PAPERS

All papers were analyzed using a pre-defined scheme (see **Table 3**). First the samples were classified into Western (W) and Non-Western (NW). Some of the non-Western groups were investigated in Western countries (e.g., Chinese Americans or Yoruba people from Nigeria living in the UK). Participants were classified as general population (G), patients (P), relations of patients (RP), students (S) and others (O) (e.g., members of self-help organizations and other specific groups of people). Sample sizes of respective groups are given in **Table 3**. Methods used to diagnose patients were classified into questionnaires (Q), and/or interviews (I). Some studies presented participants with case vignettes describing persons with depression. In most studies, a single vignette was used describing typical psychological and somatic symptoms of depression according to the International Classification of Disease (WHO, 2010) or the Diagnostic and Statistical Manual (DSM IV, APA, 2000). Methods used to investigate the conceptualization of depression as an illness vs. no illness or as a biomedical vs. mental illness were also classified into interviews (I) or questionnaires (Q). Frequently explanatory model interviews based on Kleinman (1977, 1980) were conducted. Popular questionnaires were *Reasons for Depression* (Addis et al., 1995), and the *Illness Perception Questionnaire* (IPQ), which was adapted to depression (Brown et al., 2001). Results with respect to four variables were assessed: (i) the conceptualization of depression, (ii) beliefs about the causes of depression, (iii) preferences with respect to treatment, and (iv) relations between conceptualization and assumed causes on one hand and treatment preferences on the other hand. Not all of these variables were

Table 2 | Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Design: Empirical study investigating causal beliefs with respect to depression (original research)	Case studies concerning a single or very few individuals, reviews, narrative accounts
	Publications not presenting original research
Participants: Lay-people including patients and their relatives, single or multiple cultural groups	Studies on causal beliefs with respect to mental distress or mental disorders in general
Method: Systematic assessment of causal beliefs through interviews following a protocol or standardized questionnaires	Studies with mental health professionals: e.g., physicians, psychiatrists, nurses, healers
Results: Presentation of quantitative results on causal beliefs: rating or ranking of importance of causes or percentage of persons endorsing each causal factor	Studies presenting qualitative results only, i.e., lists of potential causes without further quantitative information
	Studies presenting incomplete quantitative results

measured in all studies. Beliefs about causes were rank-ordered based on either the frequency with which a particular cause was mentioned by interviewees or the ratings given in questionnaires. The same procedure was used for treatment preferences.

To enable comparisons between cultural groups, assumed causes were then classified into five categories: (i) stress (i.e., environmental factors stressing the person); (ii) personality and psychological causes; (iii) biological, (iv) supernatural, and (v) traditional causes. The classification of causes into natural vs. supernatural causes was adapted from Murdock (1980), who used the same differentiation for causes of medical illnesses. Typical examples for stress were economic hardship, marriage problems, work overload and career failure; examples for personality and psychological causes were thinking too much, lack of willpower and low resilience, examples for biological causes were chemical imbalances in the brain, genetic factors and "nerves," and examples for supernatural causes were witchcraft, spirits and god's will. Traditional causes were causes according to non-Western medical theories. Such theories are found in India (Umma, Siddha, and Ayurvedic medicine) and in China (traditional Chinese medicine). Treatments were classified into five categories: (i) psychological treatment (e.g., psychotherapy, counseling); (ii) social support (i.e., non-professional support by family and friends); (iii) bio-medical treatment (e.g., antidepressant medication); (iv) religion or supernatural practices (e.g., praying, rituals against witchcraft), and (v) non-Western medicine or alternative treatment (e.g., Ayurvedic treatments, yoga).

RESULTS

DESCRIPTIVE RESULTS

It is not possible—and not necessary for the aim of this paper—to present all data with respect to conceptualizations, assumed causes and preferred treatments here. **Table 4** exemplifies the causes and treatments ranked highest in the studies on non-Western cultural groups. Note that categories of causes and treatments presented in **Table 4** were adopted from the respective authors. Hence they do not necessarily align with each other. A wide variety of causal factors were mentioned within and between groups. Some of these factors were culture-specific (e.g., karma in India, or ancestral spirits in sub-Saharan Africa) while others were found in virtually all groups (e.g., stress due to family issues and economic hardship).

Similarities and differences within and between cultural groups became more apparent when causes and treatments were re-classified using the same category scheme and categories were rank-ordered. **Table 5** shows the respective results for both Western and non-Western cultural groups. The overall rank order of cause categories was very similar across cultural groups. On average, stress due to environmental factors (e.g., family or job-related issues) was considered to be the most important cause, followed by psychological causes, biological causes and supernatural causes, although only one study on Western groups investigated the last category. But there was substantial variation between cultural groups, especially with respect to psychological, biological and—for non-Western cultural groups—supernatural causes. Some of these variations may be due to methodological differences (e.g., the specific causes inquired about or the setting in which the study was conducted); others probably reflect actual differences in beliefs.

More disagreement was found with respect to treatment preferences (see **Table 5** right hand side). Western cultural groups preferred psychological treatments (mostly psychotherapy) and social support over bio-medical treatments, which is in line with their causal beliefs that stress and psychological causes contribute the most to depression. A majority of non-Western groups preferred bio-medical treatments followed by social support. Religious and supernatural practices came in third ahead of traditional treatments and psychotherapy. These results, however, have to be put in context. Psychological treatments are often unavailable and therefore little known to people in non-Western countries. In addition, a number of studies—especially studies on patients—were conducted in clinics offering bio-medical treatments, which may bias participants' evaluations.

RESULTS CONCERNING SPECIFIC PREDICTIONS

The first prediction was that people across different cultural groups should have causal beliefs about depression, because it is a frequent, but abnormal condition that affords an explanation. A vast majority of people had assumptions about the causal factors that lead to or contribute to depression. Only 0–7% claimed that they did not know about the causes. Participants tended to have more difficulties to provide a cause when depression co-occurred with psychotic symptoms (Swami et al., 2010). This is in line with other studies showing that people know less about more severe

Table 3 | Overview of publications meeting inclusion criteria and description of methodological details of studies.

References	Country	Sample			Methods				Variables assessed			
		Cultural group	Participants	Sample Size	Diagnosis (patients)	Case vignette describing depression	Conceptualization/ Causes	Treatment preferences	Conceptualization	Assumed causes	Preferred treatment	Relation causes/ Conceptualization and treamtent
Aidoo and Harpham, 2001	Zambia	NW	O	139	Q	No	I_EM	I_EM	✓	✓	✓	✓
Addis et al., 1995	USA	W	S	602	Q, I	No	Q_RFD			✓		
	USA	W	P	133		No	Q_RFD			✓		
Addis and Jacobson, 1996	USA	W	P	98	Q, I	No	Q_RFD			✓		
Beck et al., 2003	Germany(Year 1990)	W	G	5025		Yes	I	I	✓	✓	✓	
	Germany(Year 2001)	W	G	3098		Yes	I	I	✓	✓	✓	
Boogaard et al., 2011	Netherlands	W	P	120	Q, I	No	Q			✓		✓
Brown et al., 2001	USA	W	P	41	Q	No	Q_IPQ	Q_IPQ	✓	✓	✓	✓
Brown et al., 2007	USA	W	P	191	Q, I	No	Q_IPQ	Q_IPQ		✓	✓	✓
Budd et al., 2008	UK	W	O	164		No	Q	Q		✓	✓	✓
Carter et al., 2011	New Zealand	W	P	177	Q, I	No	Q_RFD			✓		
Cornwall et al., 2005	UK	W	P	15	Q	No	Q_RFD			✓		
	UK	W	RP	15	Q	No	Q_RFD			✓		
Dunlop et al., 2012	USA	W	P	80	Q, I	No	Q	Q		✓	✓	✓
Fortune et al., 2004	UK	W	P	101	Q	No	Q_IPQ			✓		
Furnham and Kuyken, 1991	UK	W	G	201		No	Q			✓		
Goldstein and Rosselli, 2003	USA	W	S	66		No	Q	Q		✓	✓	✓
Grover et al., 2012	India	NW	P	164	Unclear	No	I_EM			✓		
Jadhav et al., 2001	UK	W	P	47	Q	No	I_EM		✓	✓		
Jorm et al., 1997	Australia	W	G	1010		Yes	I			✓		
Jorm et al., 2005a	Australia	W	G	910		Yes	I			✓		
Jorm et al., 2005b	Australia	W	G	3998		Yes	I	I	✓		✓	
	Japan	NW	G	2000		Yes	I	I	✓		✓	
Karasz et al., 2009	USA	W	P	74	Q	No	I	I	✓	✓	✓	
Khalsa et al., 2011	USA	W	P	145	Q, I	No	Q_RFD	Q		✓	✓	✓
Kirk et al., 1999	USA	W	G	25		No	Q	Q		✓	✓	
	USA	W	P	25	Q, I	No	Q	Q		✓	✓	
Kuyken, 1992	UK	W	G	49		No	Q, I	Q, I		✓	✓	
	UK	W	P	20	Q, I	No	Q, I	Q, I		✓		
Kwong et al., 2012	USA	NW	P	42	Q	No	I_EM	I_EM		✓	✓	
Lauber et al., 2003	Switzerland	W	G	873		Yes	I			✓	✓	
Lavender et al., 2006	UK	NW	G	20		Yes	I	I		✓		
	UK	NW	G	20		Yes	I	I	✓	✓	✓	
	UK	W	G	20		Yes	I	I		✓	✓	
Lynch and Medin, 2006	USA	W	S	23		No	I			✓	✓	
McKeon and Carrick, 1991	Ireland	W	G	1403		No	I	I		✓		
Nieuwsma et al., 2011	USA	NW	S	92		No	Q, I_EM	Q, I_EM	✓	✓	✓	✓
	USA	W	S	97		No	Q, I_EM	Q, I_EM		✓	✓	
Raguram et al., 2001	India	NW	P	80	I	No	I_EM	I_EM		✓	✓	
Shankar et al., 2006	India	NW	P	72	I	Yes	I	I	✓	✓	✓	
Swami et al., 2010	Malaysia	NW	G urban	189		Yes	Q	Q	✓	✓	✓	✓
	Malaysia	NW	G non-urban	153		Yes	Q	Q	✓	✓	✓	✓
Tully et al., 2006	Australia	W	P	392	Q	No	Q			✓		
Yeung et al., 2004	USA	NW	P	29	Q, I	No	I_EM	I_EM	✓	✓	✓	
Ying, 1990	USA	NW	G	40		Yes	I_EM	I_EM	✓	✓	✓	✓

Note: Participants were classified as general population (G), students (S), patients (P), relatives/spouses of patients (RP) or other (O). Cultural groups were classified as Western (W) and non-Western (NW). Methods used to diagnose patients were classified into questionnaire (Q), clinical interview (CI) or other (O). Methods used to assess conceptualizations, assumed causes and preferred treatments were classified into interviews (I) or questionnaires (Q), Explanatory Model interviews are marked as I_EM, Reasons for Depression questionnaire studies by Q_RFD and Illness perception Questionnaire studies by Q_IPQ. Check marks indicate that the respective variable was investigated.

Table 4 | Overview of beliefs with respect to depression in non-Western cultural groups.

References	Sample			Conceptualization	Variables assessed			Relation causes/ Conceptualization and treatment
	Cultural groups	Partici-pants	Sample Size		Assumed causes	Preferred treatment		
Aidoo and Harpham, 2001	African:Zambian	O	139	Problem of the mind, no health-related problem	(1) Problems of the mind (unhappiness, sleep disturbance, headache) (2) Poverty and resulting worries (3) Mood swings (4) Satan, witchcraft, God	No treatment		Reported relation (no statistical analysis): Conceptualization as no medical problem coincides with high preference for no treatment
Lavender et al., 2006	African:Yoruba	G	20	No agreement on whether person described in vignette was ill or not	(1) Magic, evil spirits, devil (2) Family problems (3) Problems with partner/breakup (4) Financial problems	(1) Religion (2) Doctors or nurses (3) Friends and neighbors (4) Herbalist		Reported relations (no statistical analysis): Belief in Magic/ Witchcraft as cause was associated with religious activities or witchcraft as treatment No belief in medical cause was associated with preference for no medication
Lavender et al., 2006	Asian:Bangladeshi	G	20		(1) Family problems (2) Financial problems (3) Problems with spouse (4) Worries about responsibilities	(1) Doctors or nurses (2) Family support (3) Friend support (4) Addressing the cause		
Grover et al., 2012	Asian:North Indian	P	164		Reported on spontaneously: (1) Psychological causes (2) Social causes (3) Karma, deed, heredity Reported on probing: (1) Karma, deed, heredity (2) Psychological causes (3) Social causes (4) Will of God			

(Continued)

Table 4 | Continued

References	Sample			Variables assessed				Relation causes/ Conceptualization and treatment
	Cultural groups	Partici-pants	Sample Size	Conceptualization	Assumed causes	Preferred treatment		
Nieuwsma et al., 2011	Asian:North Indian	S	92		(1) Failure (2) Unfulfilled expectations (3) Family issues (4) Stress/Anxiety	(1) Social support (2) Problem-focused coping (3) Meditation (4) Professional treatment		
Shankar et al., 2006	Asian:Indian	P	72	Worries about life's problems, thinking too much and worries about physical health	(1) Physical disease (2) No physical disease	(1) Medication (2) No treatment (3) Native healing		Reported relation (no statistical analysis): Assumption of physical disease was associated with preference for medical treatment
Raguram et al., 2001	Asian:South Indian	P	80		Reported spontaneously: (1) Social Causes (2) Medical Causes (3) Weakness of Nerves (4) Psychological Causes Rated as most important: (1) Weakness of Nerves (2) Stress, loss, shock (3) Mind, thoughts, worries (4) Marital problems	(1) Private allopath (2) Government allopath (3) Pharmacy (4) Vow, fast, prayer, sacrifice		
Swami et al., 2010	Asian:Malayan, rural	G	189	(1) Emotional stress (2) Depression	(1) Stress, pressure (2) Destiny, God (3) Biological causes (4) Environmental causes	(1) Counseling (2) Psychiatrist, psychologist (3) Holiday (4) Social support		Correlation between assumption of stress as a cause of depression and preference for treatment
Swami et al., 2010	Asian:Malayan, urban	G	153	(1) Depression (2) Emotional Stress	(1) Stress, pressure (2) Biological causes (3) Environmental causes (4) Destiny, God	(1) Psychiatrist, Psychologist (2) Counseling (3) Religion, prayer (4) Social Support		

(Continued)

Table 4 | Continued

References	Sample			Variables assessed			
	Cultural groups	Partici-pants	Sample Size	Conceptualization	Assumed causes	Preferred treatment	Relation causes/ Conceptualization and treatment
Jorm et al., 2005b	Asian:Japanese	G	2000	(1) Psychological/Mental/Emotional problems (2) Stress (3) Depression (4) Mental Illness		(1) Talking with friends and family (2) Counselor (3) Psychiatrist (4) Doctor	
Kwong et al., 2012	Asian:Chinese	P	42		(1) Life stress (2) Psychological causes (3) Medicinal causes (4) Traditional causes	(1) Lay help (self, friends, relatives) (2) General health services (pharmacy, doctor, hospital) (3) Alternative treatment by provider (acupuncture, herbal/traditional healers) (4) Alternative self-treatment	
Yeung et al., 2004	Asian:Chinese	P	29	(1) No psychiatric disorder (2) Psychiatric condition	(1) Stress or psychological factors (2) Magical, religious, supernatural factors (3) Medical problems (4) Traditional beliefs	(1) General hospital services (2) Lay help (3) Alternative treatment (4) Spiritual treatment	
Ying, 1990	Asian:Chinese	G	40	(1) Psychological Problem (2) Physical problem	(1) External stress (2) Interpersonal factors (3) Immigration (4) Physical factors	(1) Help by psychologist or general practitioner (2) Help by family and friends (3) Self-help	Assumed cause psychological: 30% seek professional help (almost all by psychologist), 30% seek non-professional help, 39% seek self-help. Assumed cause physical: 75% seek professional help (mostly by GP), 17% seek non-professional help, 8% seek self-help

Note: Assumed causes and preferred treatments were included when a majority of participants endorsed them or rated them above the midpoint of the respective scale. Presented categories of causes and treatments were developed by the respective authors.

Table 5 | Analysis of rank orders of assumed causes and preferred treatments in non-Western and Western cultural groups.

		Causes					Treatments				
		Stress (externally caused)	Personality/ Psychological causes	Biological causes	Supernatural causes	Traditional causes	Psychological treatment	Bio-medical treatment	Social support	Religious/ Supernatural practice	Non-Western medical/ alternative treatment
Non-Western Cultural Groups	N	12	11	9	9	4	5	11	8	9	5
	Rank 1	67%	18%	22%	22%		20%	55%	38%	22%	
	Rank 2	25%	55%	33%	11%		20%	27%	50%	22%	20%
	Rank 3		27%	33%	44%			9%	13%	22%	80%
	Rank 4	8%		11%		50%	40%	9%		11%	
	Rank 5				22%	50%	20%				
	Mean Rank	1.5	2.1	2.3	2.9	4.5	3.2	1.7	1.8	2.8	2.8
	Overall Rank	1	2	3	4	5	5	1	2	3	4
Western Cultural Groups	N	30	35	29	1	N/A	19	19	9	3	6
	Rank 1	60%	40%	10%			63%	21%	44%	33%	17%
	Rank 2	30%	40%	38%			26%	47%	22%	33%	50%
	Rank 3	10%	20%	52%			11%	32%	33%		
	Rank 4				100%						33%
	Rank 5									33%	
	Mean Rank	1.5	1.8	2.4	4.0		1.5	2.1	1.9	2.7	2.5
	Overall Rank	1	2	3	4		1	3	2	5	4

Note: Overall ranks were based on mean ranks.

forms of mental illness. For example, a review on lay theories of schizophrenia (Angermeyer and Dietrich, 2006), found that between 5 and 15% of respondents had no respective knowledge.

The second prediction was that people across different cultural groups should have assumptions about generic causal factors for depression and that these beliefs form complex causal models. More than 90% of participants in interview studies named more than one cause of depression. The same is true for participants responding to questionnaires which endorsed more than one causal factor as relevant for depression in general or for a specific case. Hence, people seem to have complex causal beliefs regardless of cultural background.

The third prediction was that people should have more and more specific beliefs concerning causal factors than causal mechanisms. The results of the reviewed studies hardly allow us to make an informed judgment at this point. This is mostly due to methodological limitations. Both questionnaires and interviews inquired about causes of depression. Therefore, it is not surprising that respondents hardly mentioned specific causal mechanisms and gave no details about these mechanisms. One exception was cognitive mechanisms referring to rumination or thinking too much, which were reported by studies on Western and non-Western groups. Another exception was vague descriptions of Western and non-Western physiological processes in some of the questionnaire studies (e.g., chemical imbalances in the brain or humoral imbalances), which tended to be endorsed by some responders.

The fourth set of predictions concerned higher-order theories, which should inform causal models of depression. None of the

studies reviewed here directly investigated higher-order theories and their implications for causal models of depression in different cultural groups. Some indirect evidence, however, comes from Indian studies, which often identified karma as a relevant cause of depression (see **Table 4**). Karma has to be considered an abstract theory (karma-deed-heredity), which accounts for many events and conditions including mental and other illnesses. Thus, Indian participants seem to have used this higher-order theory to causally explain cases of depression. There is at least one study outside this review, which directly addressed the question of higher-order theories. Patel (1995) investigated how lay theories of mental illness are shaped by abstract causal beliefs in sub-Saharan Africa. General assumptions held by people in this area seem to be that (i) all things and events have a cause with a greater power than the event/thing itself and (ii) that all events with high importance or impact are also caused by an intentional agent. It is believed that spirits (ancestral and others) and witchcraft can cause or at least influence events. While proximate causes are believed to explain how an event was generated, only ultimate causes are assumed to explain why a certain event happened. These general notions about causation and causal explanation explain why people in sub-Saharan Africa assume mental illnesses to be caused by social, economic, and/or biological factors (proximate causes) and supernatural causes like spirits and witchcraft (ultimate causes) at the same time.

The fifth prediction was that higher-order theories of different cultural groups should deviate more from each other than causal models of depression. Again no direct evidence is available at this moment. There are some clues, however, that may support this

prediction. Academic medical theories (e.g., Western bio-medical vs. Ayurvedic vs. traditional Chinese medicine) and lay theories of illness deviate very profoundly from each other (Murdock, 1980), while the results presented here point toward a considerable amount of agreement about the causes of depression.

The sixth prediction was that people across different cultural groups would have assumptions about hidden, not directly observable causes. In virtually all studies participants assumed biological and/or supernatural causes of depression. Biological causes include physiological, nervous, and/or genetic factors or processes. These causes are not directly observable by lay people. Supernatural causes are generally assumed to be not directly observable, although they might be considered directly perceivable in some cultural groups. There seems to be some agreement, however, that the presence of a supernatural cause in a particular case has to be inferred from observable clues.

The seventh prediction was that participants from different cultural groups should agree more on observable causes than hidden causes. This prediction seems to be supported by the results shown in **Table 5**. Stress due to environmental factors was endorsed by all investigated cultural groups as the most important type of factor. These environmental factors are easily observable. The second most important factors were personality and psychological causes, which can be assessed through communication, followed by biological and supernatural causes. The order was the same for Western and Non-Western groups although there were differences within groups.

A number of predictions were derived concerning the usage of causal beliefs for categorization, diagnostic reasoning, judgment and decision making. Unfortunately none of the studies reviewed here directly investigated the impact of causal beliefs on categorization and diagnostic reasoning. In order to do so, participants would have to be presented with several, especially constructed cases and several judgments would have to be collected. Respective research methods exist and have been successfully used to investigate how causal assumptions of Western mental health professionals and students affect diagnostic judgments and decision making (e.g., Kim and Ahn, 2002; DeKwaadsteniet et al., 2010). For example, Kim and Ahn (2002) asked their participants (students and psychologists) to describe how the diagnostic indicators of various mental disorders are causally related to each other. Based on the individual causal models, they constructed case vignettes of patients which had symptoms that were either causes of other symptoms, effects of other symptoms, or were causally not related to other symptoms. It turned out that patients with symptoms being causes of other symptoms were judged as more likely to have the disorder than patients showing symptoms being effects or symptoms being causally unrelated. This finding is surprising, because Western mental health professionals are trained to consider all diagnostic indicators as equally important (cf. DSM IV, APA, 2000).

One important prediction of causal model theories of decision making is that people should take causal beliefs into account when deciding on actions (e.g., Sloman and Hagmayer, 2006). The relation between causal beliefs and ratings of treatments were investigated by statistical methods in 11 of the studies reviewed here. For the Western cultural groups, several studies found statistically significant relations. Dunlop et al. (2012) showed that people who attributed depression to chance or fate prefered to refrain from treatment. People who conceptualized depression as an emotional illness preferred cognitive behavioral therapy (CBT) over medication, while those who considered it a physical illness preferred medication. Khalsa et al. (2011) reported a relation between beliefs in biological causes and a preference for medication, and a relation between beliefs in childhood causes and a preference for psychotherapy. McKeon and Carrick (1991) found a positive correlation of beliefs in biological causation and perceived helpfulness of medication. Budd et al. (2008) reported the same finding. By contrast, Goldstein and Rosselli (2003) found that a belief in biological causes was related to a preference for CBT. Brown et al. (2007) showed that a belief in bio-medical and environmental causes was related to perceiving less control over the condition. Brown et al. (2001) found that people who assumed interpersonal difficulties to be an important cause adhered less to medical treatments. Boogaard et al. (2011) reported that people, who believed in childhood issues and intra-psychic fears as causes, tended to be in treatment for a longer period of time. Two studies even found a relation between causal beliefs and treatment outcomes (Addis and Jacobson, 1996; Carter et al., 2011). For example, Carter et al. (2011) showed that patients who believed that interpersonal conflicts are the cause of their depression profited more from interpersonal therapy than from cognitive behavioral therapy.

Only two studies on non-Western cultural groups directly investigated the relation, while others merely claimed their presence (see **Table 4**). Swami et al. (2010) found small but significant correlations among beliefs and ratings of treatments, but they tended to vary considerably between urban and rural Malay people. Those who believed more in external causes tended to rate rest and change of diet as more effective, while those who believed more strongly in supernatural causes endorsed religion as a treatment more than others. Ying (1990) found for a Chinese American sample that 30% of those who assumed psychological causes sought professional help from psychologists, while 75% of those who believed in physical causes looked for help from a physician. Other studies pointed out that (i) a belief in supernatural causes was related to respective activities and treatments (Lavender et al., 2006) and that (ii) a belief in a medical illness was related to a preference for bio-medical treatments (Aidoo and Harpham, 2001; Shankar et al., 2006). The summary presented in **Table 5**, however, indicates a discrepancy between the moderate belief in biological causation and the strong preference for bio-medical treatment. As pointed out above, there are several possible explanations for this finding. Patients may have tried other forms of treatment, being more consistent with their beliefs, before resorting to bio-medical treatment. Another might be that other services, especially psychotherapy or counseling are not available. In addition, the costs of different forms of treatment may have affected preferences beyond causal considerations.

In sum, many of the predictions derived from causal model theories of causal reasoning and/or causal Bayes nets were supported by the empirical evidence on lay theories of depression. There is, however, a considerable lack of evidence with respect to two crucial aspects. First, the interplay between higher-order

theories of causation and illness and causal models of specific conditions like depression has not been investigated. Second, the influence of causal beliefs on categorization and reasoning has not been explored and the evidence with respect to decision making is still scarce, especially in non-Western cultural groups.

DISCUSSION

The present paper explored how cognitive psychological theories of causal learning and reasoning can inform research on systems of (causal) beliefs in different cultural groups. Based on causal model theories (Waldmann, 1996; Sloman, 2005) and causal Bayes net theories (Pearl, 2000; Glymour, 2001; Griffiths and Tenenbaum, 2009; Tenenbaum et al., 2011) predictions for systems of causal beliefs were derived. These predictions were applied to lay theories of depression. Lay theories of depression seemed to be an appropriate test case, as depression is present globally with a substantial prevalence and a common core of somatic and psychological symptoms. Established causes include both observable and non-observable factors. Therefore, all derived predictions could be tested. Most predictions entailed a similarity between different cultural groups. Differences in beliefs were only expected with respect to higher-order theories and inferred hidden causes. It was also predicted that causal beliefs should affect the categorization and diagnosis of depression as well as preferences and decisions with respect to treatment.

A systematic literature review on lay theories of depression was conducted and eligible papers were analyzed systematically by classifying assumed causes and preferred treatments into common categories. Results showed that members of all investigated cultural groups held causal beliefs about generic causes of depression and that beliefs constituted complex causal models. As predicted, substantial agreement was found between different cultural groups with respect to easily observable causes of depression, that is, stress due to environmental factors like marital problems and psychological variables like depressive thinking styles. Less agreement resulted for hidden causes. Substantial differences were found with respect to supernatural causes between Western and non-Western cultural groups and between different non-Western groups. Many of these beliefs seemed to be culture-specific (e.g., the role of karma or the influence of ancestral spirits). Assumptions about these causes also seemed to be informed by higher-order theories of causation and illness, although none of the reviewed studies directly investigated this relation empirically.

The usage of causal beliefs in reasoning and decision making has rarely been explored systematically. Especially evidence from non-Western cultural groups is lacking. When investigated, rather good agreement between causal beliefs and treatment preferences were found for Western cultural groups. The few results for non-Western groups appear to be mixed. It seems that other factors apart from causal beliefs may have an important impact on treatment preferences as well.

Taken together, the results tend to support the derived predictions. This indicates that cognitive psychological theories of causal learning and reasoning can be used to derive testable predictions for systems of causal beliefs.

LIMITATIONS

There are a number of limitations that need to be pointed out. First, there are limitations concerning the systematic literature review. Only publications describing original research on causal beliefs about depression were included. In addition, studies had to present quantitative results. We deliberately constrained ourselves to quantitative studies in order to be able to rank order causes for importance. Purely qualitative studies were therefore excluded. In consequence, more studies on non-Western cultural groups were excluded than studies on Western cultural groups. This is particular unfortunate as—for example—studies investigating cultural groups in Iran (Dejman et al., 2010), Uganda (Okello and Ekblad, 2006), and Vietnam (Niemi et al., 2009) were not considered. The same is true for studies looking at different religious groups living in the same country (e.g., Loewenthal and Cinnirella, 1999). However, these studies reported similar findings as the studies reviewed here. One exception seems to be that religious or spiritual people tended to believe more strongly in supernatural causes (e.g., loss of faith) and endorsed respective practices for treatment in both Western and non-Western groups (Wittink et al., 2009).

Studies included in this review were published in medical, medical-anthropological, social science and psychology journals. We cross-checked reference lists for further relevant publications. We are not aware of missing important empirical, quantitative studies published elsewhere. Despite this effort, hardly any anthropological studies ended up in this review. This is probably due to our focus on quantitative studies. Another reason is that the searched databases only encompass a few journals publishing anthropological research, although *Medical Anthropology*, *Transcultural Psychiatry*, and *Social Science and Medicine* seem to be the major outlets for work on lay concepts and theories of depression and other mental illnesses. A third reason may be that we concentrated on a specific mental disorder. It might well be that anthropologists take a broader perspective and look at theories of mental illness or mental distress instead of particular diseases (e.g., Kleinman, 1980; Kirmayer and Valaskakis, 2008). The reason, however, may be more fundamental. Beller et al. (2012) pointed out that cognitive science and anthropology might be incompatible with respect to perspective and methods. Therefore, findings from anthropology may be difficult to use to test predictions derived from cognitive psychological theories.

Second, there are limitations concerning the methodological rigor of the reported studies. All studies reviewed here systematically assessed participants' causal beliefs, which is good. But not all studies presented participants with case descriptions of depression. Therefore, it is not clear that all participants had the same understanding of the term "depression." Some of the non-Western cultural groups lived in Western countries, which may have changed their beliefs about depression. In fact, some Yoruba people pointed out that they would give different answers depending on whether they were in the UK or Nigeria (Lavender et al., 2006). Hence differences between Western and non-Western cultural groups may be underestimated. Unfortunately, the relation between assumed causes and treatment preferences were only assessed in limited number of studies. Found correlations were generally low to moderate. Error accumulation due to the large number of statistical tests was almost never taken into

account. Hence, the statistical validity of the results has to be rated as rather moderate.

