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Making space: instructions in joint building activities

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This contribution reports on an interdisciplinary study using multimodal space-based interaction analysis to investigate co-orientation, co-ordination and co-operation during interactional activities that structure the material space. The settings analyzed feature creative activities in ancient technology (making a sandal and building a hut) involving experts and novices. Participants in these interactions are giving, receiving and following instructions and requests in order to accomplish a joint project that has some relation to the (prehistoric) past, i.e., participants are engaged in creating *heritage environments* by making objects and architectural structures that reference the past through their design, materiality and production procedure. To accomplish their projects, participants activate, share and gather knowledge through joint cooperative and instructional activities, which makes these interactions particularly suitable for a form of multimodal interaction analysis that also takes the spatial and architectural affordances into account. By doing so, participants interact not only with each other, but also with their predecessors via the use and creation of material artefacts. The analysis shows that the establishment of boundaries as a fundamental human activity relies on multimodal instructions that employ means to create a joint mental image of the object or structure in its space-to-be in the interactional space to which participants orient until the structure is finished and becomes permanently available as a material object in the environment. The co-ordinated crafting and building activities are creative processes that become shared intercorporeal experiences in which knowledge and resources of the past are recovered, transformed and used to structure current and future actions.

KEYWORDS

interaction, space, multimodality, instruction, pastness, building, gesture, object

1 Introduction

This contribution reports on an interdisciplinary study using multimodal space-based interaction analysis (Hausendorf et al., 2016) to investigate co-orientation, co-ordination and co-operation (Hausendorf, 2013) during interactional activities that structure the material space. In the two cases discussed here, participants are engaged in the making of a sandal from animal rawhide using a flint blade for cutting, and in the building of a Mesolithic style hut using hazel rods and leather strips, i.e., both settings feature an activity in ancient technology involving experts and novices.

These settings are situated between types of activity that require instruction for their routine completion (such as medical operations, e.g., Mondada, 2014a) and a specially designed training activity for the teaching, learning and (repeated) practicing of a skill in an educational context (such as singing, e.g., Szczepek Reed, 2021). In a professional setting, usually all or most participants are trained experts acting in their respective roles that include giving and receiving instructions; in an educational setting the aim is to transfer knowledge and practice new skills in a sustainable way. In the settings discussed here, interactions are between experts and novices, i.e., untrained helpers that are neither fully

familiar with the procedure they are engaging in nor are they necessarily aiming at acquiring (and particularly not practicing) a (new) skill. Rather, participants in these interactions are giving, receiving and following instructions and requests in order to accomplish a joint project, to get a job done together (Zinken and Deppermann, 2017).

The projects are accomplished in settings that are characterized by a relationship to the (prehistoric) past. I call these settings *heritage environments* and, following Braden (2019), define them as a "physical setting of any size that is situated within the context of human habitation and thus includes architecture built for purposes of social activity and an assemblage of objects that represent past human activity, including original, modified and recreated structures" (Wilton, 2023). These past settings can either be original sites (such as Stonehenge, for example) or reconstructed on the basis of archaeological evidence, such as buildings in Archaeological Open Air Museums. Both types of sites are commonly used for the purpose of institutional interpretation (Braden, 2019: xv) and in some cases for experimental research into past lifeways, techniques and practices (Hurcombe and Cunningham, 2016). In the settings discussed here, participants are engaged in creating such environments by making objects and architectural structures that reference the past through their design, materiality and production procedure. To accomplish their projects, participants activate, share and gather knowledge through joint cooperative and instructional activities, which makes these interactions particularly suitable for a form of multimodal interaction analysis that also takes the spatial and architectural affordances into account.

The analysis draws on ethnomethodological and conversation analytic research combined with a multimodal and space-based perspective, giving each semiotic resource that participants employ to engage in meaningful interaction equal attention (Schmitt and Hausendorf, 2016:11). The aim is to identify and describe the ways in which participants organize instructional activities to jointly envisage and accomplish the structuring of material and space into a meaningful entity – meaningful in the sense that it emerges as and serves as a connection to the past.

2 Interaction, knowledge and instruction in heritage environments

2.1 Interacting with predecessors

To understand how people make a connection between the past and the present in their interactions, Schütz observes that while we can interact with our contemporaries in situations of mutual co-presence, interaction with predecessors who are no longer present is only possible through the material objects they left behind. Thus, any person has

> empirical information about his historical predecessors. He finds himself surrounded by objects which tell him plainly that they were produced by other people; these are not only material objects but all kinds of linguistic and other sign systems, in short, artifacts in the broadest sense. He interprets these first of all by arranging them within his own contexts of experience. However, he can at any time ask further questions about the lived experiences and meaning-contexts of their creators, that is, about why they were made. (Schütz, 1967: 171)