Finally, we only tested the predictions derived from cognitive-psychological theories with respect to causal beliefs on depression. It might be that lay theories of depression are different from other lay theories. Although we cannot exclude this possibility, our results seem to be in line with lay theories about other topics (cf. Furnham, 1988). Nevertheless, more evidence on other systems of causal beliefs is needed to corroborate the present findings.

IMPLICATIONS FOR FUTURE RESEARCH

The review identified two areas of research, which merit further attention by researchers investigating causal cognition in different cultural groups. One area is the interplay between higher-order theories and causal models for particular issues. Higher-order theories include general notions of causation and general theories of a domain (e.g., lay theories of illness). Although more general lay theories have been investigated (e.g., Furnham, 1988), there is little research on how theories on different levels of abstraction interact with each other and the observable evidence in different cultural groups. Hierarchical Bayes nets (Tenenbaum et al., 2011) allow us to derive specific predictions for the causal models people will induce from a set of observations and respective higher-order theories. In order to conduct respective experimental studies a multi-method approach seems to be advisable. A triangulation approach (Atran and Medin, 2009) would allow us to properly investigate the influence of different cultural backgrounds on higher level theories. For example, theories of skin diseases could be assessed in Western and Indian groups in the UK and in India. This way country and cultural background could be disentangled. In a research study, first higher level theories could be assessed using interviews. Respective methodologies have already been developed in anthropology and cultural psychology (e.g., Kleinman, 1980; Weiss et al., 1992; Atran and Medin, 2009). Based on the interviews, lay theories could be reconstructed on the group and the individual level. In a second step, participants in the study could be confronted with a series of cases showing a new, previously unknown medical condition. Dermatological problems seem to be a good starting point as there are many forms. Hence new forms can be created easily without violating general expectations. In addition, dermatological problems have many different causes (e.g., allergic reactions, cancer, somatization problems). Like in the case of depression, some of these causes are directly observable, while others are hidden. This would allow researchers to manipulate the data presented to participants. Data can be presented as descriptions of individual cases, which would ease understanding. Data may show a contingency between an observable cause (e.g., a new type of clothing) and the condition to be explained (e.g., itchy dark purple spots in the arm pit, which start to bleed later on) or the observable causes may be unrelated to the symptoms. After hearing (or reading) about a series of cases, participants would be asked to explain either a typical single case or to provide a generic explanation of the problem. Hence participants would be asked about their theory of the illness on a token (specific single case) and a type level (generic model). One prediction to be

tested would be that explanations are more strongly influenced by the observed data when observable causes were related to the condition, but more strongly affected by higher level theories of illness and skin problems when there were no contingent observable causes. In addition to experimental research, real world test cases could be explored. An interesting, historic test case may be people's causal beliefs about AIDS when the respective syndrome first grabbed the public's attention. Another example is bovine spongiform encephalitis (BSE, mad cow's disease) and variant Creuzfeldt-Jakob Disease (vCJD, the human version of BSE), which also initially created a puzzle for experts and lay-people. In both cases it is predicted that people resorted to higher-order theories about illness to account for the observed syndrome.

The second area of interesting future research concerns the usage of causal beliefs for categorization, diagnosis, prognosis, and decision making. There is already some evidence that folk ecological causal beliefs affect categorization and decision making (cf. Atran and Medin, 2009), but more evidence from different domains and different cultures would be interesting. Experimental and non-experimental research could provide important insights. While non-experimental research would show whether decisions and judgments are coherent with causal beliefs, experimental research could show whether, when and how causal beliefs affect judgments and decisions. Cognitive psychology provides a wealth of experimental paradigms to study causal reasoning in experts and lay-people in a rigorous manner. Such experimental research allows us to distinguish between judgments and decisions that are merely recalled from memory and judgments and decisions that are based on reasoning. When a decision can be recalled from memory, because it had been taken under the same circumstances before, no causal reasoning is necessary. Only when no judgment or decision is known right away, causal reasoning based upon pre-existing causal beliefs and the observed situation may become relevant (cf. Sloman and Hagmayer, 2006; Hagmayer and Sloman, 2009). Hence, if we want to study causal reasoning of lay-people in everyday contexts, we need to create novel, but meaningful scenarios, in which they can resort to their causal knowledge, but do not necessarily have to. The work by Kim and Ahn (2002) is a good example for well controlled experimental research. In these studies, participants' causal beliefs about mental illnesses were assessed individually before they were confronted with novel judgment and decision problems, which were created based on their idiosyncratic causal beliefs. For example, participants were asked to diagnose new patients, which conformed to different degrees to the causal assumptions held by the individual participant. One may argue, however, that the materials presented to participants in these studies were still impoverished in comparison to real life complexity. This is true, but the basic paradigm could be extended respectively. Using well established interview techniques (e.g., Kleinman, 1980; Atran and Medin, 2009), explanatory models of—for example— particular mental or somatic diseases could be assessed. Based on these models, different and complex case vignettes could be created. These case vignettes could either describe prototypical cases, which show all expected symptoms, or cases, which show only a subset of symptoms. In addition, it could be manipulated how many potential causes and/or risk factors of the condition

are present. As well, the course of the condition (its development over time) could be more or less typical. After creating the cases, it would be important to assess how familiar participants are with these cases and how often they had heard about a respective diagnosis and treatment before. This would indicate whether participants could resort to their memory or would have to engage in reasoning. Based on the case vignettes three types of dependent variables could be collected. First participants could be asked to name the patient's problem. This would show how participants would categorize the case. To collect quantitative data, participants could be requested to rate how likely the person has the respective condition. Second, participants could be asked to explain the condition of the respective patient. Hence, they would be asked to engage in diagnostic causal reasoning. Again, ratings of potential causes could be collected as a quantitative measure. Third, participants could be asked to choose a course of action, that is, they would have to decide on a treatment. As before, quantitative ratings of different treatments could be requested.

The research strategies outlined in the previous two paragraphs combine elements from cognitive psychological, cultural psychological and cognitive anthropological research. This shows that these approaches are not incommensurate (Unsworth, 2012). Anthropological research does not only provide interesting research questions (Whitehouse and Cohen, 2012), but also methods to develop a deep understanding of the beliefs held by people in different cultural groups as well as the inferences and decisions that these people are likely to make (Astuti and Bloch, 2012). Existing ethnographic research may already provide descriptions of higher level theories, which are needed to conduct the type of research proposed here. Murdock's work (1980) is an excellent example in this regard.

CONCLUSION

Research on systems of beliefs in different cultural groups and cognitive psychological research on causal learning and reasoning *can* inform each other. In our view, they *should* inform each other. In this paper, we derived predictions from cognitive-psychological theories for systems of lay causal beliefs. Social science and cognitive anthropological research can and—to some degree—already does provide empirical results to test these predictions in different cultural groups. Moreover, in order to investigate causal learning and reasoning in everyday contexts, it is necessary to know which causal beliefs people may bring to bear when they are confronted with judgment and decision making tasks. These beliefs range from abstract notions of causality to causal models for particular issues. In addition, it is important to know about other beliefs like moral convictions, which may also affect causal judgments and decisions on actions (Liu and Ditto, 2013). Only when these beliefs are known, it will be possible to study the interplay of causal beliefs and causal reasoning in everyday life through experimental research.

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Causal inferences about others' behavior among the Wampar, Papua New Guinea – and why they are hard to elicit

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As social beings, people need to be able to interact intelligently with others in their social environment. Accordingly, people spend much time conversing with one another in order to understand the broad and fine aspects of the relations that link them. They are especially interested in the interactive behaviors that constitute social relations, such as mutual aid, gift giving and exchange, sharing, informal socializing, or deception. The evaluations of these behaviors are embedded in social relationships and charged with values and emotions. We developed tasks to probe how people in an unfamiliar socio-cultural setting understand and account for the behavior of others conditional upon their category membership – by trying to elicit the basic categories, stereotypes, and models that inform the causal perceptions, inferences and reasoning people use in understanding others' interactive behaviors – and we tested these tasks among the Wampar in Papua New Guinea. The results show changes in the relevance of social categories among the Wampar but also, and perhaps more important, limitations in the translation and applicability of cognitive tasks.

Keywords: causal explanations, sociality, social cognition, kinship, Papua New Guinea, methodology

INTRODUCTION

As social beings, people need to be able to interact intelligently with those others who constitute their interactive environment (Sperber and Hirschfeld, 2004). Accordingly, people spend much time conversing with one another in order to understand the broad and fine aspects of the relations in which they and others engage. To understand others and to have better control about their own relations, they need enough information on the history and context of behaviors. Social interaction therefore depends on – and produces – a range of activities related to causal cognition: asking for explanations of behavior of other animate beings, construing possible causes and reasons, and/or ascribing responsibility for what emerges from this behavior.

Most people are especially interested in the interactive behaviors that constitute social relations: mutual aid, gift giving and exchange, sharing, informal socializing, deception, free-riding and so on. Social behaviors have moral characteristics that index and have consequences for particular relationships; people have definite expectations about who will or should behave in which way and these are often based on essentialist assumptions (Gelman and Hirschfeld, 1999; Gil-White, 2001; Sousa et al., 2002; Gelman, 2003; Waxman et al., 2007). Wampar, like others described in the ethnographic literature [see the special issue edited by Danziger and Rumsey (2013)], are sometimes circumspect about reading other people's minds, but in many settings they are only too eager to discuss and evaluate the behavior, motivations and reasoning of others.

Our aim was to make explicit the information-searches and presumed causes concerning social behaviors by stimulating discussions with subjects using short scenarios intended to motivate people to reason about relations and motivations involved in the scenarios. We developed tasks to probe how people understand and account for the behavior of others conditional upon their social relations – by targeting basic categories and stereotypes (Hirschfeld, 1996), as well as the models and biases in causal attribution (Morris and Peng, 1994; Morris et al., 1995; Choi et al., 1999; Bender and Beller, 2011) and ascription of responsibility (Bender et al., 2007, 2012; Beller et al., 2009) that inform the causal perceptions, inferences and reasoning people use in understanding others' interactive behaviors (Schlottmann et al., 2006). The tasks and results reported here were part of a pilot-study by the first author during her fieldwork among the Wampar in Morobe Province in Papua New Guinea (PNG) from March to May 2013[1]. The main goal of the study was to test if these tasks could be made relevant to local participants and hence could be used in a large-scale comparative study on causality and sociality. Our aim in this paper is to share the insights emerging from this process with regard to the difficulties encountered that may, but need not be specific to this field site.

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[1]This fieldwork tied in with previous fieldwork among Wampar in Gabsongkeg by the first author (1997, 1999/2000, 2002, 2003/04, and 2009), and continued a research agenda inspired by the ethnographic work of Hans Fischer, begun in the 1950s. Fischer had conducted fieldwork in Gabmadzung in 1965, and then in Gabsongkeg in 1971/72, 1976, 1988, 1990, 1993, 1997, 1999/2000, 2003/04, and 2009. In 2009/2010, Doris Bacalzo and Tobias Schwörer did research in Dzifasing, and Heide Lienert, Christiana Lütkes, Rita Kramp, and Juliane Neuhaus worked in different Wampar villages (Fischer, 1975, 1996; Beer, 2006).

In the following, we first provide some background information on the socio-cultural context of the Wampar, before describing the two studies that were conducted there, one employing an active information search with fictive scenarios on social behavior, the other using such scenarios to evoke evaluative responses. As it turned out that the main insight to be gleaned from these studies is not so much their empirical results, but rather the methodological problems they pose, the discussion focuses on those challenges that arise from this kind of cross-cultural research (cf. Baumard and Sperber, 2010).

SOCIO-CULTURAL CONTEXT

The Wampar[2] are a language group of about 12–15000 persons, occupying the area of the middle Markham River in Morobe

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[2]When we write about "the Wampar," the reader should keep in mind that "Wampar" have not always been a bounded social unit with its own territory. There have been kin groups fighting against each other and moving through the mountains and the Markham Valley. As in other parts of Papua New Guinea "ethnicity is based on continua of cultural difference in a population crisscrossed by flows of people" (Golub, 2014, p. 118).

Province of PNG (see **Figure 1**). They live in eight villages, five of them close to the Highlands Highway. The concentration of the population in villages is a post-contact phenomenon, developed under the influence of colonialism and Christianization after 1911. The Wampar practice of building houses in gardens away from the villages offsets this centralization in some areas, and in the last few decades many of these garden houses have developed into new hamlets away from the main village. With new economic opportunities through cash crops, cattle and chicken farms, and marketing along the main Highway, additional settlements have proliferated (Fischer, 1996, pp. 124–128). Today Wampar occupy an almost "suburbanized" area, with much of the population accustomed to engagement with the market economy.

Aside from the growth in number of hamlets and orientation toward the Highlands Highway (and market economy), there has also been an increasing factionalism in the dominant Evangelical Lutheran Church and the growth of new religious denominations and churches. Thus, the once centralizing force of a single institutional church as the center of village life from the early colonial period has been dissolved as well. Fischer
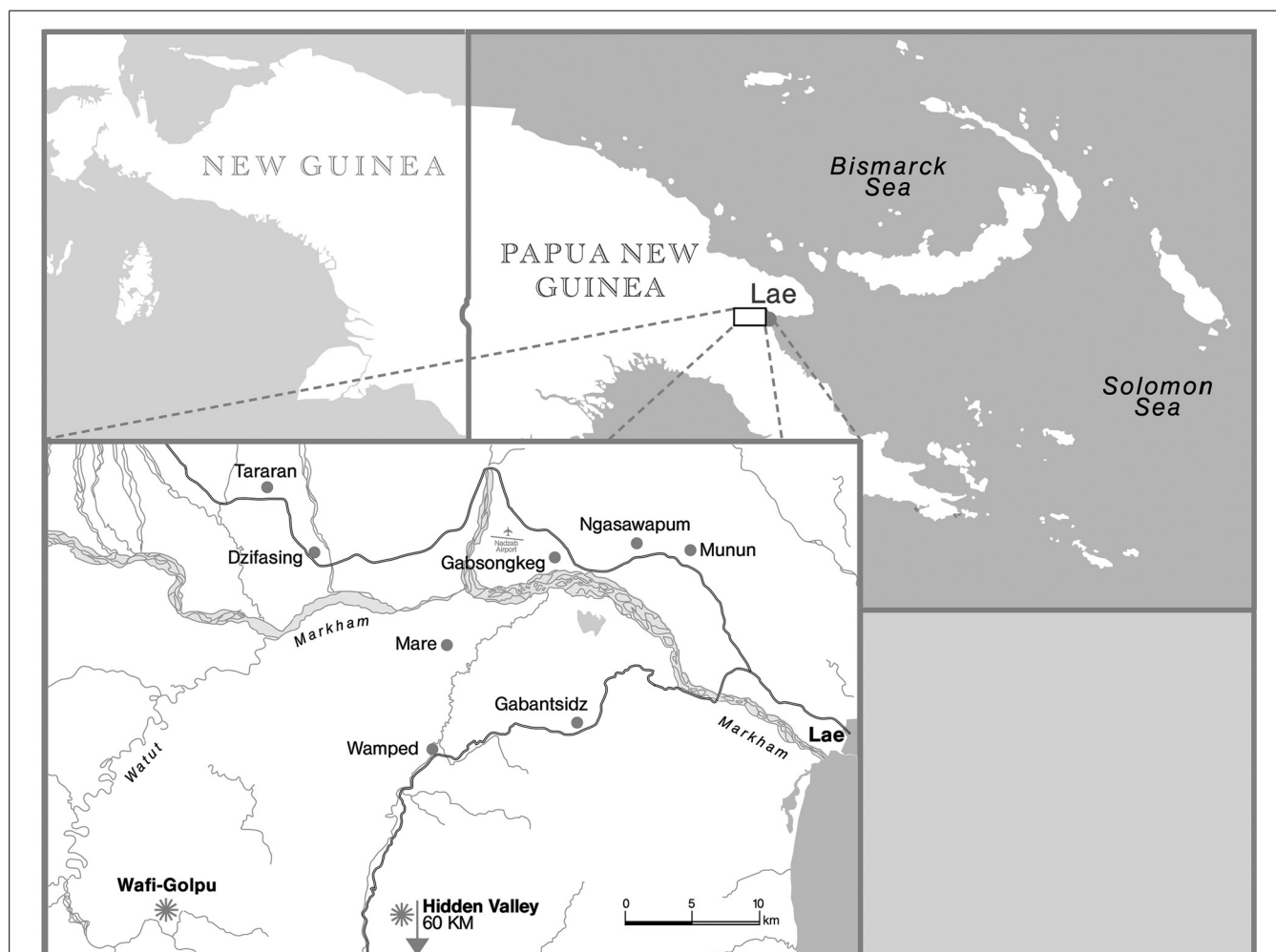
FIGURE 1 | Map of PNG and Wampar villages (map H. Schnoor).

(1975, 1996), who has studied the Wampar since the late 1950s, observed that until the 1970s, all Wampar conceptualized themselves as members of one of the about 30 named social groups called *sagaseg*. Wampar speak of *sagaseg* as patrilineal groups, but – as often happens in PNG – the incorporation of non-patrilineal kin is common. Also, the fusion of non-related *sagaseg* is historically verifiable. Furthermore, marriage patterns and practices have been diverse and are changing, with, for example, increases in interethnic marriages, children born out of wedlock and adoptions. Marriages within the same *sagaseg* were formerly subject to sanctions, but this is no longer the case, and some young people have even become unclear about their membership of a *sagaseg* (Fischer, 1996, pp. 129–144; Beer, 2006).

These changes (Beer, 2006; Beer and Schroedter, 2015) and others (including the very real possibility that a large gold/copper mine will be opened) have tended to challenge the hegemony of descent identities; what defines a Wampar, who counts as a member of the *sagaseg*, and how inter-*sagaseg* relations are configured are less clear than they once were. Fieldwork between 2009 and 2013 made it clear that kin networks, which now often join ethnically different groups, have complexified Wampar ideas concerning boundaries and significant social identities. In practice, the specific circumstances of particular social actors and the kind of relationships that they have among themselves and with their extended families, including those of interethnic marriages, have become decisive in accounting for commitments between individuals and groups.

OVERVIEW OF THE STUDY

The study consisted of two parts: the first adopted the "active information search" paradigm (Frey et al., 1996; Huber et al., 2011) and comprised two short scenarios developed to probe naïve inclinations in the reading of intentions and behaviors of others, in contrasting types of behavior (helping and deception); the second part consisted of a narrated (fictive) scenario to evoke evaluative responses to behaviors of others and assumptions about the nature of categories and relations of the people involved. The order of tasks was the same for all participants, with Part 2 following Part 1.

In contrast to the majority of cross-cultural studies, we did not take a task that had been refined for usage with "WEIRD" (Henrich et al., 2010) samples, but aimed at formulating scenarios and questions relevant to the lived experience of social interaction in the local population under study to avoid what Medin et al. (2010) call the "home-field disadvantage." We constructed stories of the sort, familiar to any social group, and especially also of non-WEIRD societies. As examples we chose behaviors which form the basis for inter-subjectivity and sociality, such as cooperation, commensality, and the morality[3] of relationships, which are grounded in structured forms of interactions

and on capacities as intention attribution, strategizing, or planned deception.

All tasks were written in English and translated into PNG's lingua franca *Tok Pisin* (which is more and more frequently used among Wampar, especially between Wampar parents and their children, and most of the time in interactions with non-Wampar), but were presented verbally.

PART 1: ACTIVE INFORMATION SEARCH FOR SCENARIOS ON SOCIAL BEHAVIORS

The main goal of Part 1 was to investigate which type of information Wampar consider to be essential for venturing causal explanations of the course of social interactions. It therefore amounted to an active information search task, in which the presentation of a target question (on distinct social behaviors) was aimed at generating further questions (e.g., about the persons involved, their relations, or the situation) relevant to the evaluation of the behavior described in the scenarios. We also wanted to know what initial reason/causes people imputed to the characters described in the scenarios.

METHODS
Participants
Twelve Wampar from the village of Gabsongkeg participated in this part of the study (five women, six men, and one schoolboy), but its analysis is confined to the adults. The trial interview with the 7-years old schoolboy generated only one answer, which was not to the point: he commented on his own past behavior[4]. The results are therefore reported for 11 participants (age $M = 40.0$ years, range: 18–73). All of them went at least to elementary school and were involved in farming and some small business. More information about biography, education, and family background of all participants is available because the ethnographer has known them since 1997. The interviews were relaxed and all participants were free to discuss personal and/or problematic topics.

Material
The task revolved around two target scenarios, each followed by a set of three questions. The scenarios focused on the social interaction of "helping" and "deceiving," respectively:

(A) "X helps Y to finish some hard and boring work:"
   (A1) "Why do you think X helped Y?"
   (A2) "Ask me questions: what do you need to know to answer the question why he/she helps?"
   (A3) "How would you say other people (living in your neighborhood/village) would explain why X helps Y?"
(B) "X deceives Y by not giving him his share of the proceeds of a joint business/work"
   (B1) "Why do you think X deceived Y?"
   (B2) "Ask me questions: what do you need to know to explain why X does that?"
   (B3) "How would you say other people (living in your neighborhood/village) would explain why X does this?"

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[3]We understand by 'morality' collectively sanctioned rules, beliefs and central values that inform the everyday considerations of actors encountering choices and ambivalence in social interactions. These considerations are contextual and relational. Accordingly, we use morality here interchangeably with ethics.

[4]That he refused to answer more questions was astonishing, as the boy is otherwise not shy, but very talkative and shares his opinions even on matters which are usually topics for adults. It is, however, in line with some of our other findings and will be discussed below.

X and Y were replaced either by local male and female names or by "a man" or "a woman." When necessary the interviewer gave for "hard and boring work" local examples like carrying something heavy, or cleaning a big garden.

The first questions (A1, B1) aimed at finding out how people reason about the described behaviors. The second questions (A2, B2) were connected to the first and are very open; they tried to identify what information people ask for if they feel uncertain about the reasons for the behavior. The third questions (A3, B3) aimed at getting access to participants' ideas about shared (and non-shared) desires, beliefs, and reasons for behavior.

Questions 1 and 3 thus directly targeted causal explanations, the latter with a focus on sharedness. We expected that mutual aid was explained more often in terms of balanced and generalized reciprocity, specificities of the situation, and less often by individual characteristics of personality or in terms of market exchange. Question 2 was intended to produce data on the information people considered most relevant to establishing causal explanations. Here, we expected people to ask either for attributes of the category of people involved (such as sex, age, or ethnicity), their personal attributes, and information about the relation they have, or for more details about the situation.

Procedure and design

All participants were given both scenarios with three questions each in the above order; scenarios were read identical or very similar to the original text; eight of the 12 interviews were fully recorded. Furthermore, the ethnographer made detailed notes on the situation and context, and recorded other pertinent observations, in a field notebook.

RESULTS

As indicated above, the prime concern of this part rested on question 2 and on the data it would procure regarding active information search; this is presented first. Findings from questions 1 and 3 on the explanations for the behaviors are presented afterward, separately for scenarios A and B.

Active information search

With respect to its main aim, the investigation of active information search, the questions about helping or not-sharing (A2 and B2) were a failure. When asked what one needed to answer the target question, literally *every* participant simply repeated the target question. When the ethnographer explained that they could ask for any further information, nobody requested any. These questions seemed to be unintelligible or too abstract. Participants made clear that they took it that the question itself sufficed to produce an answer, and, if it did not, other questions could not help. To ask in roundabout ways for further information so as to get to an answer (like in a quiz game), which one could get directly, did not make any sense to the participants.

Explanations for the behaviors

Talking about the scenarios gave some important insights, nevertheless; yet, they were different from what we expected.

(A) Helping scenario. The first question about the first scenario, in which person X helps person Y (A1), was answered by eleven people. One man was excluded from the analysis because he did not address the question. Answers of the other 10 participants can be grouped as follows (see **Table 1**; more than one answer possible).

The most frequently given answer, that helping is based on balanced reciprocity, was expected as it is a common feature of sociality in PNG (cf. Tracer et al., 2014). Several respondents located the reason for X's behavior in the situation based on a more generalized reciprocity in which intragroup exchange is organized by an ethic of as-needed assistance. The spontaneous first answer of three respondents, who assumed that Y had paid X to help him, was less expected, but might be indicative of an increasing integration of the Wampar population into market economy. Only two participants mentioned X's disposition.

The question on what other Wampar may think about the situation (A3) was answered by the same 10 participants. One said he only knows what others think if he can talk to them. Another respondent (a much criticized businessman who leases Wampar land to non-Wampar migrants) inquired whether the question referred to what people think about his own business[5].

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[5]The ethnographer had the strong impression that this man gave all answers in a way which should correct his negative image and the anticipated critique of his manners, which circulated among Wampar.

Table 1 | Explanations for social interaction: helping.

Response categories (with concrete responses)	Frequency	
	In numbers	In %
Balanced reciprocity		
Y helped X in the past or is expected to help X in the future	5	
Y provided food for X	1	
X wants to marry Y's daughter	1	
Subtotal	7	36.8
Generalized reciprocity		
X is feeling sorry	3	
Y is alone	1	
Y is weak and tired	1	
Subtotal	5	26.3
Market exchange		
Y gave money to X	3	
Subtotal	3	15.8
Dispositions of X		
X has special skills/knowledge	1	
It is X's manner [*pasin*] to help	1	
Subtotal	2	10.5
General evaluation		
This is good or good behavior [*pasin*]	4	
Subtotal	4	21.1
Total	19	100.0

Five assumed that others would answer as they had and merely repeated what they had said – with only little variation, or with additional reasons for their response. Five respondents said that there are many different social behaviors and mindsets. Three of this latter group emphasized ongoing social transformations, largely caused by the introduction of a money-based economy; they complained that today only money counts and that people become more egoistic and lazy, and/or they only focused on their own nuclear family referring to the conflict between communal and individual values (Barker, 2007, pp. 9ff.).

(B) Deception scenario. Questions on this scenario were answered by 10 participants (see **Table 2** for an overview; more than one answer possible).

The reactions of participants to the first question (B1) were split like in the helping scenario: eight respondents located the reason for the behavior in the disposition of person X. One participant mentioned the transformative power of money as a cause of deception as it changes the way people think and their social behaviors. The answers of other participants, who stated what X is doing, can be interpreted in a similar direction. They emphasized the circumstances and his desire, which explains his behavior, rather than characterizing him as a person. This resonates with everyday experience during fieldwork: when somebody took food,

tools or other things from somebody else, the ethnographer was often astonished that people got very angry about what happened, yet did not blame the person or accuse him or her of possessing negative character traits. For example, a young man once stole cooked food that an older woman had put aside to be eaten in the evening. This is thought of as extremely bad, disrespectful behavior, and the woman's family got very angry. But, even when they found out who it was, the incident was explained in terms of circumstances (he had been drinking, and become hungry) rather than by character deficits in the young man. Mostly, deception, stealing, and violent behavior were quickly forgotten and had few consequences for the evaluation of the person in the future. One respondent even blamed Y because he should find out himself about the money and not rely on X giving it to him.

The question on how fellow Wampar would reply (B3) was answered by 10 participants. Those who did answer the question in the intended way were split: three replied that other Wampar would give the same answer and four replied that they would evaluate the situation in different ways. A woman made very clear (like some participants after the first scenario), that "lifestyle" has changed; she said: "Everybody follows his wife only and does not share anymore (*bihainim meri tasol*, means looking after their own family). Selfishness has become very common."

DISCUSSION

In general, the findings from the first part of the study were informative with regard to the sociocultural dimension of the task (i.e., the attitudes and expectations involved or activated), but less so in terms of information search: while we did obtain data on the content of causal explanations, obtaining data on the processes involved in causal reasoning was more difficult.

The causal explanations used in the helping scenario corresponded partly with what we had anticipated, based on our (anthropologically informed) picture of Wampar society and the ongoing changes in their life-style (see Socio-Cultural Context). Reciprocal relations are the links in the chains constituting the fundamental relations of social networks. The principles of balanced and generalized reciprocity are internalized early in life and these thematize many types of action. Interestingly many Wampar are very aware of the transformation of intentions and motivations that has accompanied their increased integration into market economy: nowadays some Wampar actively try to avoid or curtail the reciprocal obligations that had been central to their community[6]. Several participants emphasized the transformative power of money, which encouraged people to refuse help to others who could not pay, so that inequality also becomes more pronounced. If people do not have any money they must offer work or something else as 'payment' instead. Some Wampar complained that mutual help in the context of generalized reciprocity and community values has become rare (cf. Barker, 2007, pp. 8–12).

In many answers, money is itself assigned a causal role in social behaviors and their transformation. The desire for money and things is here a causal force, which is less located in the

Table 2 | Explanations for social interaction: deception.

Response categories (with concrete responses)	Frequency	
	In numbers	In %
Balanced reciprocity		
Y deceived X in the past	1	
Subtotal	1	4.8
Action of X (attributed to circumstances)		
Money has changed the way people think	1	
X is lying (for a specific reason)	2	
X needs the money for realizing a plan	4	
Subtotal	7	33.3
Dispositions of X		
X is selfish/greedy	5	
X is lying (as a habit)	1	
X is lazy / does not like to talk	2	
Subtotal	8	38.1
General evaluation		
This is bad or bad behavior [*pasin*]	4	
Subtotal	4	19.0
Other		
Y should have tried to find out by himself	1	
Subtotal	1	4.8
Total	21	100.0

[6]This was especially a vital lesson to learn for shop owners in the villages who wanted not to give all their goods away to kin, but be able to start a small *bisnis*.

weakness of a person – following the notion of a 'personality' (Goldie, 2004) – but rather in outside powers and circumstances. Behavior in the deception scenario was explained along these lines: somebody with a plan to buy or do something, or a strong specific need for the money, is understandably motivated to deceive. This resonates with comparative studies of American and Chinese attributions of causes, which suggest differences between dispositional and situationalist reasoning about social events (Morris and Peng, 1994). It also evokes certain observations reported by Tracer et al. (2014, p. 191) of the ultimatum and the third-party punishment games as played by Au speakers in PNG: "Several player 2 s expressed concern for the plight of player 1: 'It's all right, maybe he really needs it and has some work he has to do with it,' one said, and yet another asserted, 'It's not good, it's not a good split, but I don't care, he probably has a reason.'"