This observation contains several important implications for interactions in which the past is made a relevant dimension: first, interaction includes not only those that are physically present, and who perceive each other in a state of mutual co-presence of shared experience, but also between contemporaries and predecessors via material artefacts. This is particularly obvious when people engage with objects and architectures that clearly have a past origin, such as authentic archaeological artefacts (Holtorf, 2013). Their materiality provides clues to their past origin in the form of patina or signs of decay acquired through the passing of time (Holtorf, 2013; Riegl, 1982). Their *pastness*, i.e., "the quality of being of the past" (Holtorf, 2013: 432), is the result of interpretive processes by the modern person engaging with these artifacts and their material affordances. In many cases, these authentic past objects have been removed from their contexts of use and everyday experience and have been turned into symbolically and culturally charged museum exhibits that are invested with a specific social sense (Tyradellis, 2014). However, Schütz' observation also holds for much more mundane, everyday objects that have been created by predecessors, and which are still available and in routine use by contemporaries: "even the most mundane local sequences of action frequently incorporate, and accumulatively operate on, resources and solutions created by actors no longer present, but that structure the current landscape for action" for people in the present (Goodwin, 2017: 246). Integral to our everyday lives, objects frequently feature in and structure social interaction. As Nevile et al. (2014a: 4) state, "we need objects, physical things, to conduct and accomplish ordinary practical and social activities: we depend on objects to act in the world, either as individuals or as social members." Second, Schütz states that engagement with predecessors generates unidirectional (Schütz, 1967: 293) inquiry into the lifeways of predecessors, their experiences and the contexts in which they created meaningful social life, thereby incorporating past and present experience into an understanding of the current context.

These observations are relevant for the creation of past objects and the building of a prehistoric structure: the overall aim of the activities discussed here is the recovery of lost knowledge, of knowledge and skills that predecessors are believed to have possessed, but that have become dormant or even irrelevant in the present/modern daily life in western industrialized society. As Schütz (1967: 293) observes, engagement with predecessors is a unilateral process as predecessors cannot respond to any present action, it is "a case of one-sided Other-orientation on my part." In the cases discussed here, "co-operative action with predecessors" (Goodwin, 2017: 246) takes place through the exploratory use of materials and tools which have fallen out of use in the present to create objects and spaces known or inferred from archaeological finds and contexts. These constitute the main source of information that societies in the present have of predecessors whose solutions either did not survive in modern societies or have been modified so much that the original solution is not readily accessible or relevant for modern societies. This would be the case for the two settings discussed here: the flint knife might be a precursor to modern metal knives, but its affordances and functionality are quite different. Raw hide as a material is only used in very specific circumstances today (e.g., for making drums or parchment) and its processing is largely industrialized. Similarly, people do not usually erect simple

shelters from natural materials for protection and habitation. People who engage in these activities try to fill the gap in the transmission of predecessors' knowledge and skills by exploring the affordances (Gibson, 1977) and constraints of materials, objects, tools and artefacts they ascribe to the past. By doing so, they draw on their knowledge of how to use modern materials, tools, objects and spaces, i.e., what Hausendorf and Schmitt (2013) call *sociotopographical* knowledge, and practices of joint coordination and cooperation. This exploratory process causes knowledge to be made explicit and lays the ground for instructional settings in which the knowledge is jointly expanded and/or transmitted.

The crafting and building activities discussed here are inherently co-operative: the instructor needs the help of the instructed in order to complete the task. As Mondada notes for cooking lessons andother educational settings, "following instructions relies in a crucial way on an adequate manipulation of objects, which are grasped, handled, looked at and manipulated in specific ways" (Mondada, 2014b: 201). Through the way the instructed handle the material and tools, they provide "understanding of the instructions and constitute evidence for demonstrable compliance" (Mondada, 2014b: 201). Similar to Mondada's example of cooking, crafting and building processes are transformations of materials and space: natural objects (animal rawhide, hazel rods, the ground) are transformed into a human-made object. In the case of a building, this object emerges at a particular point in space, requiring participants to establish and maintain a spatial and embodied orientation towards this object-to-be during the creative process.

Ehmer et al. (2021:670) make a distinction between more local requests (*Aufforderungen*) which aim at the immediate execution of a requested action and more general instructions which are aimed at the accomplishment of a more or less distant goal (Ehmer et al., 2021: 670). Such goals are typically not achieved by a single action, rather, they are the result of an instruction chain that structures the complex process of sequentially organized actions or steps. For the realizations of instructions in those incremental steps, participants employ a range of multimodal resources and practices, including requests, demonstrations and explanations. In many settings, these practices combine verbal, gestural, embodied and – for cases of handling objects or building structures – also material and spatial resources. As Ehmer et al. (2021: 671) point out, the multimodal realization of requests and instructions requires a fine-grained analysis of the temporality of actions as embodied resources can be employed simultaneously or independently of speech, which is essentially sequential.