The change of social relations and the attendant diversification of values was another topic repeatedly raised by participants. Therefore making claims about social behaviors and the reasons behind them among "the Wampar" has become even more difficult than it might have been in former times. Reflection by many Wampar on specific changes of values and behavior facilitates discussions about shared (and non-shared) desires, beliefs and reasons for social interactions. Our scenarios and the related questions were starting points for discussion, although more detailed and committed discussions happened in informal situations and in small groups of people who know each other well.

Although it is clear when people's exclamations express their own moral attitude with a very general evaluative response, *Em gutfela (pasin)!* ("This is good [behavior/manners]!"), central values might or might not be attributed by participants as a cause for behaviors. This lack of clarity is exemplified in the spontaneous answers to the question "Why does X help/deceive Y?" In the helping scenario, for example, these responses were often not directly connected to causal reasoning, in the sense of "X does it because it is good behavior." In the deception scenario this is particularly clear; participants often responded with a similarly evaluative statement, "This is bad behavior," without stating or implying anything about the *reasons* for the behavior.

The dominant strand of research on causal cognition is basically concerned with the processes of perception, learning, and reasoning about abstract causal relations (Michotte, 1963; Bender and Beller, 2011; Waldmann and Hagmayer, 2013). In social contexts, attributing causal involvement in an event is often intertwined with a moral dimension (Samland and Waldmann, 2014) and with the ascription of responsibility for that event (e.g., Heider, 1958; Shaver, 1985; Hewstone, 1989; Weiner, 1995). These concerns appear to be reflected in the explanations of the Wampar participants for the behavior of person X, some of which we tentatively categorized as 'dispositional' (i.e., all those that refer to the manner or personality of X in **Tables 1** and **2**), while other explanations we categorized as referring to circumstances that triggered them. Even less clear is the categorization of those cases that reflect balanced reciprocity: these explanations seem to presuppose both a situation of on-going exchange and a willingness of X to respond to this strongly normative relationship, as the joint causes of his current behavior. More importantly, however, the

explanations seem to reflect a concern with the still important relational dependencies among the protagonists. Please also note that dispositional explanations are much more frequently given to account for negative behavior (deception) than positive behavior (helping).

Investigating the extent to which relational dependencies are shaped by information on social categories such as kinship was one prime goal of this task. In particular, we had assumed that participants would be interested in collecting information that they considered relevant for an account of the event, thereby revealing salient categories. However, to accurately evaluate a person, relation, or situation by systematically collecting information was not an aim of any of the participants – at least not in the way we expected. Rather they used examples from their own social environment to make sense of the scenario (cf. Stenning, 2012). Three participants were clearly motivated in their answers by their own personal situation and/or relation to the ethnographer. The active information search task was therefore not successful in revealing the exploratory processes that people use. It also raised the question of whether people are as interested as we assumed to uncover causes behind behavior in order to evaluate it. Are reasons or causes for behavior really necessary to understand, evaluate and respond to others with whom they are in relations? If people do not assume that somebody has a constant personality constituted by lasting characteristics, which have to be uncovered to anticipate future actions, the motivation to explain causal connections between personal attributes and behaviors might be lower. To explain behavior by circumstances opens up a wide spectrum of possibilities which participants did not discuss for fictive scenarios but connected to the specificities of well-known social situations.

PART 2: SCENARIO EVOKING EVALUATIVE RESPONSES

The main goal of Part 2 was (a) to investigate further what defines and maintains relationships between people, especially kin (e.g., emotional closeness, physical substances, commensality, or sharing of food, growing up together, teaching and socialization, or procreation), and (b) to scrutinize what Wampar saw as causes of emotions and subsequent actions relevant to moral evaluations such as punishment. In order to evoke such evaluative responses, we crafted two fictive scenarios, one involving incest and one patricide, which are likely to be areas of strong moral feelings and evaluations. In the course of this study, however, it became clear that the (intense) discussion on the first scenario would take too much time to follow this up with a second round. This section is therefore confined to the incest scenario.

METHODS

The same participants were interviewed as in the first study, except for the schoolboy and a man of 35 years, with whom the interview was interrupted (thus rendering a total of $n = 10$ participants; age $M = 40.5$ years, range: 18–73).

Material

The task focused on one target scenario revolving around incest prohibition in several versions with changing types of kin, each followed (ideally) by a set of 10 questions. The basic scenario

described a situation in which close relatives of opposite sex feel attracted, have intercourse and have a child together. The first version featured a mother and her son:

> "A young man was stolen as a baby and taken to a distant town, where a family adopted him. He grew up as a son of the family. He never learned anything about the family into which he had been born. One day, when he was grown up, he came to his birth village. Here, he happened to meet his still young mother, who was a widow. The two fell in love, she got pregnant and they had a child. People found out that they were related. There were many heated discussions about what had happened and everybody started talking about it. What do you think people said?"

The second version exchanged sister for mother and was not read out in its entirety, but was just repeated with the main information staying the same.[7] The narratives were followed by a series of questions that can be clustered into three groups:

(I) Moral evaluations and their sharedness
    (1) What do you think the people of the village are saying? (And what might his/her relatives think/say?)
    (2) How do the man and his mother [sister] respond when they are confronted with what other people say?
    (3) How would you say the man and the woman feel about what happened?
    (4) Is the son [mother/brother/sister, respectively] a good or bad person? Are they equally so? If so why?
(II) Essentialist notions of persons and their relations
    (5) The story states that they did not know they were related; do you believe that? Would it be possible to recognize relatives you have never met before? Would they have intuitively felt that they are related?
    (6) Do you think it is possible that the young man became more similar to his adoptive family than to the one into which he was born?
    (7) What characteristics do you expect the baby to have?
(III) Practical consequences of moral evaluations
    (8) Do you think the baby should be adopted by somebody who lives a long way from the village?
    (9) Will this child become a bad/good or unsuccessful/successful man as an adult? Why?
    (10) Do you think the young man should stay in the village or leave?

In each section, participants sometimes gave no answer or answered earlier questions, when confronted with a new question and vice versa; this is discussed below.

Procedure and design

It was planned to read all scenarios (and variations of them) in the same order to each participant, each followed by the same series of questions. It turned out, however, that only the first version of the (first) scenario could be read in its original version. A second reading with variations (i.e., with different kin relationships between the partners) or about a new topic (i.e., the originally planned second scenario) would have been too long and boring for the participants. For example, participants grew impatient when

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[7]A variation of the scenario with a father marrying his daughter, which we had planned as well, was abandoned because it would have been even closer to a real incest case, which people referred to frequently.

asked to listen to the same initial sentences again as the ethnographer tried to test the variations in kin relations. Accordingly, she changed the procedure for the second round and only asked informally how the participant would react if the protagonists were related differently.

The first scenario was read to all participants, and the first question was always the same for all participants. The following questions had to be modified, simplified, and adjusted to the conversation for reasons discussed below. However, the gist of the questions remained the same; they were only less differentiated and repetitive. For example, it did not make sense to differentiate between the general gossip and what close relatives said, so that the second part of the first question was left out. Sometimes participants thought either the interviewer did not listen attentively enough or did not understand their answer if she asked "the same" – in fact slightly modified – question again, which irritated and annoyed some participants and made them impatient.

RESULTS

Participants' responses are presented in the same order of the three groups.

Evaluations and their sharedness for the mother/son-version

The first question (Qu.1, see **Table 3**) what other people would say about the events described in the scenario was answered by four participants immediately by affirming that there would be

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Table 3 | Responses on moral evaluations and their sharedness (cluster I).

Response categories (with concrete responses)	Frequency	
	In numbers	In %
(Qu.1) Moral evaluation attributed to the people of the village		
Assessment as bad behavior	14	56.0
Concern with practical implications	4	16.0
People's opinions will be diverse, some indifferent	3	12.0
It doesn't matter anymore	2	8.0
Focus on positive aspects	2	8.0
Total	25	100.0
(Qu.3) Feelings attributed to the couple		
They were ashamed/felt bad	9	69.2
They will stay together	3	23.1
They did not worry	1	7.7
Total	13	100.0
(Qu.4) Participants' own evaluation		
Positive (because they did not know)	4	50.0
Negative	3	37.5
It doesn't matter anymore	1	12.5
Total	8	100.0

a lot of gossip but without being precise about the content. Four emphasized that other Wampar would get angry because it is his real mother, two participants blamed the woman (or said other Wampar would blame her), that she should have found out more about the man before having sexual relations with him. While these types of responses mainly expressed a negative evaluation, four were concerned with practical implications instead; three of these assumed people would say the couple should marry, one they should separate although a separation would raise the question of who looks after the woman and her child[8]. A woman described different opinions, including indifference about social behavior of others, which she blamed on social change and the loss of the values associated with generalized reciprocity. The answers show that attitudes are diverse and changing among Wampar: participants consider a wide range of conditions for the described behaviors and are reflexive about the diversity of possible moral evaluations. Because the narrative provoked immediate evaluative responses many seemed to find it difficult to change perspective to report what they thought others would have said.

One example shows that the interpretation of answers needs to be understood in terms of the particulars of the everyday life. A woman first said that everybody in the village would get angry, and then exclaimed: "It must be LOVE! They should marry." She used the English word 'love,' unlike any other participant. She answered the second question (what the couple thinks about the gossip), and added, "They won't worry about gossip and won't follow what other people say." When asked about her own evaluation of their behavior, she replied: "They are happy because they do not listen what others say. He must have come back to the village with lots of money." Her statements painted an unusual picture of an intense love story. It turned out that she interpreted our scenario in terms of her favorite Nigerian ("Nollywood") soap opera *True Love*.

The question how the couple felt about what other people said (Qu.3) was answered (except in the above described case) by most participants consistently: that they felt ashamed, "bad" or "sorry." With respect to their own evaluation (Qu.4), participants were split (three replied that mother and son are bad people, because what they did was wrong; four said that they are good people, they did not know, what they were doing).

Essentialist notions of persons and their relations for the mother/son-version

We also wanted to probe how participants conceptualize the relatedness between mother and child and asked if the two could have known that they were related (Qu.5, see **Table 4**). Four participants answered with a clear "no." Two replied that being kin was the cause of their attraction (meaning they noticed something), but that mother and son confused affinity between kin and sexual attraction. Two respondents explained that the mother should have felt it because of her love for the child.

Table 4 | Responses on essentialist notions of persons and their relations (cluster II).

Response categories (with concrete responses)	Frequency in numbers
(Qu.5) Possibility to know relatedness	
Yes	4
No	4
Don't know/cannot know	1
Total	9
(Qu.6) Similarity with foster family?	
Yes (even if only behaviorally)	3
Not sure/no answer to the question	7
Total	10
(Qu.7) Characteristics of the baby	
He will be good	6
He will be bad	1
Depends on the strength of parents' belief	1
Don't know/cannot know	2
Total	10

To find out how belonging creates similarity or difference, and changes the quality of relations, we asked if the boy might have become like his foster family (Qu.6). Two respondents answered "yes" but did not clarify in which ways, one said his *kastom* (culture, tradition), *pasin* (behavior, manners) and relations have become the same as his foster family's but that he still looks different from them.

The next question focused on the child of the incestuous relationship and what characteristics it might have (Qu.7). Answers to this question showed the highest agreement between participants[9]. Most said that it will be a "good child," but qualified their response in different ways. Only one answered that because of the blood – according to *kastom* – the child would be "bad."

Practical consequences of moral evaluations for the mother/son-version

In respect to how the baby should grow up (Qu.8, see **Table 5**) opinions diverged. Seven of the participants said it should stay with the parents or the mother, while three thought it would be better to send it away, at least until it became an adult. On the other hand, only one of the participants thought the couple should remain together (Q.10).

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[8]Many unmarried Wampar women have illegitimate children; they usually live with their parents or a sibling, some have an independent household. That means her needs and the needs of the children (food, school fees) have to be fulfilled by the kin group.

[9]This might be due to a specific case which the question led many participants to assume was the ethnographer's real interest. That actual case might also explain why people reacted less shocked by the narrative on incest than we assumed we would be. During the interviews, it emerged that a Wampar widower married to a woman of another ethnic group just had a fourth child with her, and that, in fact, the woman was his daughter. This widely believed rumor also influenced responses to questions about the offspring of such incestuous relations. Some participants said that "*Bubu-Dadi*" (= Grandfather Daddy) and his daughter had produced healthy children, which they thought of as a proof that incestuous relations *per se* cause no health problems. Generally speaking, participants were easily drawn to volunteer views on the causes and consequences of the case.

Table 5 | Responses on practical consequences of moral evaluations (cluster III).

Response categories (with concrete responses)	Frequency in numbers
(Qu.8) Where should the child live?	
With the parents	5
With the mother	2
Should be adopted/move away	3
Total	10
(Qu.10) What should the couple do?	
Move away to the town where he grew up	3
Separate	3
Follow their own feelings	1
Stay together in the village	1
It doesn't matter anymore	1
Total	9

The variation featuring a brother and his sister as incestuous partners (X2) provoked interesting responses, with an increased number of participants ready to emphasize their relatedness by blood. Two participants rated the case as bad as that in the first story, while three said it is much worse than incest between mother and son. All five reasoned that the love between mother and child is stronger in the mother/son-version and that their blood is, in the case of real siblings (opposed to cousins or parents and their children), even more similar or identical.

DISCUSSION

Moral evaluations, their sharedness and practical consequences

The general evaluation of the events described in the scenario (assessed with the first cluster of questions) was unanimously negative. With regard to the involved persons, however, the moral evaluations diverged. Half blamed the couple (some more specifically the woman), while the other half said that the couple was not responsible because they did not know the truth. Notably, many participants shifted focus from why this happened to practical solutions for the outcome, and some refused to make any attributions whatsoever. In terms of attribution theory, the first two types of responses reflect distinct tendencies: one the tendency to personally blame the actors involved, and the other tendency to consider mitigating circumstances such as lack of knowledge.

The third type of responses appears to be linked to a widely reported disavowal of interest in reasons and responsibility for action in the societies of the Pacific and other parts of the world (for an overview, see Träuble et al., 2013). In addition, an 'opacity of mind' has been described specifically for parts of Melanesia (see Rumsey and Robbins, 2008 and the papers therein), that combines (or substitutes) the disinterest with a reluctance to attribute mental states and motives to others, based not (only) on disinterest, but on respect for others' privacy and autonomy, or on fears how

knowledge is used (for a discussion of the literature, see Laidlaw, 2013, pp. 158–159).

This raises an important question: are reasons and causes for behavior really *necessary* to plotting the personal and political consequences of those behaviors? Most of the participants took a very pragmatic line of arguing in that they seemed to be not very interested in the question *why* something happened (the attraction, the reasons for the confusion etc.), but more interested in and worried about the outcomes. How should the community deal with deviant behavior? And how should relatives handle the results and outcomes? The focus on questions like these has led to the characterization of Melanesians as 'pragmatic' (cf. Barker, 2007), but this pragmatism does not need to displace considerations of morality. One has to understand the socio-cultural context of pragmatism, as Read (1955) described in one of the first studies of morality in PNG, specifying that their pragmatism is given shape in specific cultural conceptions of the person and thus may vary according to the relationship in play (Barker, 2007, p. 6).

As in Part 1, the results of Part 2 indicate changes in the morality of kinship among the Wampar, but they also underline the difficulty of controlling the social setting well-enough to investigate cognitive responses formally (reproducibly) and effectively. Most respondents were influenced strongly by known cases in their social world. In addition to the case of "Bubu-Dadi" and his offspring, other instances of controversial marriages (for instance, between classificatory siblings[10]) influenced people's evaluations; such cases also led participants to abandon rumination upon fictional moral questions in favor of discussion of actual people and their behavior.

Essentialist notions of persons and their relations

The question of kin relations was answered in many different ways. Wampar ideas about the transmission of physical, mental, and moral qualities from parents to children are vague. Many still explain that blood determines children's affiliation to the lineage and clan of their father (as one participant in our sample explicitly did). However, most of them add that many exceptions exist and that nobody is really sure how corporeal inheritance works. Some ideas may still be based on Wampar conception theories that Fischer (1975, p. 128) described for the 1960s: the man gives (*erem*) his wife the child and she carries (*epeng*) it. The relationship between father and child is hence more important for descent than that between mother and child. The child receives his or her own blood (*wi*) only from the father, but an emotional and bodily bond (the child is formed in the uterus) between mother and child – developed through the uterus (*wawang*) during pregnancy – is also thought of as important. This theory is used in pragmatic ways, with little regard for coherence of doctrine, particularly when it comes to interpreting the belonging of children of interethnic marriages (Beer, 2006; Bacalzo, 2012).

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[10]A 2009 investigation into preferred marriage partners revealed cases of relationships that were seen as incestuous according to Wampar norms. In recent discussions about good and bad marriages, and relations between siblings and cousins, the differentiation between cross and parallel cousins has become less important in norms and practices. As kin-term usage tends to move away from Wampar norms to *Tok Pisin* or English, it seems that certain differentiae (cross-sex/same-sex relative) have become less salient.

In the answers to our questions on the nature of social bonds, Wampar were less essentialist than we had assumed and more pragmatic or situationalist ("they did not know, so let them be happy together"). The bonds between social/biological mother and child were emphasized in many answers to our questions about where it should grow up, or about the influence of foster parents, and some explained that the attraction between mother and son emerged because mother love and sexual attraction had been confused.

Most participants reasoned that an incestuous relationship between siblings would be much worse than one between mother and son who, on Wampar views, do not share blood even though the relationship remains forbidden, because she has carried and given birth to him. Some tendencies in the evaluations of behavior and reasoning processes behind it are worth mentioning. Aspects of family values and gender relations have been articulated in several statements: if one of the partners is to be blamed, it is the woman and not her son. She should have inquired about his background before beginning a relationship, and it was assumed that she would be more likely to feel that this is her child, because of a special bond between mother and child. This also resonates with pragmatic problems Wampar emphasized: who would look after her and the child? And how are the child and his parents placed in the kinship system? The degree of sharedness of evaluations of relations and sociality among Wampar is another important aspect. Even from a small number of interviews the dimensions of sociocultural change and its consequences have become obvious in the diversity of answers from participants and their reflections on this period of social transformation. Wampar seem to support Barker's (2007, p. 12) generalization: "Coastal areas that have had the earliest exposure to colonial rule and are most deeply integrated into national and international networks tend to be more tolerant of moral ambiguity."

METHODOLOGICAL PROBLEMS

It is widely agreed that, ideally, adequate psychological/cognitive testing requires cross-cultural research (Bender et al., 2010; Henrich et al., 2010; Medin et al., 2010; Beller et al., 2012). The need to combine the controlled experiments commonly used in psychology and the interpretive ethnographic research central to anthropology has also been underlined (Beller et al., 2012). Yet doing so is not easy, especially in the absence of details concerning the practical problems, theoretical traps, and misunderstandings that can emerge in cross-cultural settings. Here, we address problems arising from such cross-disciplinary, ethnographic work, some of which are similar to those experienced in economic experimental games such as the ultimatum, dictator, or third-party-punishing game (Tracer et al., 2014).

The local conditions to test our planned study on sociality and causality among the Wampar were ideal. The village people are used to having ethnographers who stay for long periods, and ask many different kinds of questions. For instance, the ethnographer had conducted some cognitive tasks on smells during earlier fieldwork (Beer, 2014), which people found entertaining. Many Wampar enjoy doing specific tasks with some interesting material such as samples of smells, colors, or pictures and stories. Some even seem to favor them compared to more

general interviews. So, the motivation was good, trust no issue, and nobody approached by the ethnographer refused to answer questions. And still, several different kinds of problems arose. For the subsequent discussion, we tentatively sorted them into three clusters: issues with the *practicability* of task design and execution, issues with data *interpretation*, and issues revolving around *validity*.

PRACTICABILITY: INDEPENDENCE OF DATA, APPEAL OF TASKS, AND HANDLING OF TASK VERSIONS

It was difficult to get Wampar to sit down and talk *alone*; furthermore, after a few individuals had completed the tasks, it was equally difficulty to find people who had not yet discussed the scenarios extensively with other members of the community. The whole point of routine interaction within the settlement – including with an anthropologist – is for many Wampar precisely the enjoyment of togetherness and casual conversation. Eventually, in the cases documented above, it was possible to create a situation in which only one person was present (at least for some time), listened to the scenarios and answered the questions, although this in itself is already a deviation from naturalistic situations. In several cases children listened or people joined for some time and left again. In case of the questions about the child of an incestuous relationship in Part 2, the laughter of others induced questions and made the interviewer aware of the real case of "Bubu-Dadi." Here, the reactions of others – which should usually be excluded in experiments – were advantageous because they made clear that many participants had this case in mind when answering the questions. To prevent participants from sharing information and their interpretations after the tasks was impossible: the main value of learning something others have not is exactly in talking about it and sharing the knowledge. So it is likely that some interpretations and ideas about why the ethnographer was interested in helping, deception, and incest would have circulated already and influenced later answers participants gave.

One option for dealing with this problem might be to consider collective sessions as a richer source of relevant discussions and results (and one that might generate more interest and commitment to begin with). However, while this might be a better strategy for grasping local understandings in the pilot phase, it would exacerbate difficulties in data analysis and interpretation within and between cultures were it used for the main study. Given the comparatively small population size, such collective sessions would severely affect sample size – even more so when different versions of the same story had to be discussed with different people or groups of people (between-subjects).

For cognitive psychologists in lab settings, employing tasks like the one used here presents almost no practical issues, even if it takes considerably longer than an hour. When working with the Wampar, however, it became clear that participants could not, or did not want to, concentrate for longer than maximal 30 min. This was particularly obvious in Part 2, where respondents began to confuse persons in the scenario about incest (e.g., the child stolen and taken to town with the child of the incestuous relation), ceased to listen carefully, and even when they understood the questions, did they prefer to talk about different topics (such as the actual case of "Bubu-Dadi," other people they know or differences

between living in town and the village). To be crystal-clear, this is *not* attributed to the Wampars' ability to concentrate on one task or to stick to a single topic; rather, the observed difficulties must be regarded as arising from the task and/or the way in which it was presented.

This difficulty points toward the more general challenge of how to design tasks in a manner that they appeal to and hold the attention of the people with whom we work. Finding a domain (such as other people's behavior) and scenarios (such as helping, deceiving, or incest) that are of sufficient interest is a step in this direction, but – as the difficulties faced in our study reveal – only a first step. It may turn out that the abstract examples, and perhaps the set of questions used to structure conversation, did not scaffold the kind of engagement we hoped it would. As ethnographic knowledge is not sufficient, in and of itself, to predict which aspects of a task would be appealing to people, pretesting remains essential – and that implies pretesting in every single cultural context in which the study is to be conducted.

Related to the problem of task duration is the problem of similarities across task variants, especially when, as in the versions of our scenarios, they were planned simply to substitute one pair of kin with another, or aimed at being more or less explicit with some aspects. Participants clearly lost interest in listening to the "same" story several times. They became impatient and the use of otherwise entertaining stories became a chore. Especially *reading* the longer narratives twice turned out to be too unnatural, and people preferred a situation in which the ethnographer 'read' or even better 'told' them a story and did not only 'administer a test.' The atmosphere for the discussion about the series of questions was more relaxed and lively after the narrative when it was read only once and further modifications (as exchanging the mother–son relationship against brother–sister) were explained informally. Bolyanatz (2014, p. 283) describes similar experiences for economic games used in other parts of PNG. This makes controlling specific variables quite difficult, especially when the obvious solution to this problem, namely a between-subject design, is not feasible due to population size.

INTERPRETATION: CONNECTIONS BETWEEN QUESTIONS, ANSWERS, AND INTERPRETATIONS

More fundamental than the practical problems are concerns with the understanding of the situation and the way the answers match the questions. Attempts to figure out what the researcher has in mind is generally an issue, and perhaps even more so with psychological experiments—where participants expect concealed purposes—than in fieldwork situation once a relationship of trust has been established. But the unfamiliar interaction still requires reconstruction of a common ground for the conversation to be sensible, and this may interfere with the intention of the task (e.g., Stenning, 2012). This problem is amplified by possible differences in conversational conventions, rules of language pragmatics, and/or habits of perspective-taking.

An example that looks simple, *prima facie*, but turns out to be rather complicated, revolves around the pragmatics of responses. For example, in the deception scenario some participants exclaimed "*Em i giaman*," or "*Em man bilong giaman*." The first

could be translated "He lies," while the second could suggest that it is his habit to tell lies, or doing so is part of his character, on the basis of the dictionary definition of *giaman*. However, in everyday life, these sentences might be used interchangeably, and only to impugn somebody's reliability rather than their truthfulness; they might also be used for the pleasure of exaggeration. Other examples could be given.

Several of the answers contain formulations which are sometimes difficult to interpret, including, for example, the simple utterance "I don't/cannot know" (*mi no klia, mi no save*). It is not always clear from the reply if the person wanted to say that s/he cannot answer due to lack of information or comprehension, or that one cannot know in general, or that she/he declines to judge the behavior of others, or has lost interest in the question. Here, our Wampar data connects up with the complex of issues discussed under the heading of opacity of others' minds and cross-cultural variability (Danziger and Rumsey, 2013 and references therein). This is generally the case in studies of the attribution of motives and causal reasoning about social interactions.

When we asked, for example, what other Wampar would answer if asked the same question, the aim was to access participant's ideas about shared (and minority) views relevant to behavior. In many cases participants answered, but did not switch perspective; instead they repeated their own opinions and expanded on them. This was not always explicated in their answers, but an impression created in the interviewer, thus highlighting how difficult it can be to assess whether participants actually try to change perspective. When asked about gossip in the incest scenario, for example, many participants continued to think and talk about their own evaluations rather than giving opinions of fellow villagers. Inter-individual differences in the willingness or experience in perspective-taking are an issue as well, especially in cases where participants simply repeated the story (rather than explaining it), shifted perspective from other's assumed opinion to one's own, or assumed that the researcher's fictive story actually was meant as a placeholder for a real event. Participants often referred to their own life-world and personal situation rather than to the scenarios we presented. In a face-to-face community, the micro-politics of relations can rarely be entirely set aside.

Some participants added ideas to the scenarios, which they found important, but which made it difficult to compare them to other answers. For example in the scenario on the incest taboo they speculated on whether the boy earned a lot of money in town. Cole and Scribner (1974), in their study of syllogistic reasoning among non-literate Kpelle of rural Liberia, report that participants were reluctant to stay within problem boundaries: they altered the conditions of the problem to be solved or added personal experiences in order to come to a conclusion. Laypeople in literate societies are also reported to resort to such elaborations when faced with intricate problems, as Henle (1962) reports of American students working to evaluate the adequacy of various syllogistic forms.

Cole and Scribner (1974, p. 166) suggest that these sorts of difficulties have consequences that go beyond the possibility of amelioration through modifications to the tasks presented to participants:

"We cannot draw conclusions about reasoning processes from the *answers* people give to logic problems. We have first to ask: 'What is their understanding of the task? How do they encode the information presented to them? What transformations does the information undergo, and what factors control these?'"

To give one example from Part 2: when we asked for the characteristics of the baby of the incestuous relationship we aimed at ideas about causal relations between immoral behavior and later events/outcomes. Some participants seemed to assume that the ethnographer meant the specific children of "Bubu-Dadi" (because the ethnographer is interested in interethnic marriages and kin relations) and responded that the child would be okay, meaning mainly "healthy." Others assumed the question referred to general Christian values, perhaps triggered by the helping/deception scenarios which address topics also discussed at church meetings; according to this frame of interpretation the child is a gift of God, which makes it *per se* "good," or its characteristics depend on the strength of the belief of the parents[11]. One informant referred in his answer explicitly to *kastom* (tradition, culture) saying the child would be bad. Two other participants responded that they could not and did not know, a definite enough statement, but one that left it unclear whether they thought that the information necessary was omitted from the narrative, or that information about how the moral development of a child will proceed is in principle unobtainable. With a greater number of participants we would face even more of these different interpretive frameworks for interpreting their responses.

This highlights the well-known problem of inter-individual differences, due to the personal histories and/or personalities of participants. These are particulars and this issue raises questions about the relationship between psychological universals and particular cultural contexts.

VALIDITY: THE "HOME-FIELD DISADVANTAGE" AND SCAFFOLDING

Cross-cultural research, even when anthropologically informed, is an intricate enterprise. In a challenging paper, Medin et al. (2010) discuss issues that contribute to what they label the "home-field disadvantage." This handicap arises whenever one cultural group (typically the researcher's own group) is unreflectively taken as the starting point for comparison, and may be manifested as: (1) a tendency to leave one of the cultural groups unmarked, as if it were the standard from which the others differ; (2) a tendency to consider other cultural groups as more homogeneous than the one taken as starting point, and definitely as more homogeneous than they actually are; and (3) an excessive trust in the equivalence of tasks across cultures – both in terms of how these tasks would be understood and responded to by different groups, and in terms of what the obtained data would be able to reveal. If one takes, for instance, a standard psychological task on causal reasoning as the phenomenon of interest, the problem with applying this for cross-cultural research is that this task will have been specifically tailored to bring about a particular effect in the cultural context (typically a WEIRD context), for which it was developed.

As a necessary consequence (reasons for which include, among others, regression toward the mean), the same task is unlikely to produce similar results in other cultural contexts (Medin et al., 2010). The antidote recommended by Medin et al. (2010) is a constant effort in marking the unmarked cultural group, collaborating with the group(s) researched, conducting research on the terms of the respective culture, and taking multiple perspectives.

With the approach taken for the current study, this was exactly what was strived for. In order to investigate how people understand and account for the behavior of others conditional upon their relationships, the point of departure was *not* a specific, well-established task from psychological research, but a set of (ethnographically informed) considerations on what the group under study may be willing to talk about. Yet difficulties remain. The most obvious is to figure out how the task should be modified in a way that the Wampar will enjoy, and that would facilitate the type of responses that in turn will help us to answer the questions we have. Some of the experiences reported herein suggest fruitful directions (e.g., replacing individual interviews with collective session, limiting the number of key questions and task versions, finding ways that invite perspective-taking more strongly).