Requests and their compliant actions have been treated as adjacency pairs in conversation analytic research (Schegloff and Sacks, 1973), where either or both parts can be realized non-verbally through gestures or other embodied means. On a grammatical level, despite imperatives being the prototypical morphosyntactic form for the first pair part of a request, the slot can be filled by a variety of other formats such as declaratives or interrogatives (Ehmer et al., 2021: 674). The choice of format for a request or an instruction can index or establish claims of authority and entitlement to direct, and are related to the kind of activity that is being carried out, i.e., a joint project or a unilateral activity imposed on a second person (Zinken and Deppermann, 2017). Instructions are traditionally researched in educational environments where the teaching of knowledge and/or skills is aimed at a sustainable and empowering outcome of students being able to apply or perform what they have learned in future contexts (see Ehmer et al., 2021 for an overview of studies). However, instructions also occur in everyday interactions when a knowledge asymmetry between participants necessitates instructional activity, such as in parent–child interactions. As Mondada points out, whether an action can be understood as directive relies crucially on its interpretation by the addressee and their following actions, as the "situated sense of directives is irredeemably tied to the particular activities and context in and through which the particular action it requires is produced" (Mondada, 2014a: 134). In the activities discussed here, directives that organize and distribute actions aimed at the accomplishment of a coordinated activity play a central role in the joint recovery, transmission and realization of the knowledge believed to have been created and held by predecessors.

2.2 Making space: boundaries, multimodality and imaginary deixis

Typically, when people interact in a face-to-face situation, they establish mutual access to each other in what Kendon (1977) calls an *F-formation*, a bodily orientation that allows individuals in close proximity to mutually perceive, monitor and engage with each other's bodily actions (Ciolek and Kendon, 1980: 240). By doing so, participants create an *o-space* (Kendon, 1977), an area that constitutes a "joint interaction space" (Ciolek and Kendon, 1980: 241). For the purposes of the study presented here, it is particularly relevant to note that by establishing a joint interaction space, participants create a perceivable boundary that they themselves as well as others outside of their group orient to:

> (…) an F-formation system can be viewed as a mechanism that shelters the content and details of the interpersonal event from being interfered with, contaminated, viewed, or eavesdropped upon by outsiders who happen to be nearby. In other words, because of their spatial arrangement, the bodies of the participants in a given exchange act precisely in the same way as do timber, glass, and plastic shielding constructed around a public telephone. They help to screen off some of the environmental noise from the ongoing exchange, while simultaneously rendering such an exchange either garbled or less visible and less audible to a bystander (Ciolek and Kendon, 1980: 245)

This observation already points to the importance of boundaries, be they interactional or physical, for social interaction. While physical boundaries are available as permanent features of the built environment (Hausendorf and Schmitt, 2016), the boundaries of joint *interactional space* are dependent on continuous interactional work, i.e., it "is constituted through the situated, mutually adjusted changing arrangements of the participants' bodies within space, as they are made relevant by the activity they are engaged in, their mutual attention and their common focus of attention, the objects they manipulate and the way in which they coordinate in joint action" (Mondada, 2014c: 250). Thus, as Ciolek and Kendon (1980: 243) note, "F-formations are characteristic of people who come together to accomplish a joint activity," which can involve the material and spatial affordances of the situated setting in which participants interact. Within the interactional space, different areas or objects can be made relevant to the ongoing interaction through indexical, often gestural,

means and through manipulation (Nevile et al., 2014a) and transformation. This is particularly relevant for the purpose of demonstration, where an activity is designed especially for the observation of others. In order to demonstrate an activity, the demonstrator needs to single out, arrange and manipulate objects within a particular area for the focal attention of the audience, thereby creating a *demonstration room* ("Demonstrationsraum," Putzier, 2012: 277) or the "ecology" of the demonstration (Mondada, 2014b: 205) as a meaningful space.

In the structuring of space, the separation of an entity from its surroundings is a basic concept as well as a basic practice testifying to human spatial competence (Wynn, 1989). Separation is achieved through the drawing of boundaries which make it possible to identify an object as an entity distinct from the environment. This holds both for the creation of objects from a larger, and conceptually more amorphous, mass of material (Mondada, 2014b), evidenced as early as the production of stone tools such as handaxes by hominins (Wynn, 1989; Hochuli and Streeck, 2022), as well as for larger architectural structures such as buildings (Barker and Louw, 2022), which constitute a segment of space physically separated from its surroundings (Hillier and Hanson, 1984). Thus, establishing a boundary is elementary to structuring space, be it through the creation of an object or a piece of architecture.