In this context, we wish to explicitly acknowledge a suggestion made by one of our reviewers. As the reviewer stressed, we need to find ways that allow the research to scaffold and enhance the participants' capacity to report on the processes that govern their considerations. A significant contribution by the ethnographer is thus to illuminate what the participants will be drawn to, what materials are familiar yet multiply interpretable, and what specific ways to representing social life are relevant to the queries at hand. In other words, relationality, historicity, and contextuality need to be accepted as fundamental to any human intention and action (see also Medin et al., 2010; Bloch, 2012) and thus would have to be made an invariable part of any testing milieu. However, as the same conditions should be granted to each participant from every cultural group included in the comparison, the most fundamental challenge will be to create comparable conditions without holding details of the tasks and of the testing context constant.

CONCLUSION

Laidlaw's (2007) characterization of the relationship between the anthropology of religion and cognitive science of religion is helpful at this point to clarify some of the problems we have encountered in our study and can partly be transferred to the realm of social interactions more generally. He takes issue with the assumption that cognitive scientists could "explain religion" in terms of basic cognitive processes while what they actually deal with is a limited subset of the features of "religion." Religions, Laidlaw insists, includes far more complex phenomena grounded in the historically located intentionality of human beings.

In our own study, we tried to investigate how Wampar people draw inferences about social interactions. The prime goal of our study was thus *not* to understand allegedly universal processes in causal inferences about social interactions (helping, deceiving, sexual relations) to be then able to explain causal cognition in general, but to understand the cognitive processes underlying causal inferences in their sociocultural contexts and embedded in social relations. Our study reveals how difficult it can be to get at basic

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[11] Even the German nationality of the ethnographer might have had an influence, as the first Lutheran missionaries were German, and although the difference between missionaries and anthropologists is known, there might still be social desirability bias in this answer.

cognitive 'mechanisms' or 'processes' through fictive scenarios precisely because of the relationality, historicity, and contextuality of people's intentions and actions.

However, Laidlaw also stresses that – while basic (universal) processes cannot explain complex behavior – their understanding is still an important pre-condition for good general understandings of behavior. In this line, we propose that it is indispensable to try to solve the problems arising when different theoretical and methodical traditions raise meaningful questions and attempt to answer them (for a compelling discussion of both the complications and the inevitability of cross-disciplinary collaboration, see also Bloch, 2012).

Cognitive science needs anthropology in order to substantiate any claims for the universality of cognitive processes (e.g., Astuti and Bloch, 2012; Barrett et al., 2012). Cross-cultural comparisons and the adjustment of research strategies and methods to the social and cultural environments of non-WEIRD populations are essential to achieve this goal. This paper exemplifies this with the description of difficulties encountered in the process of making a cross-cultural experiment relevant and reproducible in different cultural contexts. From an anthropological perspective, long-term fieldwork and naturalistic observation of behaviors with subsequent questioning still appears to be the best choice for getting answers to questions about evaluations of and causal reasoning about social interactions – although these procedures are not in the strict sense of the term 'reproducible.' If in-depth knowledge of relations and their history is crucial for understanding, psychologists are well-advised to consider alternatives to the exclusive reliance on quick experiments with a selective sample of people for fast output. As Cole (1978, p. 629, 630) wrote "for the psychologist this position poses the need to develop new techniques in order to study everyday cognitive activities and their relation to the special activities he designs. It also means the loss of certainty about his most trusted tool, the experiment". Members of the "Laboratory of Comparative Human Cognition" took important steps in this direction, especially Cole and his colleagues in the course of their long collaborative research among the Kpelle.

While the necessities of long-term fieldwork, interdisciplinary processes of developing a methodology and careful cross-cultural testing of methods contradict the political economy of research funding and the academic market, rising to this challenge is the only promising way for real progress in this field.

AUTHOR CONTRIBUTIONS

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Agency, time, and causality

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Cognitive Scientists interested in causal cognition increasingly search for evidence from non-Western Educational Industrial Rich Democratic people but find only very few cross-cultural studies that specifically target causal cognition. This article suggests how information about causality can be retrieved from ethnographic monographs, specifically from ethnographies that discuss agency and concepts of time. Many apparent cultural differences with regard to causal cognition dissolve when cultural extensions of agency and personhood to non-humans are taken into account. At the same time considerable variability remains when we include notions of time, linearity and sequence. The article focuses on ethnographic case studies from Africa but provides a more general perspective on the role of ethnography in research on the diversity and universality of causal cognition.

Keywords: causality, time, agency, ethnography, Africa

INTRODUCTION

Scientific enquiry during much of the 19th and 20th century searched for "weird" examples of human cognition in non-European societies and cultures, typically highlighting extreme departures from Western societies that were considered to be the "standard" (see for example Porteus, 1937). A programmatic turning point in this orientation has recently been marked by Henrich et al. (2010) who noted that much of experimental psychology (and economics) to date is limited by a sample that is made up of "weird" outliers of a different sort, namely a sample of university students conscripted to experiments and of similar subjects from a Western Educational Industrial Rich Democratic (WEIRD) background. It has become clear that a good number of foundational experiments exhibit such a bias since the WEIRD subjects' responses are very different from those of other populations. As soon as subjects with a broader cultural background are included, some presumed cognitive universals (such as the Müller-Lyer illusion) turn out to occur only in some populations (Henrich et al., 2010, p. 65). As a consequence the preparedness to include "non-WEIRD" groups has grown and is increasingly considered to be obligatory, except that there is often only a very vague sense as to what exactly such a desirable broadening of the sample should look like. Is it enough to include non-Europeans who were initially only considered when extreme contrasts were sought after? For instance, members of the Sudanese Zande, Nuer, and Dinka, people that feature in this contribution, are likely to be considered prototypical examples of a non-WEIRD population because they live in Africa and they have so far featured in ethnographic writing rather than in cognitive experimenting.

However, the matter is less straightforward than may initially appear to be the case. Although originally African people, there is a considerable "Western" diaspora of Nuer living in the USA with considerable economic and cultural effects on the Nuer remaining in Africa (Falge, 2006), Dinka migrants are numerous enough to make them a recognized immigrant category in Australia[1] and they are frequent participants in diaspora blogs[2]. Furthermore, Nuer and Dinka organizations have been in the media spotlight of recent conflicts and have themselves created an internet presence[3], suggesting that at least a good proportion of the members of these groups are also "educated," at least computer literate. Although Southern Sudan is currently best known for its food crisis and shortage of products, one of the main causes for this situation is the conflict about the "industrial" use of oil in this country, in particular about the question whether the national oil will be exploited via a pipeline toward the Indian Ocean (and Asia) or toward the Atlantic (and Europe). Thus, the country is oil "rich" even though currently these riches primarily pay for a large-scale military conflict between Nuer and Dinka militias in the transnational fight for these resources. Finally, Southern Sudan has had "democratic" elections. The most recent independent state in Africa has made an attempt to democratically reconcile a Nuer-dominated parliament with a Dinka president, although this constellation is also considered to be one of the factors in the current unrest. In a word, the mere fact that someone is part of the Nuer or Dinka ethnic group would not automatically make that person part of a non-WEIRD sample since all WEIRD features are present here. And this seems to be true more generally across Africa and the so-called Global South where "local" people are regularly integrated into transnational and translocal connections (Ferguson, 2006, p. 106). It would be misleading to assume that any individual

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[1] http://www.humanservices.gov.au/customer/information-in-your-language/dinka

[2] http://www.cyberspora.com/index.html (accessed August 29, 2014).

[3] http://www.splmtoday.com/; http://www.nueronline.com/

who happens to have a passport from Dubai, or who may be a resident of Singapore or who speaks a mother tongue other than English would automatically form part of a non-WEIRD sample. The five parameters enshrined in non-"WEIRD" are not necessarily easily operationalizable, and despite the catchy phrase we do not have good evidence to show that, for instance, being rich or being part of an industrialized economy or democratic political system would in itself affect responses in cognitive experiments. With regard to the Müller-Lyer "illusion," for instance, the relevant parameter seems to be that of living in a "carpentered" environment (Henrich et al., 2010, p. 65) which is only indirectly connected to features such as "rich" or "industrial" and should not to be mistaken for these. Thus, the argument made by Henrich et al. (2010) provides a rough indicator to identify likely biases in existing samples but this can only be the beginning of identifying the cultural constitution of cognition, including causal cognition.

In the light of these problems I suggest an alternative: including "non-WEIRD" people in an experimental sample is not the only way of broadening the perspective and making research less culturally biased. In the light of the problem outlined above, it may in fact not be the best option. Alternatively, we should consider "harvesting" existing ethnographies in a more systematic way. By "more systematical way" I mean reconsidering the parameters for comparison. Up to now, there has been an emphasis in the literature on contrasting "the West" with "religious" and with "magical" worldviews that came to stand for "the rest" of the world. By contrast, I will be shifting our attention to the ascription of agency and the modes of time conceptualization when searching for relevant parameters. There have been few attempts to conduct "ethnographic harvesting" in a comprehensive review way (see Lillard, 1998 for an exception) since the dominant disciplinary strategy of anthropology is the in-depth single-case ethnographic monograph. My goal is to steer a middle path here, to go beyond the single-case and, instead, to explore a limited number of accessible case studies that can provide novel insights for current research which may lead the way to a broader review. There is something to be said to re-read and reconsider the earlier ethnographic literature and to discuss the relevant parameters. Standard definitions of causality refer to the relation between (a) an antecedent and a resultant item or event whereby (b) the first item has some power that necessitates the occurrence of the second. It is a reasonable hypothesis that the defining temporal dimension of sequence (a) is affected by the cultural conceptualization of time as a relevant parameter and that the defining element of (b), "necessitating with power," is affected by cultural concepts of agency. The purpose of this enquiry into agency and time, therefore, is to facilitate research into the cultural constitution of causal cognition without making premature decisions and commitments as to what exactly constitutes relevant cultural difference with regard to any particular question. A related goal is the attempt to bring the existing ethnographic literature to bear on questions of cognition in a way that methodologically complements experimental research and that helps to theoretically "harvest" these ethnographic sources, facilitating the interdisciplinary exchange between anthropology and other disciplines investigating cognition.

CONCEPTS OF AGENCY IN THE ETHNOGRAPHY OF CAUSALITY

The first ethnographic accounts of African people like the Zande, the Tiv, the Nuer and Dinka were compiled in the first half of the 20th century (Evans-Pritchard, 1937, 1940; Lienhardt, 1961; Bohannan and Bohannan, 1969), arguably at a point in time when members of these communities were less Westernized, less school-educated, less industrialized, less rich in consumer products and less integrated into democratic nation states – while still being far from isolated or "uninfluenced." These ethnographic descriptions have earned fame in that they constitute the first serious attempts to specify what is different and what is similar when comparing the causal cognition of the European observer with that of the ordinary members of these groups concerned. The most widely discussed example is that of Evans-Pritchard's (1937) work among the Azande (Zande, pl.) where he was able to distil aspects of their causal thinking by witnessing (and eliciting) their reactions to everyday and extraordinary events such as the attribution of causal agency in mishaps. The main differences that he recorded concern not the "internal" construal of causality but rather how far causal explanations are expanded and what entities are included as causal agents.

Zande grain storage baskets are mounted on poles and also serve as shady resting places for people to sit under. Occasionally the baskets collapse and hurt or even kill people who are seated underneath. Evans-Pritchard (1937) shows that Azande are well aware of the role of termites in making the poles brittle and in contributing to the collapse of grain storage baskets. However, when people get hurt in the process, the activity of the termites are not considered sufficient but the causal explanation is expanded to include the possible effect of the socially malevolent agency of witches (Evans-Pritchard, 1937, p. 69). Thereby Azande seek to explain why the storage collapsed at exactly that point in time when particular people were seated underneath. The causal cognition is expressed by Azande in a metaphor of "two spears" whereby "natural" causes and "witchcraft" can supplement one another like two spears hitting an elephant are considered equally causally affective (Evans-Pritchard, 1937, p. 74). Considering two causes with equal impact is neither weird to "Westerners" today nor was it to Evans-Pritchard back then. Consequently, Evans-Pritchard's depiction in large parts underlines that Azande follow the same logical thought as anyone else, but that they differ with regard to the premises that they accept. The inclusion of witches as agents is such a premise and, although Evans-Pritchard would maintain that not all premises are equally valid, the extension of agency to witchcraft seems to be a matter of degree rather than kind. After all, humans universally attribute personhood (and as a consequence, causal agency) to fictitious entities. Legal persons, such as corporations, companies, and institutions (such as "the crown" or "the state") can take political, economic, and legal action by taking political decisions, by owning property, or by taking someone else to court. The emergence of such "fictitious" corporate agents in Europe is itself intertwined with religious thinking in particular with Christian thought on the Lord's two manifestations as Father and Son (see Kantorowicz, 1957) but the notion that non-human, religious beings are generally endowed with personhood and agency is more widely spread. Moreover, what has

become classified as "religious" thought in turn follows a more fundamental "fiction" of imagining corporate social agents (the kin group, the generational set etc.). In this respect it may not be useful at all to distinguish religious from non-religious thought since this overdraws a distinction that relies on fundamentally similar processes (Bloch, 2013). The ethnographic evidence supports the view that a strict separation into two domains and two modes of thought, one religious and one non-religious, is not born out. Consider the striking similarities from the Zande and Dinka cases in which there is a seamless merger, or more precisely a refusal to draw a clear boundary, between such domains of thought.

> "Thus, when a man cuts his foot either they [the Azande] do nothing or wash it and bind it with leaves, and it is only when it begins to fester that they commence to trouble about witchcraft. [. . .] In minor ailments or at the early symptoms of an illness from which a man may be expected to recover without difficulty they think less of witchcraft and more of the disease itself and of curing it by the use of drugs." (Evans-Pritchard, 1937, p. 509)

> "A Dinka may complain of a cold or a headache without reference to Powers as the grounds of these minor discomforts. Should the cold turn to high fever, or the headache become persistent and agonizing, his thoughts will turn to the possible activity of Powers." (Lienhardt, 1961, p. 147)

In both cases there is a seamless movement from human to suprahuman agents. In fact, both Evans-Pritchard and Lienhardt report on considerable internal cultural diversity and debate amongst Azande and Dinka who would discuss whether and when there is the need (or the justification) to refer to witchcraft. Evans-Pritchard reports that a potter whose clay pot cracks during the process of burning may attribute this to witchcraft whereas others may rather consider this a case of negligence on the side of the potter who failed to free the clay from stones that may cause cracks to occur in the process of pot-making (Evans-Pritchard, 1937, p. 77). Lienhardt's (1961) reference to "Powers" in the above quote underlines the point. He refers to the Dinka term "*jok*" which refers to a wide class of ultrahuman agency. It may be used as a noun in singular or in plural form (then referring to distinct individual existencies of these types) but also as a more general qualifier, an attribute. So, for instance, Dinka called some forms of European technology "*turuk ee jok*" ("the European is ultra-human Power"). But they were not blurring the human vs. non-human distinction (they would not say "*turuk aa jaak,*" the Europeans are ultra-human Powers) but highlighted that agency and humanity may overlap rather than coextend (Lienhardt, 1961, p. 31). The subcategories of the general class *jok* also provide considerable flexibility. Within the category *jok* the most important powers are called *yeeth* (which has a singular form), which in the older literature would have been translated as "spirits," and these are of two types, firstly those associated with the descent group, "clan-divinities" is the term that Lienhardt (1961) uses, and secondly those that he translates as "free-divinities" that is those *yeeth* that have proper names and who are associated with individuals rather than groups. There are not only semantic but also pragmatic aspects to these terms so that speakers may shift from implying that something "is" a Power (when giving proper names to the *yeeth*) to something "being an indication of" a Power

and "a sign of ultra-human activitiy" when explaining the unexpected behavior of an animal, for instance (Lienhardt, 1961, p. 31–32). Lienhardt's (1961) decision to translate this as "Power," rather than limiting it to religious agents such as "spirits" reflects the fact that Dinka shift seamlessly between what Europeans may consider two completely separate domains, namely the religious and the profane. For instance when confronted with a new European gadget for the first time, they may see it as an instance of "Powers" (see above) but may drop it later when realizing that it is "merely mechnical" (Lienhardt, 1961, p. 31). Conversely, something that initially was not considered to be subject to ultra-human power but discussed as a physical and social reality (for instance ordinary rain or a slight illness) may be re-classified pragmatically as *jok* once they become out of ordinary proportion (Lienhardt, 1961, p. 147).

"HARVESTING" THE ETHNOGRAPHY

Ethnographic evidence like that contained in Lienhardt's (1961) monograph has for a long time been interpreted by Western scientists as a comprehensible but ultimately unwarranted and naïve extension of agency into the "invisible world." However, some caution is in order here. For one, dealing with causality involves the universal problem that causation is not subject to direct observation but has to be inferred. The discussion as to what is considered relevant in this inference has not ceased with modern science. Moreover, the selection from a host of factors that are relevant has not begun with modern science either. Lienhardt's (1961) account shows that this is not a case of non-Westeners readily accepting the agency of spiritual beings when something unforeseen happens. The Dinka default assumption is that there are Powers at work that enable or disable human agency in the first place. But among these powers some are better known – also with regard to their effects – than others and some remain anonymous and vague to the extent that we may no longer consider them as identifiable agents, at all, but rather as the efficacy associated with a certain place or a constellation (Lienhardt, 1961, p. 32). Some Powers are specifically labeled "*nhialic*" which links them to the domain of creation and what the European ethnographers would call ritual and religion but this does not imply that the Dinka consider them "supernatural" (because ultra-human Powers are considered to be part of the "natural" world and there appears to be no culture/nature divide as in European science). Consequently, the term is translated by Lienhardt (1961, p. 30) not as "God" or "Spirits" but as "divinity" in an attempt to catch and convey a spectrum of Powers "according to context" that are either "more substantive or qualitative, more personal or general in connotation." Neither of the Dinka terms (*jok*, *yeeth* or *nhialic*) easily map on the English distinction between "a Power" as an agent on the one hand and a powerful situation where one event leads to the other without the interference of an agent on the other hand. Lienhardt's (1961) problem as an ethnographer was that the two terminologies and conceptualizations inadequately map onto one another. Anthropologically speaking, however, he is struggling with a more general problem of how to understand "action" in the first place. Lienhardt (1961, p. 151) writes:

> "If the word 'passions,' *passiones*, were still normally current as the opposite of 'actions,' it would be possible to say that the Dinka Powers

were the images of human *passiones* seen as the active sources of those *passiones*. The practice of divination illustrates the way in which a division in experience [...] is regarded as a necessary preliminary to human action. A diviner is a man in whom the division is permanently present, a Power, or Powers, are always latent within him, but he has the ability to [...] letting them manifest themselves in him."

In other words, in the Dinka way of talking about causation in terms of humans being "the object acted upon" (Lienhardt, 1961, p. 150) is a recognition that humans are always first and foremost patients. They would, for instance not talk of a man catching an illness but "the disease, or Power, always 'seizes the man'" (Lienhardt, 1961, p. 150) which is why, to Lienhardt, "passiones" seems an attractive way to put it. This applies not only to divine Powers but also to places. For instance Khartoum, when being remembered as a place, is regarded as the agent – and not the mind of a human who remembers Khartoum (Lienhardt, 1961, p. 150). Similarly, there is a notion of "guilty indebtedness" whereby debt is not primarily attributed to the debtor but the creditor (or the Power directed by him), i.e., it is an activity of the giver, who is considered the guilt creator (Lienhardt, 1961, p. 150).

Dinka do not treat the inner world, the psyche, the mind or memories as interior agents that then get "extended" out but rather as the exterior acting upon them (Lienhardt, 1961, p. 149–154). Note that in this they are not altogether different from the ways in which agency and causality are considered in post-Enlightenment Europe. Dinka do not consider spirits as being materialized in Ghosts (as in the European tradition) that can be encountered in the external, material world and are independent of human experience. Modern science largely excludes conscious experience of causality altogether if there is no material correlate. However, in both cases this results in a tendency to underrate human action. This is the case for science (see below) and for the Dinka for whom "people do not choose their divinities, they are chosen by them." (Lienhardt, 1961, p. 151). When being possessed it is "not the man but the Power" which is acting (Lienhardt, 1961, p. 148) and it is the role of a diviner to "discover a reason for the action of the Power" which in turn is related to actions of the patient (sins, omissions, and commissions) which are half-forgotten by the patient him- or herself (Lienhardt, 1961, p. 152). In other words, recognizing as to who the agent is, and for what reason, is not a trivial thing, at all, rather it requires specialist attention since there are many latent elements in one's experiences and to discover which one is an indication of an agentive Power is by no means easy, and ordinary people may actually disagree on the diagnosis. They may murmur the word *nhialic* as an appropriate account for why something "accidental" has happened, and as if Divinity was predictable to some degree, but at the same time it is also fundamentally a recognition of the unpredictability in human life (Lienhardt, 1961, p. 54). Given this general unpredictability we may therefore conclude that ways in which Dinka pragmatically deal with this situation has many parallels with what "ordinary" Westerners do. This observation has led Lillard (1998, p. 3) not only to replace the broad notion of "Westerner" with the narrower "European American" (EA) but also to distinguish EA from the European American Social Science Model (EASSM). While EA, ordinary Westerners, may accept the influence of "nonmaterial source like spirits" on the mind,

EASSM does not (Lillard, 1998, p. 3). The move, since then, from "mind" to "brain" may make it necessary to make a further distinction between the EASSM and something like an European American Neuro-Science Model (EANSM). The diversity within all cultural groups, including the Dinka, also holds for "the West." The strategies of "ordinary Westerners" may be equidistant from "the scientific view" as non-Europeans are. Science is less than ever before a monolithic block.

The assumption that ordinary Europeans share "non-scientific thinking" with indigenous people abroad is not new. Frazer (1993/1922, p. 40) juxtaposed the Batak of Sumatra, the Baganda from Africa and midwifes from Berlin and Bavaria, as well as "malignant savages in Australia, Africa, and Scotland" (p. 13). In the meantime there are good studies on so-called "modern heathens" and others, usually considered "subcultures" of the West (Rozin and Nemeroff, 1990; Luhrmann, 1991, 2012; Medin and Bang, 2014) that substantiate this point. However, there is something peculiar here in that Westerners may in practice follow strategies not dissimilar to those described for "magic" in non-European settings but that in cross-cultural comparison "science" is claimed to be part of European culture, in fact the prototypical image of what Western culture and the concept of "culture" stands for (Wagner, 1981, p. 24). To begin with, the opposition "science-religion" is a peculiarity of a particular European history. In other words, both "science" and "religion" as separate but mutually constitutive categories are not necessarily to be found at other times and in other places (Bloch, 2013, p. 32). Therefore, "Western culture" is not to be confused with "science" but it is defined by a link between the two within a single social system that is not universal. Moreover, that which is typically considered "magical" practice need not fall on the same side of the equation as "religion" but rather on the side of science. Several early comparisons consider magic to be a precursor to science, and science to "revert" to a magical preoccupation with "inflexible regularity in the order of natural events" after a historical interlude of religious metaphysics (Frazer, 1993/1922, p. 712). In a similar vein recent contributions on causality, too, consider the "scientific" preoccupation with linear, uninterrupted causal chains a manifestation of human attempts to install an illusionary control over unpredictability and to rid oneself of unresolved questions, ultimately an expression of fear and compulsion (see Fuchs, 2008, p. 300). This makes some approaches in science look similar to magical thinking elsewhere but dissimilar to both religious metaphysical position and to minority positions in Western philosophy. In this sense we may find a similar spectrum ranging from "obsession with control" to "accepting uncertainty" both within the cultural worldview of the Dinka as well a within "the West."

While it is useful to distinguish Euroamerican folk psychology from Euroamerican Science Models (Lillard, 1998) it is also important to note that science does not take place in a culturally neutral sphere but that it is "infected" by non-scientific ideas, for instance with regard to the attribution of agency. For the case of modern science, Deacon (2012) has recently shown that most accounts based on genetics and Darwinian evolutionism in fact show considerable continuity to pre-scientific world views in that they recreate a "homunculus" when giving causal accounts. Depending on the

orientation of the researchers it is either the DNA or physiological correlates of "the brain" that are attributed with agentive power or the exterior supra-individual process of natural selection (Deacon, 2012, p. 52). His own view is an inversion of the ultimately Cartesian dualism according to which non-material aspects of the action-process need to be treated as being "on top" of, and supplementary to, physiological ones. He suggests that the "unfinished" and immaterial aspect of human action in terms of plans, aspirations/anticipations and apprehensions is best conceived of as an effective "absence" (Deacon, 2012, p. 23).

Deacon (2012, p. 14) diagnoses a deeply entrenched bifurcation in the current "Western" perspective in which the materialist Darwinian worldview that excludes the phenomenological reality of human subjectivity in causal cognition brings about "fundamentalist" tendencies that cater for this reality but at the price of largely negating or encapsulating the results of modern science. In the Dinka case we do not find this bifurcation but we also find variation within the Dinka as a cultural group as to how they interpret situations in which unusual things happen. People disagree as to whether something should be interpreted as a sign of intervention by divinity or not (Lienhardt, 1961, p. 48). The early ethnography suggests that a plurality of views is not a recent invention of the European enlightenment. It is not that THEY are governed by a religious world view while WE agonize about uncertainties. Rather, we AS HUMANS are faced with the "uncertainties and chances of [all] human life" (Lienhardt, 1961, p. 54). Lienhardt (1961, p. 54) concludes that what he observed among the Dinka was not "a pious aspiration toward resignation to the will of an ultimately benevolent personal God" but "a recognition of real ambiguities in experience." However, that plurality need not take the form of a choice between alternative views but rather manifests itself as variations within a broader spectrum. There are again striking parallels in other African ethnographies. Evans-Pritchard, using the notion of magic that Lienhardt (1961) tries to avoid, draws a similar picture for the Azande:

> "Magic may give a greater measure of success to an undertaking than would have been obtained without its use. [...] Natural conditions and human knowledge of them, and skill in exploiting them, ensure a harvest of termites. The use of a magical technique is secondary [...]. It cannot normally replace it. It is an aid rather than a substitute." (Evans-Pritchard, 1937, p. 467)

There is further evidence from other parts of Africa that indicates that the "bifurcated" and "dualistic" solution of current mainstream Western science is "weird" by comparative standards. Bohannan and Bohannan (1969, p. 36) write about Tiv of West Africa, a long way away from the Dinka and Azande: "if things are going wrong, and you are not begetting enough children or getting enough money or good enough crops – if things in general are not going as well as they should – then you 'plant' (tim) an itymbe mku" – a sacrifice to the ancestors (see East, 1965, p. 211–214 for a detailed description). When being prompted the Tiv responded to the ethnographers that the dead parents could not actually do (read: cause) anything for you, since they were dead (Bohannan and Bohannan, 1969, p. 38) but that all other things being equal the mku ritual "is for good luck – to make things go more smoothly. It isn't something you have to have to get along – but if you do not have it, there is a greater tendency for wives to

leave, children to sicken and die, your luck in hunting to be poor and your crops not to amount to much. After it [the mku] is set up, none of these things happens to you unless something else [...] intervenes. However, any akombo [ultrahuman agent] [...] can still seize you. The mku can't stop that. It is just that if nothing else happens to you, things will go well" (Bohannan and Bohannan, 1969, p. 39).

These passages show a number of things: they reflect the culturally specific ideas and practices of dealing with the universal occurrence of mishappenings, malevolence, and the vulnerability of human life. At the most general level we may say that they are a recognition and a measure with regard to the fact that the world is not an ideal place for humans to live in. There are elements of probabilistic thinking as Tiv charms set in to decrease "the tendency" for mishaps to occur and for things to go wrong. There are also elements of interventionist thinking – the assumption of natural things such as procreation and growth to happen unless there is intervention which in turn leads to the assumption that there must have been malevolent intervention when these natural processes are stopped. And there are many indications for a recognition of complex causality since measures such as putting up ancestral shrines are not seen as "definite" solutions but rather as supporting causes that some may want to do repeatedly in order to increase the effect (Bohannan and Bohannan, 1969, p. 41–43).

A common bias among WEIRD people is to insist that there are two fundamentally opposed alternative modes of access to the environment, one religious (or metaphysical) and the other non-religious (pure physical/empirical/material). However, as indicated earlier, the ethnography does not support such a separation but rather one between "confidence in the normal" and "cooption of special measures" which does not coincide with the "metaphysical/material" divide. "Confidence" may cover both metaphysical and material knowledge while "cooption," again, can involve restricted specialized knowledge in a spectrum that covers both the metaphysical and the material. It would be less biased and more appropriate to recognize that the dominant natural science view is one such specialization which follows a logic of increasingly reducing the range of "why questions" that can be asked. The ethnographic context suggests a seamless spectrum of "why questions," ranging from the personal and the everyday (such as: "why did I catch this disease or fail that exam?") to the existential and universal (such as: "why do we live and why do we die?"). Moreover, religious practices and ideas are not necessarily directed toward control but also at what may be called "coping" with causes, causative agents and complex causal chains. Practices may be geared toward a better recognition (or relevation) of causal agents and causal chains, not necessarily in order to interfere with them but rather as to adapt to them and to position oneself in a way that avoids harmful effects. The practice and attitude of much of modernist science is in many ways the striking opposite. Questions that appear to be non-verifiable are deleted from the positivist scientific discourse, the question of creation (or ultimate cause) being a case in point. As Schnepf (2006, p. 90) has shown, any "why question" that is hypothetical and that involves absences tends to be excluded from the start in favor of those "why questions" that create observable facts. Questions of causality are narrowed down to questions of verification and prediction to the

extent that causality is narrowly understood purely in terms of prediction and not of explanation, an account as to how something came about. "Why p" is made to equal the predictive "Why was it to be expected that p?" while excluding "How did it happen that p?" which would target the actual emergence and mechanism of a phenomenon in any particular case (Schnepf, 2006, p. 92–93). Note that this narrowing down of causality to its nomological and statistical sense generates resistance within "Western culture" including explicitly non-religious philosophy exemplified by Schnepf's (2006) critique, hence generating at least as much cultural diversity as African ethnographers have noted for their cases.

What Evans-Pritchard (1940), Lienhardt (1961), and Bohannan and Bohannan (1969) were struggling to express in their ethnographic monographs indicates that we are not dealing with a shift of gear between "profane" causal thinking and a religious worldview. Rather they describe a larger underlying pattern that encompasses both. It is a notion of mediation which "enables humans to act" or of "*faire faire*" as Latour (1993, 2010) would call it (see below). One of the main problems for today's readers of these ethnographies is that they tend to see and interpret possible "other" ways of doing things and of conceiving causality and agency in terms of those ways from which Western science has tried to emancipate itself. The ethnographic statements are primarily categorized as "religious" (or "magic"), which in a secularized world is identified with religious views in opposition to which science has emerged and against which science is gaining its own profile. We may see this as Durkheim (1912). throwing his long shadow. Durkheim (1912), it may be recalled, argued that humans can create things larger than themselves but that in the early evolutionary phase of religious life they mistook the true powers of their own society to be exterior religious powers. And since Durkheim's times, one could argue, the so-called life sciences claim that Durkheim and the social sciences in turn mistook the powers of the collective for the powers of the genetic program of the DNA and the neural system of the brain. What shifted in these debates about agency is the place in the chain where "true agency" is identified. Creationists and geneticists usually differ on where to allocate agency and the "true cause" of things. Where they do not differ is in their conceptualization of agency as a total power, undetermined by anything prior. "Just plain folks" may locate that center of agency at the level of the individual, creationists at the level of some higher being in the sky, and many natural scientists at the level of the DNA. What they all share is that the agent is determining the patient in a mechanistic way. When represented graphically as "A–>B," there may be considerable disagreement as to who or what needs to be put at the position of A (and B) but there is a broad cultural consensus that links positivist scientists and creationists, namely that they agree on the arrow in the middle. Lillard (1998, p. 10), following D'Andrade (1995), reproduces this consensus by conventionally glossing every arrow between items in the graphic representation of the European folk model of the mind as a "direct cause," with arrows against the linear temporal flow labeled "influences" (not "causes").

When we come across other ways of doing things in the African ethnography, we mistakingly align them with positions in these current debates so that they are supposed to side with religious positions in a very peculiar secularized society. However, the ethnography that I have presented above suggests something else. It suggests something that may be graphically depicted as "–>A–>" whereby A could be anything, ranging from Gods to humans and further to non-humans but whatever the As (or the Bs for that matter), their actions are enabled by being bound into a larger network and they are enabled by being conditioned by attachment as hinted at by Latour. This also applies to the actions of most ultrahuman agents who are themselves conceived of as bound and not as completely free. They do not only make things but allow things to happen and humans can try to side with them and bind themselves to ultrahuman beings so that they can benefit from the things that are being made possible.

The evidence on causality contained in ethnographic monographs is also "harvested" in a different way by a (minority) position in Western thought, most recently popularized in the works of Latour (2010) but rapidly gaining more ground. Latour (2010, p. 65) refers largely to non-religious examples that he uses to make similar points about the variability of the notion of agency: for instance the action of a speaker speaking a language (or in his terms: a language allowing someone to speak, and the speaker allowing a language to be spoken), a writer writing on a notepad, a puppeteer performing with his string puppet, a cigarette smoker smoking a cigarette. All of these can be read against the grain: a smoker thinks he is the agent when he is smoking but there may be the opposite description whereby the cigarette is forcing the agent to be smoked, not completely off limits as a description if we think of a nicotine addict. But the critical point is this: although opposite, both descriptions adhere to a view of agents being determining for what happens, except they inverse the subject-object relation, the position of agent versus patient. In the one account it is the smoker, in the other it is the cigarette. The real alternative, Latour (2010, p. 58) insists, would be a "middle voice" which reminds us of Lienhardt's "passiones" (see above) and it may also be seen as a continuation of Gibson's (1979) notion of the "affordances" of objects . An opposition in terms of (full) determination versus (complete) freedom produces a dualistic image of the human being as someone who is internally free (at least has the representation of freedom) while being externally completely determined (by society, the markets, global finance, the genes or whatever). But when comparing African ethnographies with "modern lives," Latour (1993) suggests, we are not moving from a pre-modern state – in which agency is limited – to a modern state – in which agency is liberated. Rather, Latour critizises the WEIRD societies to cultivate a non-modern state in which bounded agency is denied because they ignore the fact that agency is always bounded in one way or another (in terms of role models, kinship ties, evolutionary forces etc.). This in turn leads to an inability to see and compare the different forms that bind our agency and to influence them accordingly. In other words we should concentrate on what allows us to do (*faire faire*) certain acts (as Latour, 2010, p. 58; suggests). Rituals for instance are not binding people who would otherwise be free but rather they bind them in a particular way. If they did away with the rituals their agency was bound by other forms, be it for instance the play of violent powers, of majority forces or some other structured

way of organizing cooperative action. The modernist separation into pure agents and pure patients creates all sorts of conceptual problems such as the search for prime or "real" causes. In the alternative model each mediator is thought of as allowing the next piece of the chain to become the beginning of a new action itself. The mediators enable the successor in the chain to generate an effect.

Latour's philosophy shows clear parallels with the mode of thought described in the African ethnography of (e.g., the Tiv, Azande, Dinka) but it also helps to redefine the position of these ethnographic cases in a comparative study of causality. Earlier readings of these ethnographies were comparisons between "us," the Westerners on the route to emancipation, striving to free ourselves from all attachments that bind us, becoming free agents and "them," the ones who are (still) bound by attachments (religion, kinship etc.). In this comparison the others will always appear positively strange because they claim that they can only live through their attachments (for instance to divine beings) that allow them to do things, thereby violating the modernist ideal to do away with all attachments that infringe on our agency. The new reading of the comparative ethnography, by contrast, realizes that "we" (humans) differ with regard to the attachments that bind us in our actions but that at the same time allow us to exist and act in the first place. Moreover, there are cultural differences to the extent that some bindings are considered to be relevant for creating responsibility in action, while others are not. Some individual agents may be considered so closely bound up with one another that they are considered to be one agent (a kinship group, a nation, a company or corporation etc.). The non-Europeans appear to the Europeans as exotic only as long as we contrast their reality of being bound and limited in their agency with an abstract ideal of a free agency. In the new comparative paradigm individuals (and possibly cultural groups as clusters of individuals) differ with regard to WHAT binds them. As I want to discuss in the remainder of this contribution the conceptualization of time is an important feature in such a comparative ethnography of causal cognition.

CONCEPTS OF TIME IN THE ETHNOGRAPHY OF CAUSALITY

When "harvesting" earlier ethnographies for evidence to do with causality, the notion of "time" emerges as a critical domain, next to that of agency and personhood which I have discussed above. Again, Evans-Pritchard is one of the most-cited ethnographers, but in this case with reference to his ethnography of the Nuer rather than the Azande. In parallel to my discussion above we can read his ethnography as representative for a larger body of literature and, again, we can see an emerging social science critique of the universalist assumptions of the so-called "hard sciences." As already indicated, Durkheim (1912) insisted that society was the source of all categories, including the most basic categories of time and causality – and hence the assumed importance of the new disciplines of the social sciences. His contemporaries in the social sciences elsewhere, especially in North America and Germany, were making similar arguments based on the notion of culture rather than society but found themselves in the same position to the precursors of what today are the cognitive sciences (see Bloch, 2012, p. 86). They claimed that human cognition on

time varies and that this variation can be considered a proof to the importance of society and culture as opposed to mental or biological nature. It is noteworthy that the first works that made these claims were themselves compilations of earlier ethnographic work rather than field studies. This is true of Durkheim's (1912) work on Australian Aboriginal religion and Mauss' (1906) work of the Eskimo. The latter had argued that Eskimo seasonality, which manifests itself in large sedentary aggregations during the winter and small and dispersed mobile groups in the summer was so pronounced that it would bring about not only two modes of polities (one more hierarchical and one more egalitarian) but also two different mind-sets associated with these two seasons. Winter became associated with a greater need to seek the advice of magicians for coping with uncertainties, to conduct communal ceremonies and to convey mythology, while summer was associated with secularism, pragmatic leechcraft, peace of mind, and the economic and ritual autonomy of domestic units. Mauss (1906) relied on second-hand information and his compilation has given rise to conflicting interpretations, some leaning toward a form of ecological determinism and others supporting a view that emphasizes the relative freedom and flexibility of social forms and modes of thought even in apparently "simple" human societies (see Wengrow, 2014 for a recent interpretation). Evans-Pritchard not only had the benefit of knowing the theoretical comparative work of Mauss (1906) and Durkheim (1912) but of having the opportunity for long-term field research to investigate these matters, in this case among the Nuer of Sudan (neighbors of the Dinka). Among the Nuer Evans-Pritchard also found a marked seasonal contrast between dry river villages in the savanna where the Nuer subsist mostly on cattle-keeping and the wet season in which floods force them to aggregate and retreat to the hills where they practice agriculture and focus on communal rituals and kinship ties. All of this, Evans-Pritchard argues, is reflected in the Nuer time concepts. Their "cattle clock" is determined by daily and seasonal routines of cattle-keeping. They measure their time according to the tasks that need to be done as required by the needs of the animals (conditioned by the environment and the material world at large) rather than being "controlled by an abstract calendric system" with "autonomous points of reference" Evans-Pritchard (1940, p. 103). This "ecological" and task-oriented time management made the Nuer appear to Evans-Pritchard to be less bothered with time pressure and therefore more fortunate than those living under his home time regime. Added to this "defiance" of time is that the Nuer seem to be only interested in the past as a means to establish relative distance or nearness with regard to one another in their kinship obligations of the present. All Nuer consider one another to be genealogically related – as members of clans, major and minor lineages that have branched off from another. To know the point in time when the lineages of two individuals have split is to know the relative distance between them, the further back in time the split occurred the more distant one's kinship link. Given the importance of time in the construction of causality, it is easy to see that reports on such "diverging" time concepts lend themselves to the interpretation that the Nuer also have different concepts of causality or that they invest less in establishing causal relations, giving less importance to chronology and to before–after relationships.

It is not only the Nuer for which variation in time concepts has been described. In fact, the notion that conceptualizations of time in "cyclical," "reversible" or other modes of departing from a linear mode of time-reckoning have been realized elsewhere seems to have attracted the cultural imagination. It was reported upon in ethnographies (Alverson, 1978, p. 170), and picked up by philosophers (Fuchs, 2011, p. 215) and the social scientists pursuing a relativist agenda that challenges sequentiality as one of the defining features of causal relations (see above). Summarizing these debates, Maurice Bloch has recently pointed out that "The Nuer" and other ethnographies deserve a more careful reading and a more complex interpretation (Bloch, 2012, p. 91–97). He underlines that the faculty to live by imagined time regimes that are not dictated by ecology or "nature," is an important feature that marks off humans from other species (Bloch, 2012, p. 108). This capacity to "time travel" includes the examples already given, when Eskimo and Nuer are "freezing" seasons into two modes of social and cognitive organization and two modes of grappling with problems and of seeking explanations. This capacity allows us humans to make past and future events relevant for memorizing, planning and structuring our lives. It has wide-ranging implications since the "normal rules of time and space are temporally suspended" for the benefit of imagining alternative scenarios to the ones that we find ourselves in at a particular here and now (Bloch, 2012, p. 108). However, this human ability to imagine different time regimes, Bloch (2012) reminds us, is irrespective of the fact that there is a before–after linear time reckoning still in place that is instrumental for causality. In fact, it is the particular strength of ethnographic monographs based on long-term field research (in comparison to narrowly focused survey or experimental work) that they usually contain evidence of the parallel existence of these two modes of time reckoning. Evans-Pritchard's work on the Nuer is a case in point. He not only shows how Nuer "imagined" genealogical time and how pastoralist task oriented time helps them organize their society in a way that allows them to lead complex and satisfactory lives. He also describes scenarios and rules which show that the Nuer take account of the linear time that structures for instance the calculated give and take of cattle when negotiating bridewealth (Evans-Pritchard, 1940, p. 222, see also Bloch, 2012, p. 94). Here the marrying out of a girl in one generation will cause cattle to be transferred to the wife-givers which in the next generation in turn will cause an inverse flow of cattle when the daughters of that girl are married off with cattle going the other way. Irreversible, calculable time sequences, Bloch (2012, p. 94) argues, are underlying Nuer relationships in the everyday and they are key for the communication between the Nuer and for their ethnographers for establishing enough shared common ground to explain the subtleties of those parts of the time regime that are "imagined" and not necessarily shared culturally. On the basis of this example Bloch (2012, p. 115) formulates some general guidelines for the cooperation between anthropologists and cognitive scientists which he sees as being necessarily complementary because they target different levels of cognitive processes: anthropologists focus on the cultural imagination that differs culturally while cognitive scientists such as developmental psychologists focus on the level of time and causality concepts that are acquired early in life and are universal. The full story, however, that is provided by comprehensive ethnographies, is to recognize the co-existance of apparently "cyclical" ideas about time and an underlying before-and-after time reckoning.

Bloch's (2012) treatment of Evans-Pritchard's ethnography echoes an earlier attempt by Gell (1992) to summarize the rich comparative material on the time concepts of non-WEIRD people. Going back to the terminology of John McTaggart and David Mellor, Gell (1992, p. 151) distinguishes A-series from B-series time concepts whereby the former refers to the culturally harnessed experience of past–present–future (yesterday–today–tomorrow) while the latter refers to the before-and-after row of typically measurable events . This shorthand summary of time types allows Gell (1992) not only to distinguish the many different philosophical approaches to time but also to classify cultural manifestations, as found in ethnographic descriptions, that either tend toward an A-series or the B-series conceptualization.

The time concepts of the Nuer can be described in terms of an intricate combination of these two time concepts. Their "cattle clock" is an example of "concrete, immanent and process-linked" time reckoning of one action or task leading to the next, at the microscopic level. By contrast their lives at the long-term macroscopic level, like in most African societies documented in the classic ethnographies, is structured by intricate social concepts of generations, age-set and other socially "constructed" units (Gell, 1992, p. 17). The construction of a lineage and generation in a sense "immunizes" these social units of "generation," "age set" etc. from the duration of time. A generation has no fixed number of years and age-sets can cover more or less years depending on demographic factors since a sizable group of young men need to grow up to form such a ritually constructed age-set. People belong to an age-set or a lineage not due to a specific time that has lapsed but with regard to the cultural limits set by rituals and other cultural means. The relationship between socially defined "cultural epochs" and the relationship between ancestors and present-day people is not altered by the durational intervals between them. However, these cultural rules do not undermine an understanding of a (before–after type) preceding of one epoch before the other (Gell, 1992, p. 22). Having surveyed both the comparative ethnography and the spectrum of time theories Gell (1992, p. 320) concludes that B-series time is in fact more fundamental than A-series time but he recognizes that many of his colleagues arrive at the opposite conclusion.

It is interesting to note that Gell (1992, p. 320), like Bloch, advocates a methodological bridging of the gap between the measuring approaches that focus on B-series time (time-geography approaches are his example) and the anthropologists – the "cultural/cognitive approaches" in his words that focus on A-series time. However, he also gives some hints as to why this complementarity of approaches may not be so easily achieved. Since there appears to be a direct link between debates on the conceptualization of time and those on causality we may transpose his arguments from temporality to causality in the following way: Gell's example (1992, p. 169) relates to preparations for ceremony whereby the (B-series) sequence may be "Six moons pass before the great ceremony: one moon for fishing, one for hunting, one for making gardens, one for gathering nuts, one for visiting relatives, and then the great ceremony occurs." What if, after

6 months, the ceremony still has not been conducted? According to Gell (1992) that is a common situation in which visitors find themselves frustrated in their communication with locals, either questioning the reliability and capability of informants or assuming that there is a completely different worldview and concept of time and causality at work. It is easy to read the statement on the right time of a ceremony as a list of causes whereby any question on "Why is there (or isn't there) a great ceremony?" may be answered with reference to fishing, hunting, gardening, gathering, and visiting as causal prerequisites that lead to a great ceremony. However, the cognitive task is not that of counting the months and of knowing the correct sequence (B-series time) but rather to establish whether enough hunting, gathering, visiting, etc., has occurred for them to be considered "past" and "done" (A-series time). This is the situation for anyone who strives for a successful harvest. One relies on B-series time sequences of appropriate circumstances (springtime, lack of frosts etc.) that need to be in place "to cause" a good harvest (Gell, 1992, p. 173). The Nuer who leave the flooded savanna to start gardening in the hills rely on their ecological calendar for that purpose, "causing" their seasonal movement. And, presumably, at a more microscopic level their "cattle clock" works in a similar way as an orientation for the daily tasks for tending cattle that are necessary causes for a herd to survive. However, as Gell (1992) – no doubt informed by his background as an ethnographer – is quick to add, these sequences of time events (or causal events for that matter) are not by themselves decisive for human action. The ecological calendar or cattle clock may be known to be sequences that are true at all times and for everyone. In order to act, however, I need to establish where we are in the sequence and in that process agents rely on A-series type time features. What tells me that it is indeed the rainy season now and indeed time to plant or to move to the hills and so forth? The A-series time of experiencing changes from yesterday to today or from dry to rainy season or from taking the cattle out to bringing them back into the corral is decisive here. It is only a sense of the current moment that enables me to act. With reference to causality we might say that the spectrum of (immediate, distant, intermediate etc.) causes are important to know but for taking action I also need to know which of these causes need attention right now, which are the ones that are unproblematic at that particular point in time, and which are the ones that can or should be influenced at any particular moment. In Gell's (1992, p. 174) words: "It is the farmer's belief that springtime is truly here, and that frosts will not damage the growing shoots, [i.e., his A-series time belief, TW] which causes him set to and plant his fields."

Gell (1992) observes that the combination of the two time series often leads to confusion when conducting ethnography but we may safely generalize this as a problem of "reading" cross-cultural data. The researcher who wants to establish when a ceremony is being held may seek an A-series answer but is actually given a B-series response or vice versa. Respondents may repeat, month after month, that the months of fishing, hunting, gardening, gathering, and visiting have to pass which may frustrate the ethnographer who actually wants to know whether the time for the ceremony has come, here and now. An observer may ask Azande what caused the death of a person but will not

be given a comprehensive (B-series type) of response about contributing factors such as termites eating poles of grain storages but instead will be provided with remarks about witchcraft and the need to ask a diviner about current social conflicts because these are the factors that are relevant to clarify at that particular point in time. It is not far-fetched to recognize the different interests of ethnographers and psychologists here since the interest of the former is typically to understand the complexities of a case situation whereas the latter may be more interested to get at the more stable sequences. This is the "danger" involved when cognitive scientists read extracts from ethnographic monographs. They (like ethnographers starting their fieldwork) tend to either mistake (A-series type) comments about what is relevant "here and now" as remarks of generality or, conversely, mistake (B-series type) comments about what typically occurs as remarks of what necessarily should occur in that particular instance. Experiments geared toward general statements of "what causes what" may get interpreted by the respondents in different ways and the responses may be interpreted by those conducting the experiments in inappropriate ways. At the same time, this explains an important strength of ethnographic accounts: it is not only that they produce statements (about time or causality) that probably could not have been gained in any other way of elicitation, but rather that they provide enough context to see what type of response(s) are made as activities and events unfold. Humans effortlessly switch between the different modes of thinking about time and causality but documenting these switches with regard to events and processes unfamiliar to the observer does require considerable effort. Both, Gell (1992) and Bloch (2013) strongly underline that cultural gaps can be overcome in the process. The task of ethnographically investigating how people juggle conceptualizations of causation across different social situations is ongoing, independently of the question whether respondents are considered weird or not. Bloch (2013, p. 115) insists that ethnographers and their subjects, despite diverse explicit cultural representations, sufficiently share "core knowledge that all human beings require" for getting about their everyday life – a shared B-series, if you will that allows mutual understanding. Gell (1992) sees the possibility of understanding across "cultures" not so much in a culture-free core than in the fact that we are able to recognize "artificial" cultural roles (largely of an A-series type) through the principle of reciprocity of perspectives that allows us to understand different conceptualizations because we produce them ourselves all the time. We understand the social role played by others on the basis of our own filling in roles over and again (Gell, 1992, p. 319), exploiting a shared human facility for "excentric positionality" (Plessner, 2003, p. 364).

CONCLUSION

In this contribution I have argued that broadening the spectrum when investigating the cultural constitution of causal cognition does not necessarily mean confronting "exotic" people with experimental tasks that were so far limited to a small WEIRD sample. Revisiting a few of the existing ethnographies can provide important insights, too, in particular with regard to differences in establishing agency and in conceptualizing time. With regard to agency, a careful analysis shows that supernatural agency does

not mean that there are no universal human abilities to recognize causal chains – but that the recognized items in these chains may differ considerably nevertheless. The divide between metaphysical/material that is so pronounced in Western thinking may be much less relevant for understanding cultural diversity than the spectrum between control and accommodation. In terms of time the ethnography suggests that a co-occurance of partly conflicting time modes entertained by a group, or an individual agent, is a common feature. Moreover, there are different operations at work, that of establishing agreement about series of sequences and that of establishing whether a state in the sequence has been reached or completed. However, it is important to note that these are within-culture rather than between-culture differences. What, then, are cross-cultural differences that are likely to remain? While this awaits further concerted research beyond this contribution there are some points to note: the difference between agent and event cognition, over which much ink has been spilled in Western philosophy and psychology appears to be much less fundamental cross-culturally than commonly assumed. Similarly, there seems to be much less necessity to establish whether A-series time is more basic than B-series time than long debates in this field suggest. Ethnographic accounts show that in practice agent and event may merge beyond recognition and that both modes of time reckoning are equally involved.

It remains to be seen whether revisiting ethnographic accounts can actually correct psychological problems that have been operationalized as experiments, or even render some of the existing questions obsolete. One major corrective that ethnography can provide has already become apparent: against a dualistic image of cognitive processes made up of "unconscious quasi-mechanical cognitive processes" on the one hand and "higher, conscious thoughts, social representations and ideas" on the other hand, that is so common in psychological research, ethnography opens up perspectives that integrate both and thereby reduces "weirdness" in a number of ways. While the integration of "weird" results into the investigation of the cultural constitution of causal cognition is now a widely shared aim, the notion of "weird" in this context has received a number of different meanings: initially applied to the "aberrant" responses of non-Western peoples, it has shifted to connote the narrow and culturally rather specific sample of WEIRD respondents of most of experimental science. In this conclusion I suggest that there is, in fact, a much deeper gulf to be bridged than the one between "Western" and "non-Western" samples. It is true that ethnographic accounts have for a long time focused on non-western societies whereas experiments focused on those who are culturally close to the mind-set of cognitive scientists. However, any ethnography, independent of its location, highlights the role of *conscious* agents both in causality and in the analysis of causal cognition. We may conclude that experiments and ethnography are designed to target different aspects. There is also an element of evaluation involved and one that seems not to have changed much since the days of early ethnographic writing in the 20th century. Evans-Pritchard, it has been highlighted (Winch, 1964), may have been sympathetic to his informants but he ultimately thought that they were wrong. Materialist natural science, and a cognitive science that orients itself toward it, privileges the detection of linear causal chains (Gell's B-series) and

considers these to be "ultimately" important. By contrast, ethnography, or other methods that are experience-near, insist that it is "ultimately" the beliefs of the agents about the current state of the world (e.g., the arrival of a season, see above) that causes them to do things. As a result there is what may be called a mutual suspicion of weirdness. Enlightenment science is predicated on its fight against spiritualism and transcendentalism. Only things that were materially or energetically present were considered to be legitimate agents in causal relations following a "causal closure principle" (Deacon, 2012, p. 38) according to which nothing comes from nothing and teleological phenomena could not set causal chains in motion, neither at a situation interpersonal level nor at an evolutionary interspecies level. A lot of scientific time and energy was spent to understand "mechanical causality," for instance in chemistry or the meteorology, which as long as they were obscure were routinely applied to gods or spirits to explain disasters or whatever deviated unexpectedly from the norm. With regard to some fields of science, in particular the inanimated processes and effects at the microscopic level this strategy has been very successful, so successful that it has been extended as a default explanation for all phenomena in which spiritual or other ultra-human agency was proposed. Almost all of the causally relevant agents in the above-mentioned ethnographies would be brushed away on this basis, either as cognitive errors or as correct inferences that are, unfortunately, based on unwarranted, pre-scientific assumptions devoid of their necessary material basis. The model of mechanical causality has become the only accepted explanation for phenomena of living and sentient beings more generally. The assumption was that even though there are considerable gaps in the material links and causal chains to allow for a full explanation of life and consciousness, it would only be a matter of time when these gaps will be closed. In the meantime, as Deacon (2012, p. 52) has recently shown in detail, the homunculi of earlier times were re-introduced in covert forms. Activity and teleology were (and still are) routinely attributed to "the brain" or "the DNA" as "unacknowledged gap-fillers" that in fact are markers for an unfinished analysis that effectively bracket out what is most in need of explanation, namely the new process dynamics that emerges with living beings and with consciousness. Although the experience of consciously influencing causal chains is the "most commonplace phenomenon of everyday waking life" (Deacon, 2012, p. 33) the detailed scientific knowledge about the physical world (including recent advances of neural activities) suggests that plans, values and consciously set purposes are illusionary because our scientific knowledge about the physical basis does not make them easier to comprehend. However, there is growing uneasiness about this state of affairs which in effect excludes human experiential reality and the most pressing questions related to it (Deacon, 2012, p. 34). In other words, the everyday experience of humans, all humans, appears to be "weird" to the dominant science model. Conversely, a dominant science model in which the highly evolved phenomena of subjectivity and consciousness have no room, is also positively "weird" and inappropriate to explain living beings (Fuchs, 2008, p. 86).

In this context the ethnography discussed in this contribution gains particular attention: when the positive science discourse denies agency to conscious actors and dissolves it to undirected

processes then this is not only questioning the particular Azande or Dinka worldview that are described here but it is also the end to any account that would be able to handle worldviews of human agents without reducing them to illusions. Similarly, when the before-and-after timeline of physical processes is said to replace meaningful identifications for "the right moment" to do something, then this renders not only the Nuer concepts of time irrelevant but more generally the human ability to decouple themselves from the here and now in which they operate.

Deacon suggests that the heart of the problem is that materialist natural sciences cannot handle "ententional" phenomena, i.e., phenomena that are causally effective (intentional, purposeful, functional, adaptive etc.) but are characterized by an absence of detectable and identifiable physical substrates. The examples he gives are of very different kinds, ranging from hemoglobin and its functions to social inventions such as money that has causal outcomes but "no essential specific physical substrate" (Deacon, 2012, p. 27–29). But examples multiply at the level that ethnographies usually tap into, namely with regard to phenomena of treating disease and dealing with misfortune that I have outlined above. Here nothing less is at stake than the realization that to a materialist science that brackets out everything that cannot be reduced to a physical or energetic process we are, as human agents, all positively "weird" in the way that we experience ourselves and the world around us. In other words, ethnographies are a constant reminder of the incompleteness of the dominant natural science account because they are populated by agents who experience themselves (and one another) as interfering in causal chains when consciously deciding when "the right moment to plant" (or to move or to burn, or whatever) has come. There is an unbridged gulf between the highly sophisticated account that the natural sciences could give on the behavior of termites on the effects of their feeding patterns onto the stability of wooden structures and the questions of meaning that Azande pose when being confronted with the physical harm that particular persons suffer at particular points in time. Deacon's example (2012, p. 18) of a boy throwing a stone to make it skip over a surface of water underlines that point: while science may be able to provide a near to complete causal history that causes the stone to "jump" across water (in terms of what happens in the child's muscles and brain etc.) it "leaves out what is arguably the most important fact," namely the mental image of a skipping stone that the child may have constructed based on observing such an event elsewhere and by someone else (Deacon, 2012, p. 19). Ethnographies typically capture these images and draw these "causal" lines between events, e.g., the observation at an earlier time and place together with the pleasure of seeing a stone skip over water that is imagined by the agent. From the perspective of conscious agents these are the relevant constraints that have led to this particular event. From that perspective the geomorphological events that have placed the stone where it was found at the water shore become as insignificant as the feeding behavior of termites in African millet storage baskets – independently of whether they are known or not known.

At the end of the day this may be the most important use of ethnographies in the investigation of causal cognition: the demand for a scientific theory that satisfies both criteria, namely the critical

discovery of homunculi to which agency gets attributed as a consequence of a lack of a better account *and* the insistence that phenomena such as purpose and intention are not bracketed out of consideration only because they are absent from the physical constitution at a specific place and time. This may also explain why there is less productive coexistence between ethnography and experimental work in the way that both Alfred Gell and Maurice Bloch recommend (see above). After all, this is not only a matter of combining two slightly different methods, the one more qualitative the other one more quantitative. Rather, we are dealing with indicators of a much more fundamental divide at the theoretical basis of contemporary science. A mechanistic understanding of science that is restricted to what is physically present will tend to render the purposeful behavior of conscious agents, as contained in ethnography, irrelevant. Conversely, a humanistic anthropology that focuses on the reports of conscious agents will continue to consider any advances in understanding the physical processes, typically based on experimental work, irrelevant. Unless there is a theoretical integration between the two spheres of life.

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Bringing history back to culture: on the missing diachronic component in the research on culture and cognition

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Introduction

A growing body of evidence shows that cognitive processes in general, and causal cognition in particular, are variable across cultures (Choi et al., 1999; Norenzayan and Heine, 2005; Henrich et al., 2010). The majority of these findings are based on cross-cultural comparisons contrasting well-defined groups, with little explicit consideration of temporal change within those groups. While this strategy has undoubtedly proven successful, an important limitation is that it can implicitly lead to a view of cultures as stable entities and associated cognitive processes as essentialized.

A prosaic illustration serves to introduce this idea. Suppose we hypothesize that smoking cigarettes and culture are closely related. We measure the number of cigarettes per capita and find that Chinese smoke more than Americans (Ng et al., 2014). If we collect time-series data, however, we might notice that had our measurements been taken in 2000, we would have found no cultural difference. Further, if our time-series had gone even further back to measurements taken in the 1980s, we would have found just the opposite pattern, such that Americans smoked more than the Chinese. Clearly, findings for cultural differences are of limited utility when they do not account for within-culture historical trends. Furthermore, theoretical explanations for cultural difference risk reifying an incomplete perspective if they take such results as indicative of some atemporal notion of "culture" itself.

In this paper we argue for the need to develop methods of within-culture diachronic analysis as a necessary step for understanding the complex links between culture and cognition. We specifically focus on the link between culture and causal cognition, yet the argument is applicable to the field as a whole.

A Brief History of Cultural Causal Cognition

Seminal work in culture and cognition focused on comparisons between Easterners (mainly Chinese, Japanese and South Koreans) and Westerners (mainly North Americans and Western Europeans).[1] Using this East-West framework as the comparative lens, researchers found that Easterners use a holistic mode of thinking while Westerners use an analytic mode. Holistic thinking relies less on formal rules, attends to the whole field, and is more open to dialectic contradiction than analytic thinking (Nisbett et al., 2001; Nisbett and Miyamoto, 2005). In terms of causality, holistic thinkers are more likely to attend to external forces and group patterns over internal dispositions (Morris and Peng, 1994); less likely to use decontextualized information when making inferences (Norenzayan et al., 2002);

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[1]For some notable exceptions see Barrett et al. (2005), Beller et al. (2009), Abarbanell and Hauser (2010), and Bender and Beller (2011).

consider a larger number of possible causes (Choi et al., 2003); are more sensitive to covariance and perceive stronger associations between events (Ji et al., 2000); are more likely to expect change from prior trends (Ji et al., 2001); and tend to see causes as extending further in a system (Maddux and Yuki, 2006).

In a move that proved remarkably generative, researchers theorized that contemporary East-West cognitive differences reflected epistemological orientations that could be traced back to Ancient Chinese and Greeks. Much like contemporary Eastern individuals, ancient Chinese philosophers were interested in continuity, changes, transformations, and dependence between objects, while Greek philosophers were interested in universal truths, formal rules, and discrete objects and entities. Further, ancient Chinese were interested in technological advances driven by pragmatic goals, while the Greeks valued intellectual endeavor for its own sake and were less concerned with concrete applications of knowledge (Norenzayan and Nisbett, 2000; Nisbett et al., 2001; Nisbett, 2003). Such parallels between historical philosophies and contemporary cognitive patterns subsequently informed a major line of comparative research.

This historical explanation assumes considerable psychological continuity within cultures across time. Yet accumulating evidence has begun to challenge the strong claim that contemporary cultural differences are rooted in ancient East-West philosophies (Varnum et al., 2010). First, when a group changes its environment, it may start to resemble other groups in similar environments rather than their original ancestors. Kitayama et al. (2006), for example, showed that settlers in Hokkaido in northern Japan were more individualistic and made more dispositional causal inferences than people from mainland Japan. The authors suggested that the Hokkaido's hostile environment fostered a "frontier spirit" similar to the spirit of North American settlers from 19th century. Second, within-culture differences in analytic and holistic processing closely mimic the original East-West distinction. Within the U.S., Na et al. (2010) found that working class Americans were more holistic and less analytic than middle class Americans. At minimum, this suggests that variation in cognitive orientations is not unique to East-West cultural differences. Third, cultures that share little with ancient Chinese in terms of epistemological frameworks are still found to share many features of a holistic cognitive style. Russians, for example, are historically closer to the Greek intellectual tradition but are holistic in terms of categorization, causal attribution, and reasoning about change (Grossmann, 2009, cited in Varnum et al., 2010). At minimum, these findings show that variation in holistic vs. analytic cognitive orientations are not unique to historical East-West cultural differences.

If cognitive orientations also vary within cultures that share a single Ancient tradition, then this points to shifting cognitive patterns across time. On this perspective, a fuller account of the links between culture and cognition can be realized by including within-culture comparisons aimed at mapping historical trends.

Diachronic Approaches to Cultural Cognition

Adding an explicit diachronic dimension to current work on culture and cognition raises many methodological and theoretical questions. Methodologically, the main challenge facing researchers interested in within-culture historical trends is the lack of longitudinal data. Part of the problem is that cognitive psychologists, especially those working on causality, often pursue very specific theoretical questions and rarely use standardized measures or common procedures. Other fields are in a more advantageous position, having collected continuous time-series data long enough to detect trends. One widely debated example comes from research on general intelligence (Teasdale and Owen, 2005; Flynn, 2007), where scientists have detected a stable increase during the last century (Flynn, 1984, 1987). Similarly, social psychologists working in the U.S. have detected increases in self-esteem (Twenge and Campbell, 2001) and decreases in conformity (Perrin and Spencer, 1981; Bond and Smith, 1996), need for social approval (Twenge and Im, 2007) and trust (Putnam, 1995; Robinson and Jackson, 2001) over the last half century. Over the same relatively short period, clinical psychologists have observed reliable increases in depression and other psychopathologies (Twenge et al., 2010) and decreased empathy and perspective taking (Konrath et al., 2011). In short, data from standardized intelligence tests, personality measures, and laboratory experiments suggest that Americans are changing on some major psychological variables.

Unfortunately, comparable data is not readily available to investigate similar shifts in cognitive dimensions. Longitudinal designs are rare among cognitive psychologists, but there are some documented cases of within-culture cognitive change. For example, in 1969/70 Patricia Greenfield brought a complex weaving task to Maya children and young adults in Mexico. Twenty years later she revisited the community and ran the same task with the same age groups (Greenfield et al., 2003). As compared to the earlier sample, the new participants demonstrated more abstract thinking and greater propensity for novelty.

Another example comes from work on cognitive models of the environment and folkbiological reasoning with several cultural groups in the Peten rainforest in Guatemala (Medin and Atran, 2004). In the 1990s, the indigenous Itza' Maya dwellers demonstrated elaborate knowledge of plant-animal interactions within a belief system oriented toward ecological centrality (Atran et al., 1999). In a second round of data collection about a decade later, researchers found that the younger generation of Itza' Maya had less folkbiological expertise than their parents, and that Itza' Maya values had shifted away from ecological centrality and toward monetary incentives (Le Guen et al., 2013).

Such examples of research documenting cognitive changes within a culture are rare, because there is no systematic longitudinal data for the vast majority of cognitive tasks (Greenfield et al., 2003, p. 456). Moreover, both aforementioned studies covered relatively short time periods where cognitive changes were attributed to abrupt socio-economic shifts within

local communities. Exploring other, more gradual, forms of cultural change may require data from longer time periods to detect reliable cohort differences. Unfortunately, identical cognitive tasks are rarely used across studies, and when they are, the two measurements are rarely distant enough in time for longitudinal analysis.

Given this dearth of data, it becomes important to consider alternative approaches. Are there methods that can yield proxy measures of psychological variables when direct measurements are not available? The answer to such a question is limited only by the creativity of the researchers. One approach is to analyze ethnographic reports from different time periods and to draw inferences about a particular cultural group based on the descriptions. In one such analysis, Widlok (2014) scrutinized ethnographic accounts to provide evidence for cultural systems of causal cognition observed across many decades. Another promising method comes from analysis of cultural products, such as magazines, advertisements, websites and news coverage (see Morling and Lamoreaux, 2008). For more distant periods where ethnographic description is unavailable, a researcher might analyze extant artifacts such as tools, for example, and offer some hypotheses about how previous humans represented causality and reasoned about agency, goals and cause-effect relation (Haidle, 2014; see also Alberti and Bray, 2009).

More recently, automatic text analysis has extended classical anthropological and archeological methods to infer psychological variables. Various methods of automated text analysis are now in use by psychologists (Iliev et al., 2015). In dictionary-based methods, which are the most straightforward to apply, researchers assemble a set of words related to a particular variable of interest. For example, positive affect in a text might be measured by constructing a dictionary of terms such as "happiness," "joy," "cheerful," "optimism," etc. The relative frequency of target words across texts can then be used to test hypotheses about positive affect associated with different texts across time, for instance. While researchers can assemble their own dictionaries, many social scientists have begun using a dedicated software application called LIWC (Pennebaker et al., 2001), which consists of multiple categories oriented around general topics such as social processes, affect, cognition, perception, and grammatical features of language.

Automated text analysis can be particularly useful for detecting historical trends in large corpora. One compelling demonstration comes from a study by Wolff et al. (1999), who were interested in probing why contemporary U.S. college students do poorly in folk-biological tasks. The authors assessed the temporal dynamics of folk-biological knowledge encoded in common English using a digitized historical dictionary of the English language. The key finding was that cultural conceptual knowledge about trees evolved from the 16th to 19th century, but sharply declined during the 20th century. This analysis was

limited to dictionary entries, but researchers can now explore a wider range of texts with the time-stamped ngram corpora from Google (Michel et al., 2011), making historical comparisons easier to implement and more precise in detecting year-to-year changes. The ngram database is featured in Greenfield's (2013) study of cultural change in American and British values during the last two centuries, where she found a stable decline of words related to duties, obligations and belonging, accompanied by increases in words related to individualism, choice, and materialistic values.

Applying automated text analysis to study historical trends in causal cognitive processes may be more challenging than studying changes in knowledge content or social values, which seem more amenable to direct analysis via word frequencies. Still, some applications might be straightforward. For example, LIWC offers a causality-focused dictionary that could be used to measure cultural shifts in the frequency of causal language. Cognitive psychologists interested in historical trends can also develop specialized dictionaries guided by particular cognitive theories. Such an approach was used by Dehghani et al. (2013) to compare cultural epistemologies in Native American and majority-culture American children's books. This strategy is particularly useful when the objective is to distinguish between multiple cultural views on causality, rather than studying causal thinking as a unitary construct.

Conclusion

The field of cultural cognition traces its foundations to scholars who treated culture and history as complementary constructs (Vygotsky, 1978). Yet most subsequent empirical work in the field has been focused on cross-cultural comparisons alone, rather than diachronic analysis within cultures. Accounting for historical trends in cultural cognition will not only demand new methodological developments, but will also press us to apply a more dynamic concept of culture (see Brumann, 1999; ojalehto and Medin, 2015). Theoretically, researchers are challenged to consider whether "culture" is as much a temporally as it is a spatially (and politically, economically, linguistically) bounded construct. Treating culture as a dynamic system of social, ecological, economic, institutional and psychological factors will complicate our task, but it will also bring new insights and deeper understanding of the complex interaction between culture and cognition.

Acknowledgments

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Building a bridge—an archeologist's perspective on the evolution of causal cognition

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The cognitive capacities of fossil humans cannot be studied directly. Taking the evolution of causal cognition as an example this article demonstrates the use of bridging arguments from archeological finds as starting point via identification/classification, behavioral reconstructions, and cognitive interpretations to psychological models. Generally, tool use is linked to some causal understanding/agent construal as the tool broadens the subject's specific capabilities by adding new characters to its action sphere. In human evolution, the distance between the primarily perceived problem and the solution satisfying this need increased markedly: from simple causal relations to effective chaining in secondary/modular tool use, and further to the use of composite tools, complementary tool sets and notional tools. This article describes the evolution of human tool behavior from the perspective of problem-solution-distance and discusses the implications for a linked development of causal cognition.

Keywords: causal cognition, evolution, tool behavior, problem-solution distance, cognigram, effective chain, cultural performance

There are no data available about past human cognition. But if you want to learn something about the causal cognition of past human populations and its evolution you can look for past behavioral evidence. However, there are no direct data available about past human behavior. If you want to learn something about what people did, which knowledge and skills they had and which decisions they made, you should examine the material remains of the past behavior. This is what archeologists are dealing with. The archeological record represents materialized aspects of behavior. However, also within its limits this narrow record is not comprehensive. It is restricted by processes of embedding in the soil, by preservation over thousands or even millions of years, by discovery and the recognition of the significance, by the way of documentation of the find itself and of its context. If everything went well, you still look only at a piece of stone or wood with traces of manipulation in association with other such objects. The object does not speak for itself. Archeologists try to give the artifacts voices through interpretations, which depend on the incorporated knowledge about similar finds, analogies and/or differential diagnoses and their context, but also on current scientific paradigms and on individual experiences and world views. Sometimes the interpretations can or could be falsified, but as long as adequate evidence is lacking the quality of an interpretation relies on the simplicity of the argument and its plausibility in scientific standards. This is a possible starting point from which to explore the evolution of causal cognition. What archeologists can contribute in detail to bridge the gap between material remains of past human behavior and insights in the cognitive background will be discussed in the following explanation.

BUILDING A BRIDGE—STRUCTURAL DESIGN

As explained above, the archeological record does not provide direct insight into the behavior of past hominins, just as artifacts do not give direct evidence on the (causal) cognition underlying the material behavior. Archeological assessments of prehistoric cognition must rest on a series of bridging arguments (Wynn, 2009; Botha, 2010; Wadley, 2013) (**Figure 1**). For example, a fragmented piece of stone with traces of modification (data A) represents the starting point, the "safe bank." This object can be identified as part of a composite spear (interpretation C) using artifact attributes such as metric dimensions, weight, and functional interpretations based on the manageability for different purposes, traces of possible use and recent analogies (bridging arguments B). Assuming that the bridge (A–B–C) is correct, we can infer the activities needed to produce such a composite spear the stone point was a part of, how the activities were organized and what artisans had to know, conceive and do, to accomplish their goals (interpretation E). This interpretation is developed with the help of technological evidence, experiments and, again, ethnographic analogies (bridging arguments D). Assuming that the bridges (A–B–C–D–E) are correct, a third group of bridging arguments (F) about the cognitive systems underpinning the activity can then lead to cognitive interpretations (G). These are linked by further bridging arguments (H) to psychological models

FIGURE 1 | Bridging arguments: from archeological data to psychological models.
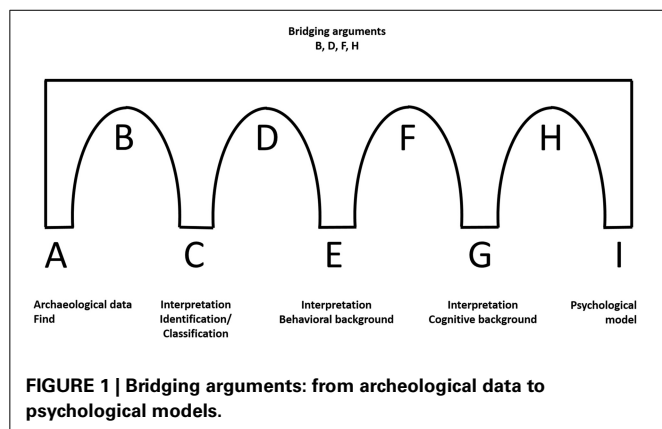
(I). Tools don't speak for themselves, but have to be interpreted with theories of behavior. The resulting interpretations are pillars from which, with the help of explicit theories of cognition, the platform of probable cognitive requirements of the past behavior can be reached (Garofoli and Haidle, 2014).

BUILDING THE BRIDGE—RAW MATERIAL

The data on which the bridging arguments concerning the evolution of causal cognition rest are tools manufactured and used by animals today as well as by past and recent hominins. Tools are defined here "as freely movable objects that are used in a controlled manner with hands, feet, beaks, mouths, trunks, and tails as an extension of these in order to change the form, position, or condition of another object, organism, or the user himself" (Haidle, 2012, pp. 147–148). Because of their extra-corporal and as such, object status and general materiality tools represent a perfect raw material through which to explore past human behavior. They are materialized products of behavior, have been documented in numerous animal species, mainly in birds and mammals and especially in primates (Beck, 1980), and form the majority of the archeological record.

But tools are also behavioral media; they are deployed in situations in which the subject's capabilities are insufficient or inadequate to cause an effect–that is to change the status (form, position, condition) of the subject itself or another object. The subject operates the tool as causal *agens* with the implicit intention that it causes an effect. Although it is the subject that initiates and controls the action of the tool, it is the tool and its specific qualities that produce a change in form, position, or condition of the target; therefore, and in this context, the tool is regarded as an agent with active potential. A chimpanzee opens a nut with a hammerstone (Boesch and Boesch, 1984): the animal handles an *agens* that she selected from the environment and that possesses qualities making it more capable than herself to solve her problem. A New Caledonian crow uses a modified twig to extract insects from holes in dead wood (Hunt, 1996): the *agens*–chosen, modified and manipulated by the animal–has a specific effect on the desired object; it causes a change of status of the prey. Tool behavior deals with this form of agents/*agens* and effects, and thus it is a perfect starting point to examine the unfolding of causality-based behavior in human evolution in comparison to the faculties of recent animals.

Additionally, tool behavior allows the search for a cognitive background (cf. McCormack et al., 2011). There are few examples of tool use in animal behavior which are probably triggered mainly or exclusively by instincts such as the use of a hammering device by wasps of the genus *Ammophila* and *Sphex* to close their breeding cavern, or ant lions throwing sand to let prey slide into a sand pit (Beck, 1980). Most cases of tool behavior seem to be more or less selective and flexible (cf. Seed and Byrne, 2010). Although often an inborn tendency to manipulate objects can be observed in tool-using species, the specific tool behaviors are acquired in an individual or social learning process not only in how a tool is applied, but also why this item serves as a tool to solve a problem better than another item. Causal reasoning as the ability to identify the relationship between causes (in tool behavior: tools as agents/*agens*) and effects (the change of the status of an object on which the tool is applied) is fundamental to conceptualize tool use. Goswami and Brown state that: "··· the conceptual structure may be heavily dependent on causal relations, with natural concepts always needing to be embedded in causal theories to have real meaning or inductive power" (Goswami and Brown, 1989, p. 70; see also Keil, 2006). To obtain the meaning as hammer a stone needs to be embedded in causal theories about hard and heavy items and their potential effect to open nuts. If the hammer stone solution is not only used in one specific problem-solution setting, but also transferred to other problems than nut-cracking, even a broader causal theory (and analogical reasoning) is necessary. And the causal theory has to be extended further in the chaining of several tools and their effects as it is typical for human tool behavior. *Homo heidelbergensis* produced and applied different stone tools to shape a wooden thrusting spear to hunt for horses: 300,000 years ago humans made heavy-duty tools and sharp flake tools and used them to fell small trees; remove the bark, branches and twigs; optimize the form (possibly also with the help of fire and water); and smooth the surface in a process probably lasting several days (Thieme, 1997; Haidle, 2010). The process of transforming a small tree into a hunting gear with the help of different tools depends on causal understanding–that is the development of a functional theory about physical properties of raw materials and tools and the mechanisms that change the status of the target. Besides applying different agents/*agens* in a chain of effects in order to receive a dietary income, the human being had to control the impulses, inhibit spontaneous reactions, learn individually as well as in social and historical contexts, and plan the activities to gain a delayed profit. The manufacture and use of tools are determined by several cognitive aspects, including different levels of causal reasoning, and are commonly reproduced culturally. As such elements of behavior, tools are well suited to build the bridge to reach into the blackbox of past human cognition.

BUILDING THE BRIDGE—CONSTRUCTION WORK

Archeologists have to interpret their raw data, the archeological finds, with the help of bridging arguments (A–B–C) to proceed in further steps with the reconstruction of the activities, knowledge, and conceptions behind the manufacture and use of the tools (C–D–E). The studies of animal tool behavior begin at a different point as most of the raw data stem from direct, though often fragmented or anecdotic observations of an animal's practice

with a certain tool. Ethologists mainly start at C, and the bridge (C–D–E) has to be reconstructed only partially. To parallelize the bridges of different archeological artifacts and of animal tool behavior the data have to be made comparable. To represent the individual bridges in a contrastable way the underlying perceptions and behavior in the process of manufacture and use can be coded in cognigrams and effective chains (see e.g., Haidle, 2010, 2012; Lombard and Haidle, 2012; Hunt et al., 2013). This method is based on the problem-solution distance approach, which originates in the comparative research of Wolfgang Köhler (1926) and takes each tool behavior as an extension of a simple and direct way from need to satisfaction. While a hungry sheep has only to bend the neck to feed on grass, a chimpanzee with appetite for termites has to find or produce an appropriate probe to extract the insects from their mount to appease her hunger. The use of a tool incorporates a moment of inhibition of the impulse to satisfy a need as quickly as possible; the distance between a problem and its solution is increased.

The extension of the perception of a need and the following actions can be systematically coded and illustrated in cognigrams (**Figure 2**). Starting with the subject's perception of a basic need, a line of subsequent problems is perceived, opening new attention foci, which are acted upon to satisfy the basic need. The attention foci can be classified as active if they are actively controlled by the subject and act upon other foci. They can encompass the subject itself or the tools. In contrast, passive foci are objects that are acted upon or locations. Returning to the examples of the sheep and the chimpanzee the method becomes clear. The sheep (subject) feels hungry (basic need, first attention focus) and wants to eat some grass (second attention focus), bends the neck (action 1) to rip off the grass (action 2) to feed on (action 3) to become full (satisfaction of need) (**Figure 3**). While the grazing-sheep example describes a basic problem-solution distance with the subject as the only agent, the grass as the object and bending the neck and grazing as necessary actions, tool behavior always represents an extension of the problem-solution distance with at least one more active attention focus (the tool) with a certain effect. If the chimpanzee (subject) feels hungry (basic need, first attention focus) and wants to feed on termites (second attention focus), the animal looks for an adequate location (third attention focus), perceives the additional need of a probe (fourth attention focus), which has to be searched for (action 1), obtained (action 2), and transported to the termite mount (action 3), to insert it into holes of the mount (action 4) to catch the insects (action 5), which cling to the probe (effect of tool), to strip them off the tool (action 6), and to feed on (action 7) to become full (satisfaction of need) (**Figure 4**).

In cognigrams, the different elements of a behavior are broken down by active and passive attention foci (subject, tools, objects, locations), by perceptions of need opening the attention foci, by actions within or directed to an attention focus, by effects of attention foci on other attention foci, and by phases–clusters of actions that have to be executed as a group or, if interrupted, started again with the first action of the phase. A crucial point for the comparison of behaviors is an equivalent starting point (basic need) and the tracking of all elements including actual

Perception of a need or a problem
Here the subject opens a new / additional focus of attention

Operational step / activity
Indirectly evident in the inventory , partially identifiable by refitting or characteristic debitage / waste products

Tool (here, e.g., H for hammer stone)

Direction of course of the process

Direction of course of additional problem perception, besides primary chain of activities

Element of composition
Adding formerly independent foci to become one composite focus

Element of technological symbiosis
Combining foci to become a complementary set of foci

P-Focus 2
object
nut

A-Focus 3
tool

Focus
Center of attention of a subject .
a) A-Focus: Active foci can encompass the subject itself, or a tool that acts on an object.
b) P-Focus: a passive focus can be a location, or an object which is acted on.
c) N-Focus: a notional focus.

Effect of a focus (here A-Focus 3 – tool) on another focus
Active foci (the subject as well as tools) are able to have an effect on other foci (active or passive) and influence or change their qualities.

Phase of activities
Integration of single activities which are tightly connected and possess a common intermediate aim.

FIGURE 2 | Graphic elements of a cognigram.

or probable interruptions until the final satisfaction of the basic need. The cracking of nuts with a hammerstone by chimpanzees is not directly comparable with the production of a simple stone tool with a hammerstone by a hominin, because the manufacture of the stone tool is only part of a process to fulfill a basic need, which can be the satisfaction of hunger or defense, for example (cf. Haidle, 2010). If tool behavior includes several tools with different effects to fulfill a need, the cognigrams can be simplified to effective chains that represent only the attention foci of the behavior and the effects they have on each other (**Figure 5**) (Lombard and Haidle, 2012). Cognigrams and effective chains, however, are only as good as the reconstructions of the behavior they illustrate. Cognigrams therefore consist a) of a formalized description of

the reconstruction of the behavior with the elements in chronological order of appearance and b) of a graphical representation. The bridging arguments (D) that lead to the interpretation of the behavioral background (E) shown in the cognigrams are given in a reference section explaining the background and listing the sources.

The reconstruction of the behavioral elements contributing to the overall picture of a certain problem-solution unit can be more or less detailed and can vary. Even descriptions of direct observations of a problem-solution unit can identify different details, e.g., in problem perceptions and actions, and variegate them by splitting or lumping; the more so do reconstructions based on archeological finds. The following options A, B, and C of the grazing-sheep case exemplify how different the descriptions can be even in such a simple instance.
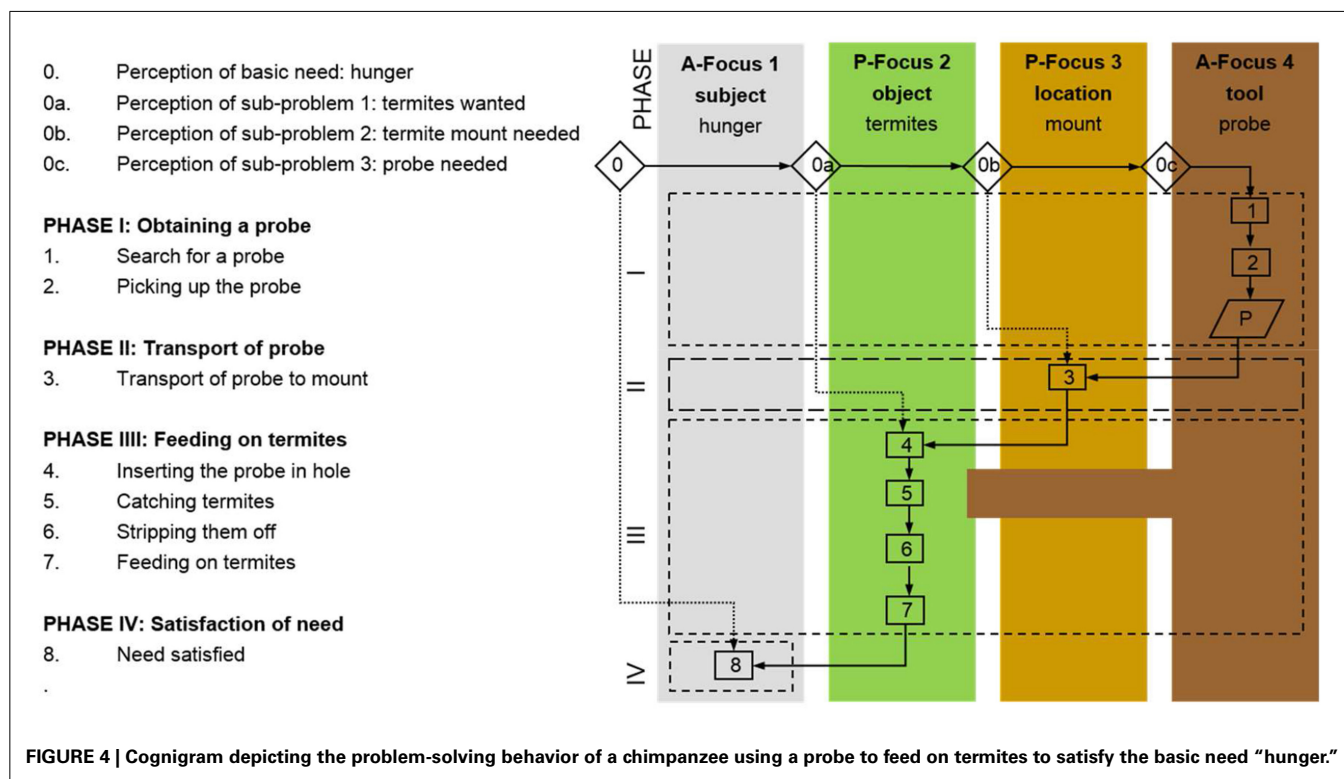
Option A

1. First attention focus, basic need: the sheep (subject) feels hungry
2. Second attention focus: the sheep identifies edible plants (object)
3. Action 1: the sheep bends the neck···
4. Action 2: rips off the plants···
5. Action 3: feeds on them ···
6. Action 4: and becomes full (satisfaction of need).
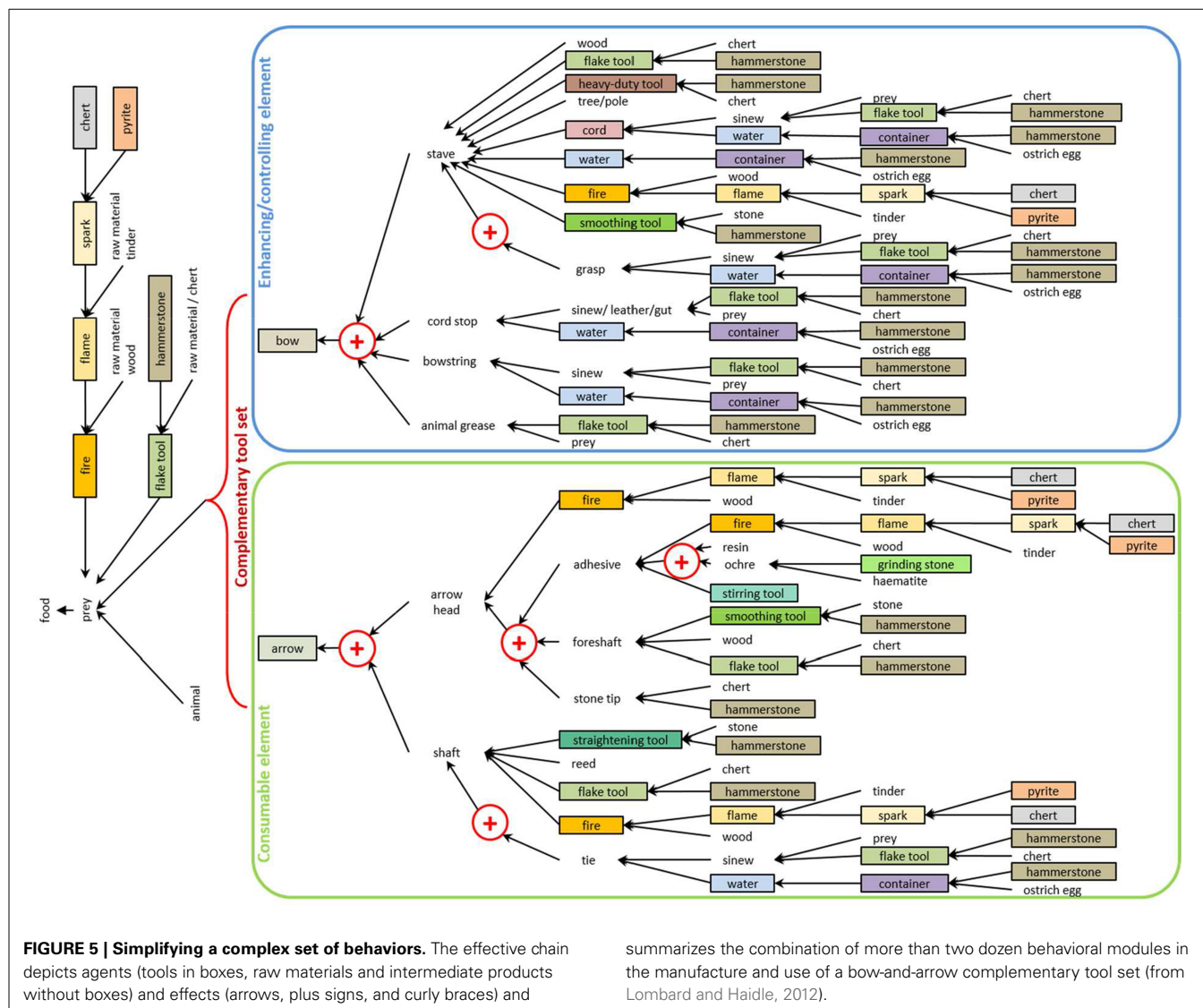
Option B (shortened version)

1. First attention focus, basic need: the sheep (subject) feels hungry
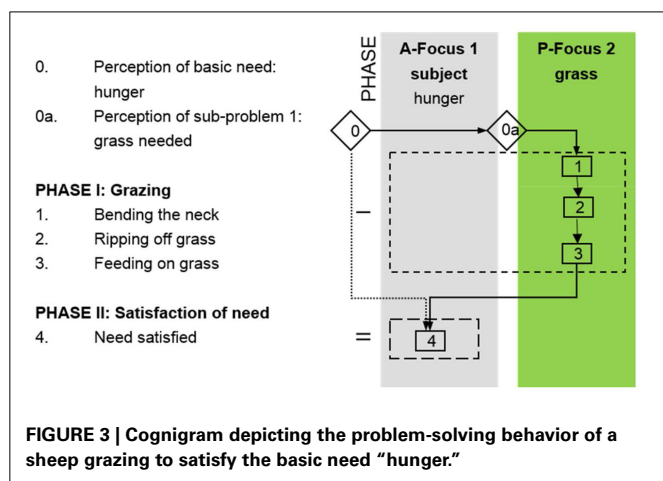
FIGURE 3 | Cognigram depicting the problem-solving behavior of a sheep grazing to satisfy the basic need "hunger."

FIGURE 4 | Cognigram depicting the problem-solving behavior of a chimpanzee using a probe to feed on termites to satisfy the basic need "hunger."

FIGURE 5 | Simplifying a complex set of behaviors. The effective chain depicts agents (tools in boxes, raw materials and intermediate products without boxes) and effects (arrows, plus signs, and curly braces) and summarizes the combination of more than two dozen behavioral modules in the manufacture and use of a bow-and-arrow complementary tool set (from Lombard and Haidle, 2012).

2. Second attention focus: the sheep identifies edible plants (object)
3. Action 1: feeds on them ···
4. Action 2: and becomes full (satisfaction of need).

Option C (extended version)

1. First attention focus, basic need: the sheep (subject)
   Subfocus A (referring to subject): notices that the stomach feels strange/hurts
   Subfocus B (referring to subject): "realizes" that it is hungry
   Subfocus C (referring to subject): "knows" that it needs to eat something
2. Second attention focus: the sheep identifies edible plants (object)
3. Action 1: bends the neck close to the grass ···
4. Action 2: opens the mouth ···
5. Action 3: rips off the grass ···

6. Action 4: chews the grass ···
7. Action 5: tastes whether it is good or not ···
8. Action 6: swallows the grass ···
9. Action 7: and becomes full.
10. Re-opening of first attention focus, satisfaction of need: the sheep (subject)
    Subfocus A (referring to subject): notices that the stomach feels better
    Subfocus B (referring to subject): "realizes" that the hunger is gone
    Subfocus C (referring to subject): "knows" that it can stop feeding

Although the grazing-sheep case shows at first sight impressive differences in depiction, the lumping and splitting of subfoci/main foci and of operational steps/actions do not really change the overall picture of main active and passive foci and their effects on one another. If, however, new elements are added or old ones are completely omitted (instead of being separated from or
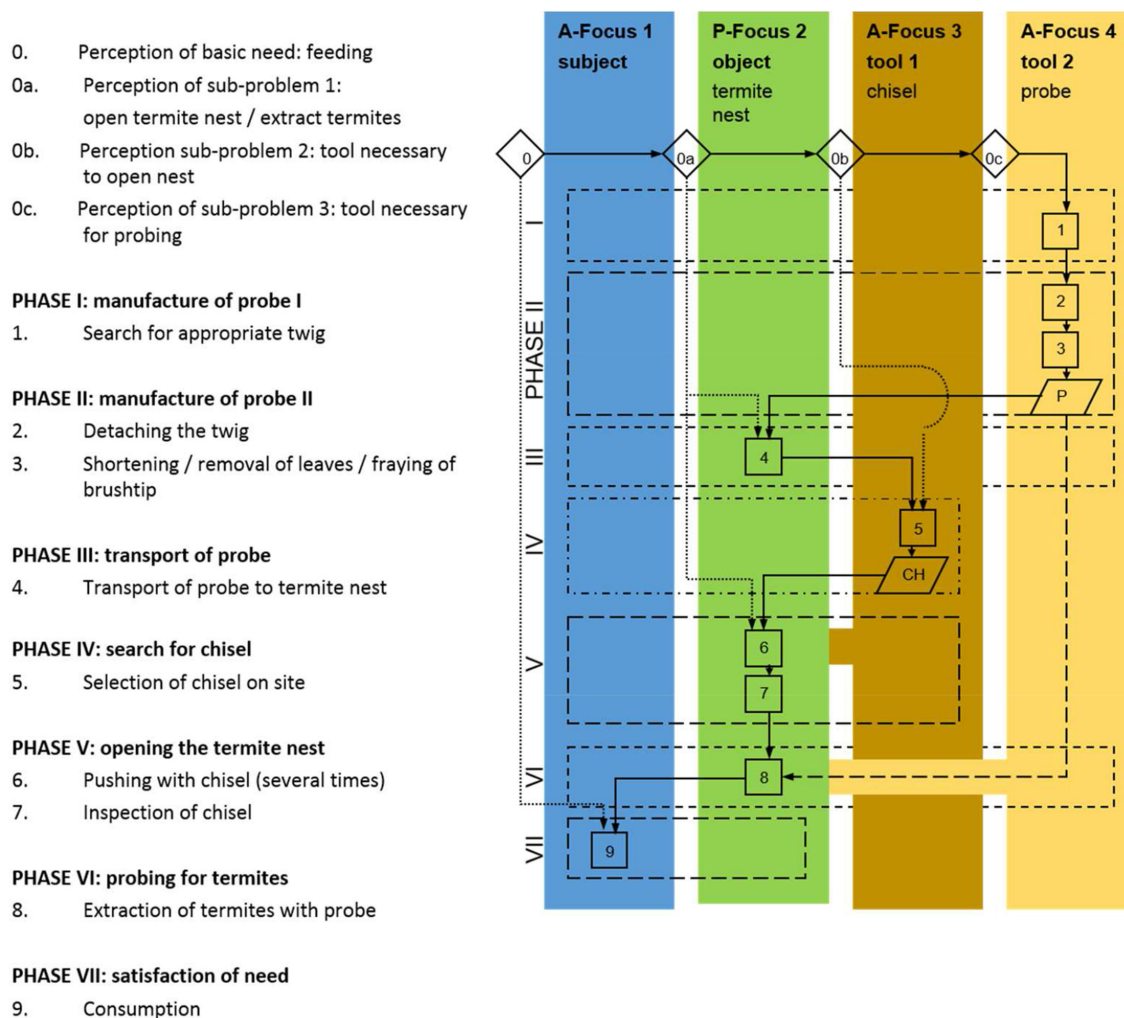
FIGURE 6 | Cognigram of a chimpanzee using a tool set of chisel and probe to extract termites (after Sanz et al., 2004**).**

integrated in more comprehensive steps), then real variants of a problem-solution unit are documented. Commonly, the reconstructions of prehistoric behavior (E) and the cognigrams as their graphic representations depict idealized behavioral processes derived from a multitude of slightly different possibilities. To give a current example: several observations of brewing coffee with hot water and a simple paper filter lead to a generalized description of the behavioral process; the planning differences about the facility used to boil water, whether coffee beans are first ground in a mill or ready-made powder is used, and the amount of coffee powder taken are not discussed in detail. It depends on the aim of the analysis if this idealized description is sufficient. The idealized depiction is sufficient, if you want to compare traditional German coffee making with simple paper filter with an Ethiopian coffee ceremony or with the use of a coffee dispenser. It is not sufficient, if you want to study variability in the behavior of an individual, small differences within or between groups, or changes in family traditions of the same behavior "brewing coffee with a simple paper filter." For the identification of major leaps

in behavioral concepts in human evolution major changes in the reconstructed behavioral processes have to be identified. The fundamental reconstructions (E) have to be evaluated regarding the preceding argumentative bridge (A–B–C–D).

The possibility of equifinality, the fact that a problem may be solved by different means, that a tool may be manufactured and applied in different ways, raises the question of how convincing the reconstructions (E) and their graphic representations in cognigrams are. To avoid the possibility of equifinalities, or to discuss the alternative ways of problem-solution in-depth, the underlying argumentative bridge (D) has to be given special consideration. Therefore, technological evidence on the artifact such as traces of manufacture and use wear, together with data obtained from experiments or ethnographic analogies have to be thoroughly described. And it has to be discussed (a) to what extend especially simpler alternatives of behavioral processes could produce similar results, (b) if elements, on which an identification of a leap is based, are really necessary, and (c) if the contextual evidence points to the possible or probable parallel application of different
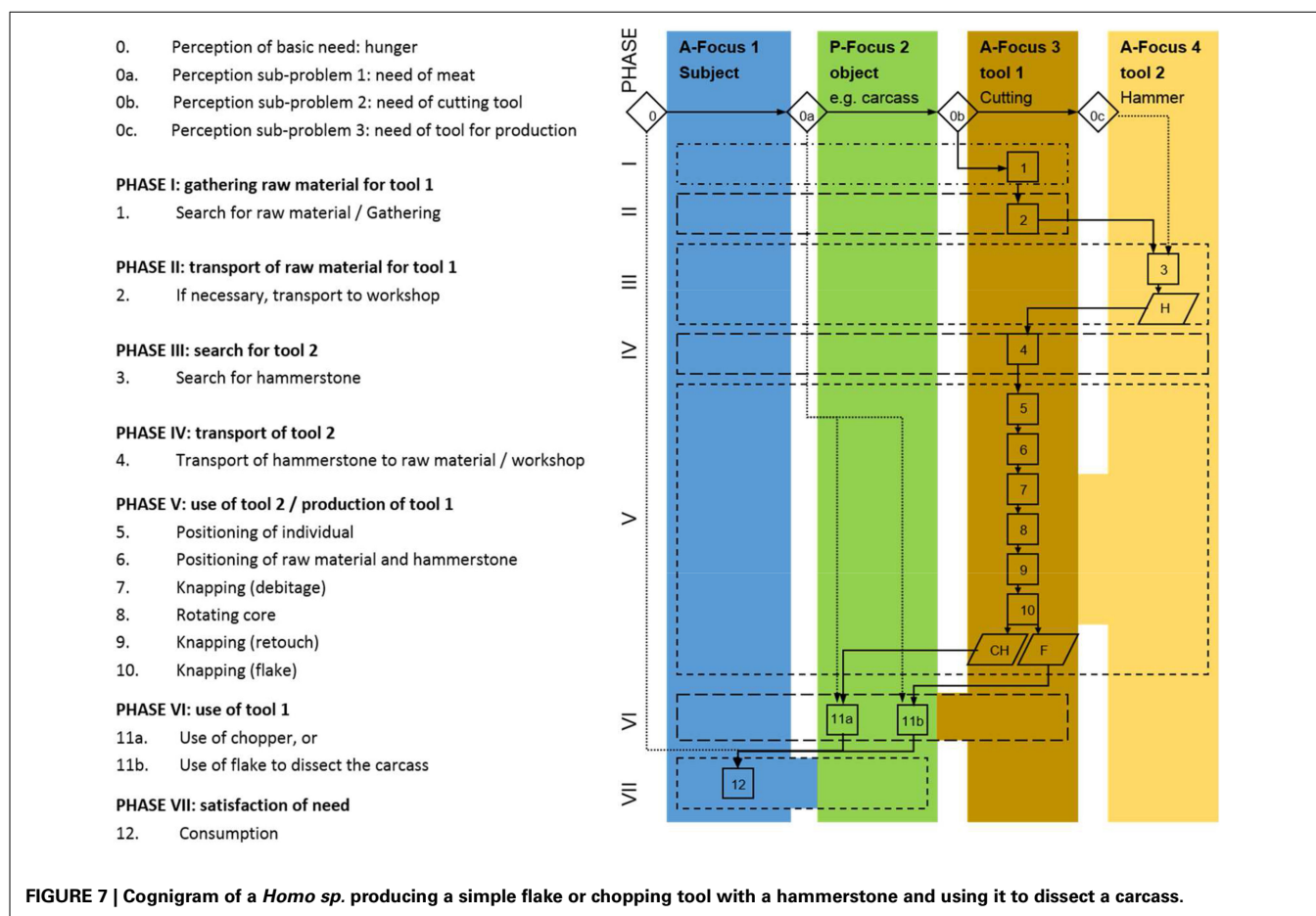
FIGURE 7 | Cognigram of a *Homo sp.* producing a simple flake or chopping tool with a hammerstone and using it to dissect a carcass.

The legend text within the figure reads:

0. Perception of basic need: hunger
0a. Perception sub-problem 1: need of meat
0b. Perception sub-problem 2: need of cutting tool
0c. Perception sub-problem 3: need of tool for production

PHASE I: gathering raw material for tool 1
1. Search for raw material / Gathering

PHASE II: transport of raw material for tool 1
2. If necessary, transport to workshop

PHASE III: search for tool 2
3. Search for hammerstone

PHASE IV: transport of tool 2
4. Transport of hammerstone to raw material / workshop

PHASE V: use of tool 2 / production of tool 1
5. Positioning of individual
6. Positioning of raw material and hammerstone
7. Knapping (debitage)
8. Rotating core
9. Knapping (retouch)
10. Knapping (flake)

PHASE VI: use of tool 1
11a. Use of chopper, or
11b. Use of flake to dissect the carcass

PHASE VII: satisfaction of need
12. Consumption

ways of solving a problem. Nevertheless, even the most thorough reconstruction process only remains valid until it is replaced by a simpler explanation or a hypothesis that comprises more evidence. Equifinality is a problem immanent to all reconstruction processes; and sometimes no decision for one or the other way of reconstruction can be taken. Cognigrams, however, help to facilitate the discussion about the alternatives in clearly showing the differences of the reconstructed processes.

BUILDING THE BRIDGE—JOB SITE

With the help of cognigrams and effective chains with which the bridging (C–D–E) is formalized and illustrated, numerous small bridges from single artifacts or tool types (A) to the interpretation (E) can be constructed and set parallel to each other to form a more load-bearing bridge. If these bridges are set in a chronological order, it creates a historical perspective and the course of development becomes visible. This procedure indeed makes it possible to document the expansion of the causal structure of agents/*agens* and effects that accompany the development of tool behavior in human evolution.

SIMPLE TOOL BEHAVIOR

Simple tool use comprises the application of one or several tools on one object. The tools can be unmodified or modified with the help of the subject's own facilities (**Figure 4**; for the variety of simple tool use in animals and the representation

of these behaviors in cognigrams see Haidle, 2012). Basis of a selective and flexible tool behavior (cf. Seed and Byrne, 2010) are (a) the inhibition of impulses, (b) a certain perception of an agent-effect or means-end relation that is applied in a tool-on-object behavior (for the discussion of the possible range of perception see below), and (c) a goal-directed manipulation of the chosen tool. Capuchin monkeys, for example, select hammerstones to open nuts according functional features like friability and weight (Visalberghi et al., 2009). Chimpanzees use different tool sets (perforators and probes) to extract termites from subterranean and aboveground nests: they choose the suitable means to get the desired result (opening the different termite nests). In addition, they search for both elements of the tool sets, perforators and probes, in advance before approaching the nests (Sanz et al., 2004) (**Figure 6**).

MODULAR TOOL BEHAVIOR

An extension of the problem-solution distance beyond the application of a set of several simple tools on one target becomes evident with secondary tool use, the use of tools to produce other tools to solve a problem (Kitahara-Frisch, 1993). Not only intermediate targets in direct connection to the satisfaction of the basic need have to be perceived, but also tools have to be prepared in advance to change the status of an object to become the tool to solve the problem. Such a chaining of agent-effect relations is the foundation for the manufacture of stone tool by hominins

reaching back at least 2.6 million years (Semaw et al., 2003): a hammerstone and adequate stone nodules as raw material have to be organized in order to produce cutting tools to process e.g., animal carcasses (**Figure 7**). So far, the chaining of different agent-effect relations has not been observed in animals in the wild. Experiments with capuchin monkeys imply that this species is able to understand the relationship between two items (tool and food object), but lacks the understanding of the relationship between three items (Fujita et al., 2003), a necessary condition of secondary tool use. Associated with the use of secondary tools is the chunking of parts of the tool behavior into independent behavioral units, which can be combined in different ways to act on and modify one another. A hammerstone can not only be perceived as a means to solve a basic problem like the exploitation of hard food resources, but can also be used to solve secondary problems such as manufacturing of tools. In human evolution, tool behavior becomes increasingly decoupled from basic needs. Behavioral units are not exclusively bound to specific and acute problems. Instead, the elements of behavioral units (stimulus, concept of solution, goal) are increasingly abstracted from specific purposes and become applicable in different contexts: a modular capacity arises. The execution of modular cultural capacities can occur on various technological levels based on differing knowledge and skills: knapping stone tools with different techniques only takes a few minutes, yet requires the same modular cultural capacity as does the manufacture of a simple wooden spear which is likely to span several days (Haidle, 2010) (**Figure 8**).

COMPOSITE TOOL BEHAVIOR

New qualities in the perception of agent-effect relations are the basis of composite tools. In composite tools such as a wooden spear armed with a stone projectile, the problem-solution distance is extended to a combination of different behavioral units with specific qualities (wooden spear with good flight qualities, projectile point made from stone with good cutting properties, adhesive and binding material with good fixing potential) that are fused to form composites with new qualities (composite spear with increased penetrating power). While tools made out of many pieces of the same kind, such as a piles of boxes to be used as a ladder as documented for chimpanzees (cf. Köhler, 1926) or sophisticated baskets made by humans, only escalate the properties of the basic element, composite tools demonstrate a new combination of different qualities. The different elements of a composite tool "may be obtained at different times and in different places" (Ambrose, 2010, S139) while the new functional unit may be assembled much later (Ambrose, 2010). Within the archeological record, hafted tools and compound adhesives (Wadley, 2005; Wadley et al., 2009) are typical material examples of such composites (**Figure 9**). Early evidence of composite capacity reaches back at least 200,000 years with finds of stone tools with wear traces of wooden hafts in Africa (Rots and Van Peer, 2006) and stone tools from Neanderthal contexts in Italy fixed with birch tar to now decomposed handles (Mazza et al., 2006).
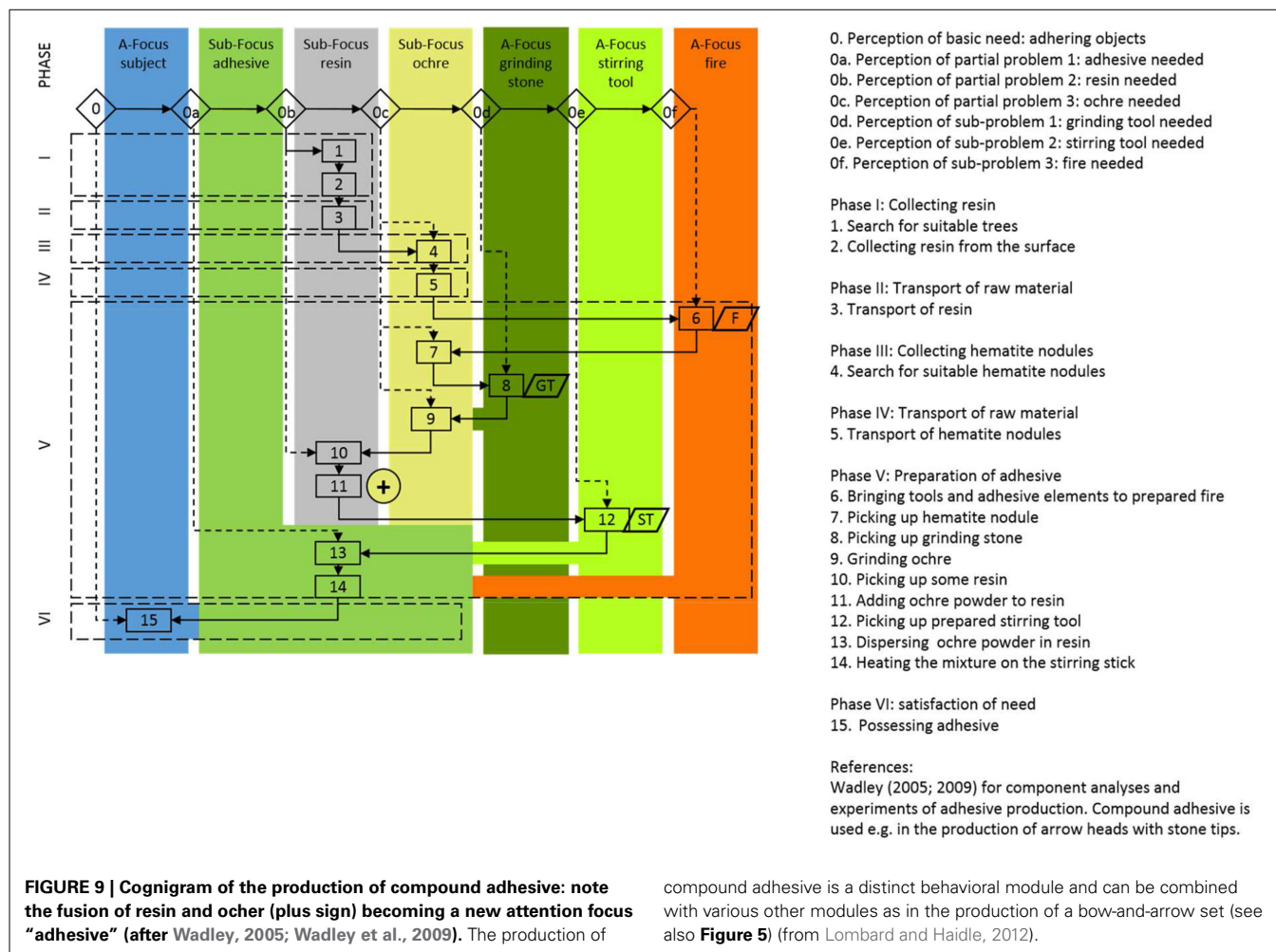
COMPLEMENTARY TOOL BEHAVIOR

While the subject generally operates composite tools, complementary tool sets apply a new aspect of problem-solving with

FIGURE 8 | A sophisticated example of modular tool behavior: a 300,000-year-old wooden spear from Schöningen (Photo: P. Pfarr, Niedersächsisches Landesamt für Denkmalpflege, Wikimedia Commons).

a tool controlling or enhancing another tool which provides the actually desired effect. Bow-and-arrow, needle-and-thread, screw-and-screwdriver, key-and-lock are only some examples of the symbiotic relationship of two discrete, but concerted elements working together to fulfill a common task (Lombard and Haidle, 2012) (**Figure 10**). **Figure 11** shows the cognigram of the application of bow-and-arrow for hunting: note here the curly brace on the effect of the bow-and-arrow set on the prey, indicating technological symbiosis (for a detailed depiction of all behavioral modules necessary for bow-and-arrow manufacture see Lombard and Haidle, 2012; for an overview of foci and effects in the complete process of manufacture and use of a bow-and-arrow see **Figure 5**). The elements of a complementary tool set must be developed and used as acting entities with two or more interdependent and exchangeable parts in complementary correspondence with each other. To solve a problem with a complementary tool set two different agent-effect relations have to be taken into account, which are released by only one action of the subject: the acting individual draws the bowstring, for example, and lets it go, which propels the arrow, and the arrow consequently penetrates the prey in order to hurt or kill it. The impulse for the

FIGURE 9 | Cognigram of the production of compound adhesive: note the fusion of resin and ocher (plus sign) becoming a new attention focus "adhesive" (after Wadley, 2005; Wadley et al., 2009). The production of compound adhesive is a distinct behavioral module and can be combined with various other modules as in the production of a bow-and-arrow set (see also **Figure 5**) (from Lombard and Haidle, 2012).

goal-directed tool respectively, its effect is given by the controlling/enhancing tool of the complementary set and only indirectly by the subject. As early archeological evidence of complementary behavioral capacities, stone tips from South African sites are discussed, which were probably used as projectile points of arrows and date back to ca. 64,000 years (Lombard, 2011). Eyed needles and parts of spear-throwers are other archeological finds which give hints on the use of complementary tool sets between 30,000 and 10,000 years ago.

NOTIONAL TOOL BEHAVIOR

Finally, with notional concepts causal reasoning beyond purely physical effects of exclusively physical agents/*agens* has been introduced. As notional concepts "objects" are defined, which can be manipulated only in the mind or through imagination, but can be combined with and may have effects on physical or other notional modules. Notional concepts can be represented in (a) the signification of objects/signs (e.g., the meaning of the cross, a crescent, and the Star of David as symbols of religions), (b) systems of ideas (e.g., myths, religious beliefs, philosophical question, constitutions of states) (c) normative definitions (e.g., metric and value systems), or (d) virtual beings (e.g., angels), and characters (e.g., protecting capacities of an amulet). A notional

FIGURE 10 | A complementary tool set: sinew fibers controlled by an eyed-needle made from bone (Photo: Rudi Walter).

concept as attention focus can be combined with a physical object to form a composite with new functional qualities emerging out of the basic physical qualities and a certain meaning. For example, a certain signification derived from the European monetary
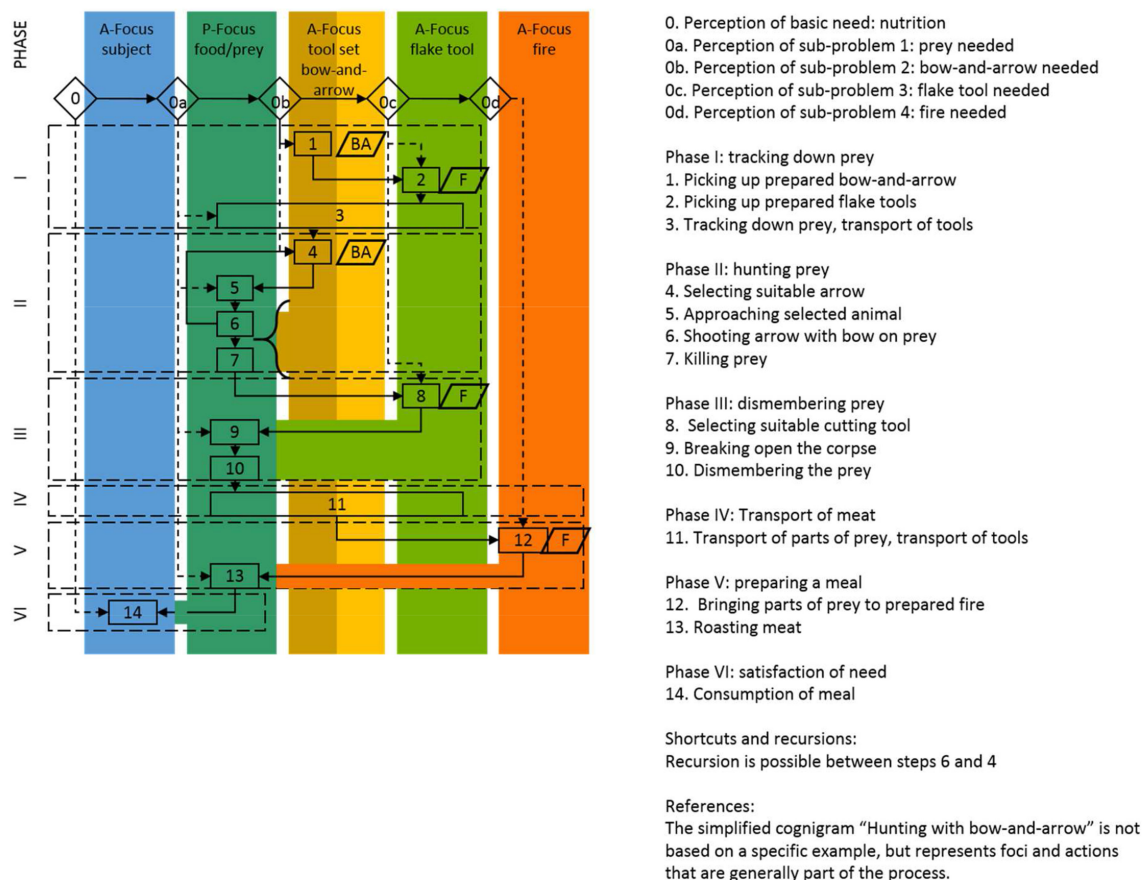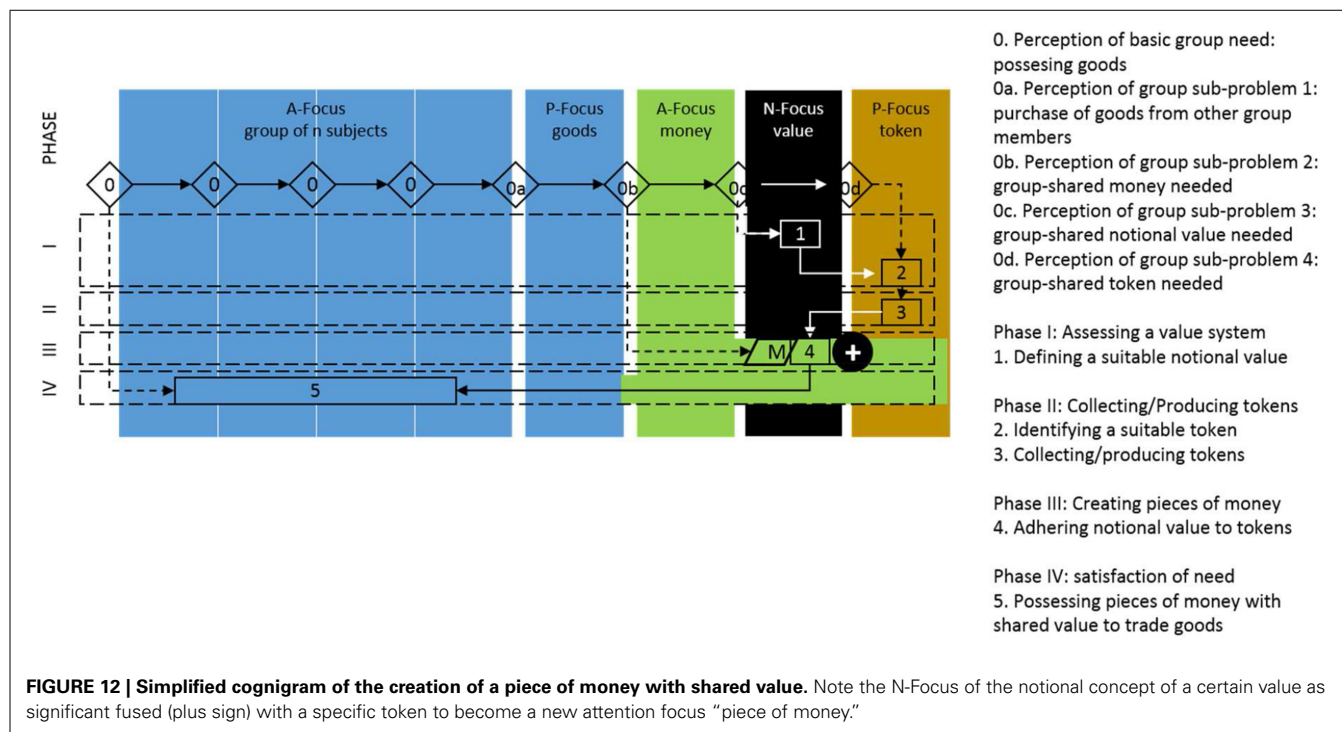
FIGURE 11 | Cognigram of hunting with a bow-and-arrow-set: note the curly brace indicating technological symbiosis (from Lombard and Haidle, 2012). The hunting process may, of course, be an independent module separate from transport, preparation of a meal, and consumption.

system can be combined with a specific metal object as token to form a coin with the economic value of 1 €. The value, however, is neither bound to the material value of the metal object nor to a specific merchandise value. Currency can be overvalued or devalued; this manipulation is primarily non-physical, although in a secondary step it has influence on the physical world indeed (**Figure 12**). However, there are also notional concepts, which are not linked to physical objects such as significations linked to an object to form a sign/symbol, but are independent operational foci as the ideas of "justice," "reincarnation," or the "devil." Of course, the idea of "justice" is triggered by human experiences in the real world, but it is an abstract notion that can be discussed in philosophical disputes without referring to physical manifestations. Due to their nature, the detection of notional concepts or mental representations within the archeological record is difficult. If not explicitly described in written historical sources, notional concepts can only be vaguely traced from the context or tools with which they have formed composites or complementary sets. The best material expressions of notional behavioral capacities are unambiguous information carriers associated with the notional component like notations detailed and numerous enough to identify the underlying system, as for example alphabetical letters, Roman or Arabic numerical

signs, or Incan quipus, a recording system using knots in sets of strings. In these cases, the depicted signs such as the letter X or the numeral 4 are physical components of a composite tool, which receives its individual qualities in combination with a mental notion. Early evidence of notional concepts are artistic representations of probably metaphysical beings such as the ca. 32,000-year-old lion-man from the Hohlestein-Stadel cave in South Germany (**Figure 13**) (cf. Wynn et al., 2009). For other artistic artifacts such as the ivory figurines from caves of the Swabian Jura (Conard, 2009) or parietal art in France (Vialou, 1987; Clottes, 2001), be it figurative, abstract or ornamental, a notional component is often assumed, but cannot be proven (cf. Malafouris, 2007).

EXPANSION OF PROBLEM-SOLUTION DISTANCES AND OF CULTURAL CAPACITIES

The expansion of the problem-solution distance regarding agents and effects as described above is associated with an expansion of cultural capacities in human evolution. Cultural behavior is a subset of behavior in general, defined by a historical-social dimension of development additional to the biological and individual dimensions more or less active also in other forms of behavior (Haidle and Conard, 2011; Haidle et al., under review). Advanced

FIGURE 12 | Simplified cognigram of the creation of a piece of money with shared value. Note the N-Focus of the notional concept of a certain value as significant fused (plus sign) with a specific token to become a new attention focus "piece of money."

tool behavior with an extended problem-solution distance is commonly not invented individually again and again, but at least some information is passively provided or actively handed down (historical aspect) by other, though not necessarily cognate members of the group (social aspect). Regarding the limited time for learning in an individual life span, the possibility to adopt knowledge and practices from other individuals becomes more important, as the problem-solution distances in single tool behavior become more complex and more different tools are used in various spheres of life. Associated with the expansion of the problem-solution distance in human evolution, the impact of the historical-social dimension to the development of (tool) behavior increases regarding the transmission of information, but also concerning the scope of application. Artifacts with notional aspects unfold their full potential only if they are used within a group that shares that notion.

The different tool behaviors in hominins, and with it the handling of agents/*agens* and effects to satisfy individual needs, can generally be taken as different cultural performances with interrelated biological, individual and historical-social aspects of development embedded within a specific environment/resource space (Haidle and Conard, 2011; Haidle et al., under review) (**Figure 14**). The *biological dimension* refers to the biological potential and constraints for behavior given in genes, gene expressions, anatomical blueprints and physiological standards of a group of organisms and is expressed, for example, in the structure of the nervous system and the brain, in sensory perception, in motor and articulation skills, in the form of sociality, and in the principle abilities to communicate. The *individual dimension* of behavior reflects individuals' preferences, aversions, skills, and disabilities. The individual dimension incorporates the potential and constraints of an individual, or of a group of individuals,

set by individual talents or poor aptitudes, by the personal social setting and by individual life histories of physical, mental, and emotional experiences. The *historical-social dimension* represents historical and social potentials and constraints. The set of historically acquired knowledge and skills, customs, views and opinions, and the social access to it, makes up a part of the individual's environment that can be acted on, and used as a basis for further innovation. The forms and extent of storage, transmission, permutation, and transformation of the knowledge and skills, customs, views, and opinions support or hamper the unfolding of cultural performances. The three dimensions are multifactorial and interdependent with each other and the embedding environment. This specific environment comprises conspecifics and other agents/*agens* and objects. The conspecifics, agents and objects are linked to the organisms in focus by functional relations effective within a certain time depth. The analysis of the developmental aspects of a specific behavior is thus difficult, and the identification of some factors should not entail the conclusion that all factors are understood. The same is likely to be true also for the cognitive background of the behavioral performances.

BUILDING THE BRIDGE—SNAG LIST
Numerous micro-theories helped to build parallel bridges from prehistoric finds to the archeological reconstructions of the activities, knowledge, and conceptions behind the manufacture and use of the tools (A–B–C–D–E). They can be set in chronological order and viewed from a problem-solution distance perspective to get an impression of the development of the handling of agents and effects in tool behavior in the course of human evolution. The final bridge arches that connect the archeological reconstructions with their possible causal-cognitive background (E–F–G–H–I)
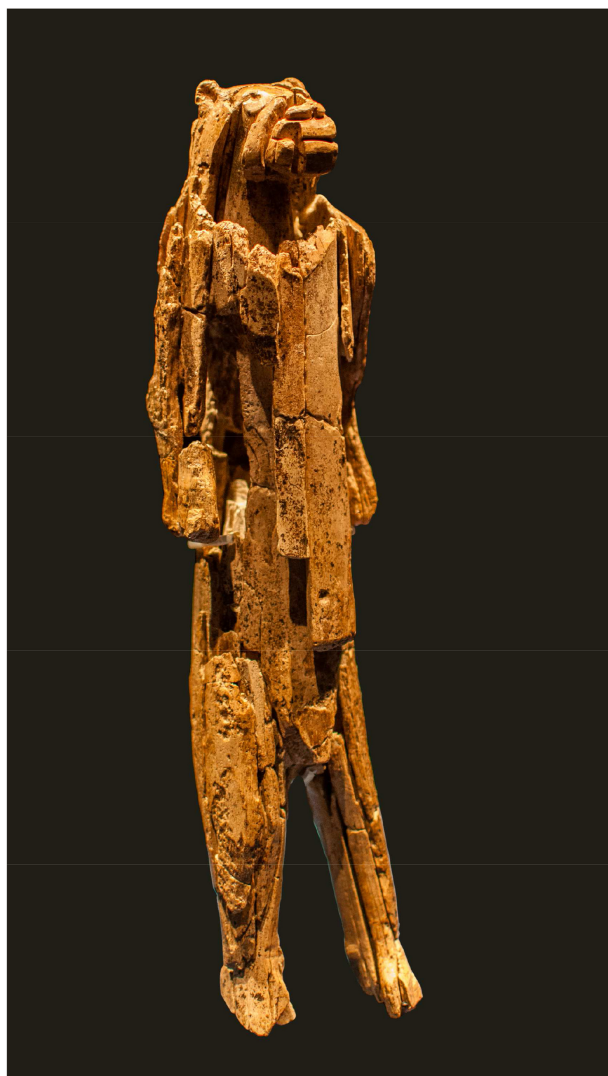
FIGURE 13 | The ivory figurine of the lion-man from Hohlenstein-Stadel, probably representing a virtual being (Photo: Dagmar Hollmann, Wikimedia Commons).

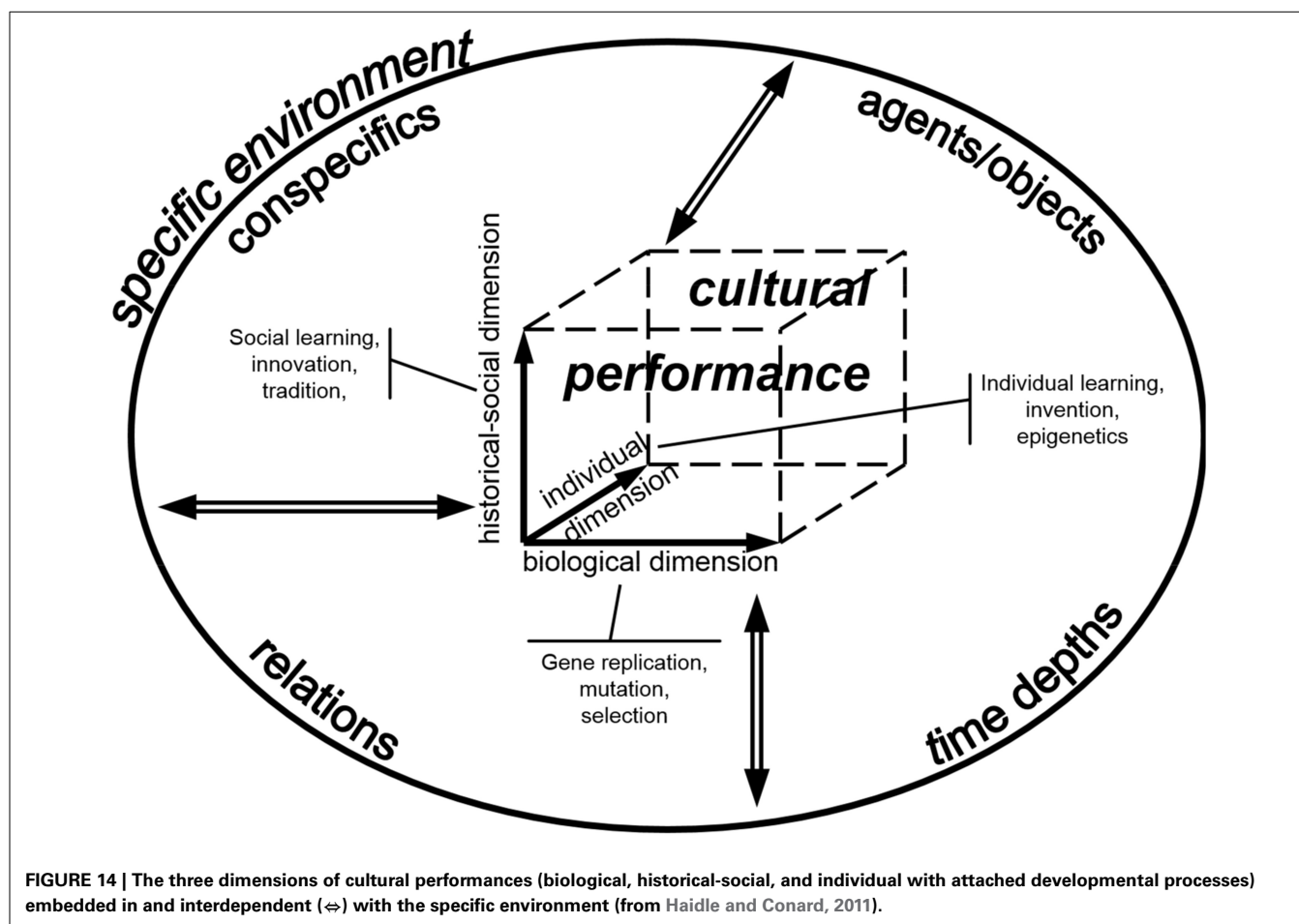are still only in the project phase. Two main factors hamper the construction progress.

- Interpretation of the reconstructions: The coding of tool behavior in cognigrams/effective chains provides a breakdown of involved agents and their summarized effects and illustrates the implicit causal structure of a certain behavior. Yet, controlled laboratory experiments with non-human primates and different species of crows show the difficulties of determining (a) which features of an agent are perceived to cause the effect, (b) the understanding of how causes produce their effects (based on which physical mechanisms), and (c) which cognitive processes are active (e.g., Limongelli et al., 1995; Bird and Emery, 2009; Emery and Clayton, 2009; Taylor et al., 2012; for an overview see Penn and Povinelli, 2007, pp. 107–111). If it is difficult to assess to which extent a capuchin

monkey or a chimpanzee understands the causal role of different features of a tool, the more this is true for the behavior/cognition of extinct hominin species. To prevent possible over-interpretation of the data, minimal explanations have to be looked for. Instead of awarding non-human primates with the capacity "to distinguish causally relevant from causally irrelevant properties of a tool and thus possess a 'functional concept of artifacts'" (Penn and Povinelli, 2007, p. 107), Penn and Povinelli, for example, present "a more modest hypothesis; i.e., non-human primates are predisposed to perceive certain clusters of features as more salient than others when selecting among potential tools without understanding anything about the underlying causal mechanisms involved" (Penn and Povinelli, 2007, p. 108).

- Cognitive theory: from an archeologist's perspective, a comprehensive and discrete psychological model about causal reasoning and its development seems to be lacking so far, and the neural mechanisms specifically supporting causal reasoning are poorly understood (cf. Penn and Povinelli, 2007; Osiurak et al., 2010; Vaesen, 2012, pp. 204–206). Although marked progress has been made in the last years in the study of neural mechanisms related to tool behavior in *Homo sapiens* such as the functional reorganization of visuotactile limb representations (Maravita and Iriki, 2004), the role and development of specific sectors of the parietal (Goldenberg and Spatt, 2009; Peeters et al., 2009; Bruner, 2010), and functionally specialized networks involving temporal, parietal and frontal areas within the left cerebral hemisphere (Johnson-Frey, 2004), "to date there are remarkably little data concerning the neural bases of processes required to understand physical causality of the sort necessary for complex tool use" (Johnson-Frey, 2003, p. 203). Thus, the final bridging (E–F–G–H–I) for causal reasoning can only be the fragile attempt of a temporary bridge until more stable construction elements are provided from the side of cognitive sciences. A good example of the potential of a successful bridging from archeological evidence to cognitive models is the Extended Working Memory hypothesis (Wynn and Coolidge, 2011).

BUILDING THE BRIDGE—SUMMARY OF THE PROJECT

Tool use, in most cases a cultural behavior, is commonly associated with aspects of causal cognition at least in the simplest form of understanding a causal structure. Furthermore, this understanding of an agent-effect relationship is not only retrospective, but also prospective in its application on new tasks. The manufacture of a tool fitting to a specific task additionally requires an identification of certain qualities of the tool to be gained by the modification in order to solve the basic problem (Hunt et al., 2006). Whether all necessary and sufficient qualities of the tool within the specific task are completely understood is not important; the modification of certain characteristics implies a basic causal reasoning. The basic cognitive faculties are not specific adaptations for tool behavior but domain-general cognitive capacities as experiments with rooks show, a bird species that does not use tools in the wild but appears to possess an understanding of tools (Bird and Emery, 2009). However, experiments with chimpanzees demonstrate special cognitive affordances of

FIGURE 14 | The three dimensions of cultural performances (biological, historical-social, and individual with attached developmental processes) embedded in and interdependent (⇔) with the specific environment (from Haidle and Conard, 2011).

tool use that may obscure causal cognitive efforts. Variations of the trap-tube problem with and without tools show that "even a simple tool-using task is likely to place a load on the attentional system, because unlike the automatic movements of the hands, manipulating a tool to bring about an effective action will require increased attention. The amount needed is likely to depend on the complexity of the task, and the degree of familiarity with the tool-using action required. Moreover, the need to split attentional focus between the end of the tool that is held by the chimpanzee, the end that contacts the food, and any relevant features of the substrate on or in which the food rests (such as a trap) may be a further challenge" (Seed et al., 2009, p. 33).

The examination of the problem-solution distance with the help of cognigrams and effective chains allow us to reconstruct the causal structures in tool behavior and provides starting points for bridging the gap to the identification of (causal) cognitive capacities underlying different forms of tool behavior. *Simple tool behavior* in general requires at least minimal forms of inhibition, allowing a shift of the focus from the desired goal to a means to reach the target. The means are not chosen completely arbitrarily, but selected for a set of (necessary and random) features providing an approach to achieve the aim. The manufacture of tools is commonly directed to improve the tool's quality to help to satisfy the need. *Modular tool behavior* based

on secondary tool use requires an understanding and application of causal chains. While 15-month-old children are able to understand causal chains (Cohen et al., 1999), capuchin monkeys e.g., understand only spatial relationships between two, but not three items (Fujita et al., 2003). It can be hypothesized that such a constraint is also active in chimpanzees, the most proficient tool users beside humans, which show the conception and use of sophisticated tool sets applied one after the other to the same target, but no chaining of a tool to produce another tool to achieve an aim which seems to be exclusive to hominins. The individual case of the bonobo Kanzi (Schick et al., 1999) who learned to produce flake tools with a hammerstone may simply show how years of training skills acquired in a historical-social setting from experienced individuals (here humans) can help to overcome cognitive limits. *Composite tool behavior* also requires the combination of different tools with different qualities. Instead of being applied in a causal sequence, however, the tools with different qualities joint in a composite tool unfold their effects together and interdependently to reach the target. In modular as well as in composite tool behavior the subject triggers the application of each tool in a sequence independently. In *complementary tool behavior*, in contrast, only the controlling part of the tool set is activated, which then gives an impulse on the other part of the tool set in order to achieve the desired aim. To conceptualize and produce

a functional complementary tool set the application of a subject-independent trigger extends the necessary causal understanding. *Notional tool behavior*, finally, requires abstract causal reasoning about not observable agents and their effects. Though also New Caledonian crows reason about hidden causal agents (Taylor et al., 2012), it is unclear what the animals expect to be the causal agent. In notional tool behavior the subject does not only look for hidden causal agents, but mental representations as tools respectively, components of tools are applied. Penn and Povinelli (2007, p. 111) emphasize a strong relationship of abstract causal reasoning with analogical reasoning. Vaesen (2012, p. 266) summarizes that "causal thought involves both the ability to infer causal mechanisms relating cause-effect covariances (i.e., inferential causal reasoning) and the ability to recognize that such mechanisms underpin causally analogous events (i.e., analogical causal reasoning). Current evidence suggests that chimpanzees perform rather modestly in both respects. Humans, in contrast, have a drive for seeking and generalizing causal explanations, and often learn about causality through their own diagnostic interventions—a behavior not yet observed in the great apes." Additionally, *Homo sapiens* is able to conceptualize mental representations as agents/*agens*.

The studies on prehistoric tool behavior presented above strongly suggest a multi-leg evolution of several components of causal cognition and adjacent cognitive features. Additionally, the development of the different cultural performances of tool behavior is not only based on biological and individual factors, but also on historical-social factors. The three dimensions are multifactorial, interdependent, and embedded in the specific environment of the population (Haidle and Conard, 2011). The same can be assumed for the different performances in the cognitive sphere. A cultural performance may have different cognitive backgrounds. Prior individual experience helps to manage a new task (von Bayern et al., 2009); historical-socially transmitted experience of other individuals in cultural context can do the same. If trained by a knowledgeable individual, naïve individuals may perform very well in a lot of problem settings also with sophisticated tools, and without understanding the basic causal relations. Consequently, not all individuals in a group with cultural behavior have to share the same cognitive capacities to perform in some aspects in the same cultural way. And with the same cultural capacities of problem-solving different individuals and populations may perform very differently. I assume that the cultural background, respectively the historical-social dimension also shapes the cognitive performances behind the behavior. There are no data available about past human cognition. But with the help of argumentative bridges at least some impressions on the evolution of causal cognition can be gained from prehistoric artifacts.

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What "causal cognition" might mean

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As something of an outsider to the study of "causal cognition," I want briefly to query what it might be taken to mean in general—outside of any particular disciplinary understanding. Next, from that perspective I look at some empirical approaches to selecting problem-relevant senses of causality, and senses in which cognition might be seen as causal. I then turn, at more length, to the nature and significance of collective causal cognition, including the cultural models type.

THE SUBJECTIVE PERSPECTIVE—OUR COGNITION OF CAUSALITY

Our default senses of what we mean by causality vary from one another. My own personal default is that causality is human and individual (vs. collective), and that culture provides expectations regarding what kinds of causality are understood to work in the world, what kinds apply to "all people" and what kinds (physical, psychological, social, etc.) apply in what form to other individuals.

One can, also, separately—as an outside observer—consider the causal processes that one sees working on or in a group—from mob behavior on up. Some of this attribution of causal processes seems universal while other seems culture-specific, or, even, more individual.

A RANGE OF MEANINGS AND MEASURES

But note that the issue depends on what one means by "cause" and by "cognition"—and thus on where one's interests lie. There exist various (well-known!) kinds of "causes" in addition to the efficient (or active) causes I opened with—such as final causes, indirect causes, enabling conditions, and so forth. "Cognition" can range

from individual knowledge without any active decision-making element, through more broadly defined knowledge that includes an individual's potential action plans, to collectively held knowledge including appropriate collective action. Alternatively, "cognition" can go to the root of action, as in the "flight/fight response," where a uniform physiological response in the brain can be interpreted as fear (leading to flight) or aggression (leading to fight)—depending on the situation/context and on one's prior experience. One's modeling of the mental states of other beings—"theory of mind"—also represents a potentially causative cognitive activity.

EMPIRICAL APPROACHES

One way to approach the general issue of causal cognition might be to take everything that is needed for a simulation of some action/event (such as, for example, Schank and Abelson, 1977 restaurant simulation) and then see what of that is cognitive—and in what sense. But I suspect that the answer might be overwhelming in both its breadth and its length!

More sensible, perhaps, is for one to consider why in particular one is asking about "causal cognition" and see what speaks to that particular instance or version.

As an ethnographer one can turn to people's everyday default senses of what they mean when they speak of the "cause" of some activity or situation. Based on Evans-Pritchard's classic Zande example (Evans-Pritchard, 1937; pp. 69–70), one might ask "why did the corn crib fall on Uncle Joe?" The answer is the answerer's sense of what "caused" it to fall. That

is, the answer is an instance of cognition about causality. If the view is widely shared within the culture, we have an instance of culturally shared cognition, and if people in the culture act on the answer (based on shared and accepted views of, say, crime and action), then we have cognitively caused social action.

If, in the Zande example, an actor argues for a particular response—based on what happened and on those shared and accepted views of crime and action—then we have an instance of individual cognitive causality (since her understanding has led to her arguing a case). Evans-Pritchard says the typical Zande answer would be a statement about whose witchcraft triggered the collapse. And a social witchcraft settlement process might be initiated. The process would involve culturally-based understandings of what kinds of events trigger witchcraft accusations.

In my American culture the answer would be "because the crib was rotten from a termite infestation"—a material state answer. And possibly the polity might enact stricter corn crib inspection standards, or punish the builder for faulty construction practices. Evan-Pritchard's Zande are aware of the risk posed by a termite infestation, but are more concerned with why the collapse happened *particularly when Joe was there*. We, on the other hand, tend to dismiss the timing question with "It's chance" or "Shit happens" responses.

But, the range of "causes" is still far from exhausted. We can come up with a raft of enabling causes. For example, why was the corn crib built (in that place, and so insubstantially)? Why was Uncle Joe sleeping there? And, for that matter, why were the Azande people there (vs.

somewhere else) growing corn that had to be stored in that manner?

COLLECTIVE COGNITION AND CAUSALITY

Nadel (1952) provides a different kind of example of the interaction of witchcraft accusations with causally relevant cognitively based collective social structures (formal age grades and the power—including property—which goes with each) and demographic factors in two East African societies. In both societies, when men enter the senior grade they are supposed to turn over their political power and major economic goods to their heirs. In the society with few age grades, the turnover takes place while the new seniors are still relatively young, vigorous, and ambitious. These "rising seniors"—much resenting the pressure of their heirs to move on and make room for the next class—try to drag out the process, which causes resentment among the class of their heirs, which leads to accusations of witchcraft against the seniors (for trying to hold the heirs back). In the society with a greater number of grades, the seniors are older when the turnover takes place, and more ready to move on, and the class of heirs is in a middle-age grade that entails a significant societal role, and so they are much less apt to be resentful. In Nadel's examples, it is culturally standardized knowledge about the consequences of age grade membership which produces ("causes") the incidence of witchcraft accusations.

Collective cognition that involves an action is necessarily causative because it is only the collective knowledge that makes the action efficacious. That is, the products of actions such as marriage (see below) don't exist unless relevant communities recognize them.

Collective action of many sorts depends on differentially shared and overlapping knowledge, knowledge that involves shared goals, shared procedures and rules, shared expectations about likely actions, and insightful interpersonal knowledge. Mundane examples can be seen in the behavior of a well-organized soccer or basketball team. Effective offense depends not just on organized plays, but even more on knowledge of teammates' personal characteristics in the context of a play and of opponents' likely responses. Successful defense depends on a shared but shifting dynamic understanding of the playing space and the flow of action in it—not just where the ball is or who has it, but where it's likely to go and how it's going to get there.

A similar kind of collective knowledge was pointed out by Romer (1984) in connection with the coordination among members of an ancient Egyptian work group implied by their production of art forms in which a single line flows as if carved in a continuous act by a single hand—where size and material would make execution by a single hand impossible. Classical European painters' ateliers have sometimes exhibited that collective unity.

Marriage is an example of collective cognition that can cause substantial effects. Marriage can "cause" property ownership (as in "Why does she own that house?" "Because her husband bought it, and it's joint property"). People are only married—with the resulting legal and social concomitants—if they are known to be married—even if that knowledge, in their culture, presumes some efficacious words or ritual. Much of kinship, in effect, depends similarly on knowledge—except that sometimes DNA can be appealed to. Inheritance is an example of collective cognitive causality—not just its reliance on kinship but for the rules that members of the culture have defined which specify who gets a dead person's stuff and, sometimes, social and political role.

Cultural models (as in Kronenfeld, 2008 and see Bennardo and Kronenfeld, 2011) are one particular kind of collective cognitive system that can be indirectly causal. They don't directly make things happen, but in a given situation they do provide individuals with models for how they might act in a given situation.

Other apparent examples of collective cognitive causality include joint tasks by a collection of people where none of the participants know the full plan or system and where there exist no explicit written plans. Examples of such tasks include Hutchins' (1994) account of how an aircraft carrier is actually navigated inside an enclosed bay, Gatewood and Lowe's (2008) account of the nature and operation of credit unions, and my own (Kronenfeld, 2011, pp. 575–576; 2014, p. 85) example of house construction.

In Hutchins' example, it is sailors' individual knowledge of their own specific roles—including how their roles link with those they immediately connect with—that allows their behavior to fit into a patterned process. The process is kept aligned with the ultimate navigational task (including interrelating the ship's location and speed relative to the shoreline, water depth, other ships, and target dock) by someone who puts the products of the sailors' action sequence into a format that translates into the Bridge's understanding of the task and which is used as the basis of instructions to the helm and engine room—where timely execution is needed to prevent crashes and cope with surprise emergencies.

In Gatewood's example, we see that no one in the organization (not directors, officers, staff, or customers) held full knowledge of the goals, organization, and operation of a credit union, and that this information was nowhere completely written out. We see that—as it turned out—somewhat divergent views were held (by people in the different positions) of why credit unions existed, what they were useful for, and how they operated. Here, the unifying shaping comes via customer's satisfaction and usage in response to staff actions and financial offerings as guided by officers.

In my example I examined the roles involved in a small construction job—adding rooms onto an existing house in California. These roles include the owner (who commissions and pays for the work), an engineer who produces the plans (incorporating building code standards), the people who do the constructing, and the city inspectors who check for code compliance. Construction roles include the contractor who oversees the job, the carpenters, electricians, plumbers, floor installers, wallboard installers, painters, roofers, appliance installers, and so forth who do the actual work. The construction people know their own jobs through some combination of formal training and experience, and this knowledge includes how their roles interact with neighboring roles—thus they typically have some knowledge and experience of the work of these neighboring roles. Since this

is a small job, and the level of expertise required for some of these roles is not too high, it is not uncommon for one person to fill several of the roles—depending on that person's training and experience. Commonly, the contractor will have started as a carpenter, and often carpenter/contractors have some experience with simple electrical work and plumbing, and so may or may not hire experts to do such work, depending on availability and price. The engineer's plans are never detailed enough to anticipate all contingencies, and so much of the detail is decided on the fly—sometimes in consultation with the owner (who may or have only limited knowledge). No one knows all that is needed for the job. Typically, the expert (relevant to a particular problem) makes decisions based on his or her knowledge, and in consultation with others directly affected; but both owners and city code enforcers play major roles.

CONCLUSION

These examples illustrate how (successful) collective action depends on systems of collective knowledge and on individual possession of relevant parts of that collective knowledge. The collective project cannot take place without both collective and individual knowledge, and so the knowledge (i.e., cognition) has to be considered causative.

Finally, an understanding of even individual "causal cognition" requires attention to default understandings which often are culturally based.

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