Generally, the creation of objects and buildings follows principles of functionality as well as style as an expression of social meaning (Hillier and Hanson, 1984: 1). Furthermore, creating objects is a process that brings form and material into a dynamic relationship with each other (Ingold, 2010). While the relevance of objects in interaction is widely recognized by a growing body of research (see the contributions in, e.g., Nevile et al., 2014b), and some studies specifically study the creation of objects in interaction, notably in instructional contexts (Mondada, 2014b, Ekström and Lindwall, 2014), the actual emergence of objects in interaction as a process that structures the material space has not attracted much attention so far.

When it comes to buildings, their functionality as well as their social and cultural significance are evident. Even in their simplest form, they are designed to provide shelter and protection, warmth, and a space to carry out social activities. At the same time, they are styled into a distinctive and meaningful object, through the conscious use of materials, colors, decoration and embellishments. However, as Hillier and Hanson point out, buildings differ from other artefacts and objects in one crucial aspect:

> Buildings have a peculiar property that sets them apart from other artefacts and complicates the relation between usefulness and social meaning. It is this. Buildings may be comparable to other artefacts in that they assemble elements into a physical object with a certain form; but they are incomparable in that they also create and order the empty volumes of space resulting from that object into a pattern. It is this ordering of space that is the *purpose* of building, not the physical object itself. The physical object is the means to the end. (…) Insofar as they are purposeful, buildings are not just objects, but transformations of space through objects. (Hillier and Hanson, 1984: 1)

Most critically, by providing a continuous boundary (Hillier and Hanson, 1984: 53) in a particular space, a building structures the previously unstructured area, separating a *here* from a *there* and thereby transforming an area into a defined space that is disconnected from its (continuous) surroundings (Hillier and Hanson, 1984: 144). It has been argued that the establishment of a boundary in a spatial setting is the beginning of architecture (Norberg-Schulz, 1983: 66), a manifestation of a uniquely human desire to separate and connect (Barker and Louw, 2022).

Bringing the concepts of interactional space and the material and physical space together, the joint creation of objects and buildings in interaction require a shared understanding of what the end product should look like and—in the case of buildings – where it should be placed. Instructional activities aimed at the creation of a product, therefore, include multimodal strategies of demonstration and depiction (Ehmer et al., 2021). In the widest sense, what interests us in this contribution are verbal, embodied and spatial means of turning a previously unstructured space or piece of material into a meaningful space or object that is recognized as such through visible boundaries separating it from the surrounding material environment. While the significance of multimodal interactional resources in the creation of joint imaginations of buildings has been recognized as part of the planning process in architectural research (Murphy, 2004, 2005), means of structuring the interactional space to visualize objects and structures *in situ* have yet to be explored in detail.

Streeck, following Dreyfus (1991), calls the meaningful organization of a space "clearing" the space (Streeck, 2009: 59). Clearing can be done by employing various practices, of which tracing as a gesture is particularly relevant for the data discussed here. Tracing involves the gestural depiction of an imaginary line to visualize and delineate something in space. This visualization can be the result of tracing as a tactile experience; for the person doing the tracing on the surface of an object or material, the tracing is tactile as well as visual, while transforming this multimodal experience into a visual for the viewer: "(t)actile experience is visualized; the finger, while moving along in microscopic increments, following locally available input, ends up drawing what others can perceive as a straight line" (Streeck, 2009: 70).

A line as a result of a tracing gesture can follow a real line (e.g., the edge of an object, a fold, a gap…) or it can be a depiction of the outline of something that is not (yet) available. As such, it makes use of or is an instance of what Bühler calls "imagination-oriented deixis" (Bühler, 1934/2011:140). Imagination-oriented deixis is different from the primary mode of deixis, which involves reference to objects in the immediate environment, usually by pointing verbally as well as visually (*demonstratio ad oculos et ad aures*). Imagination-oriented deixis instead references objects and spaces that are not visually present: "(w)hat is imagined, especially when movable things such as people are concerned, often comes to us, that is, into the given order of actual perception, within which it can be localized, though not quite "seen" (Bühler, 1934/2011: 150). In one of three forms of imagination-oriented deixis (see Stukenbrock, 2014 for a detailed discussion), non-present objects or other entities are evoked and integrated into the here-and-now of the speaker: "the imagined thing that appears to the mind's eye in the normal (non-eidetic) manner can receive a place in front of, next to or behind me, located directly among the things in the room in which I am, among the things that I in part perceive, in part imagine" (Bühler, 1934/2011: 151). This is particularly evident in activities like storytelling, where participants create and maintain a joint imaginary scene as a displacement from the *here-and-now* of their spatially situated interaction (Heller, 2022).

In interaction, these mental images or situational visualisations (*Vergegenwärtigungen*, Bühler, 1934/2011:149) are made available by the speaker through deictic practices using verbal, gestural and embodied means. This is particularly the case for entities that are not existent at the moment of speaking, but are to be created by the participants in the space where the gestural visualisations situate them. The plan to jointly create an object of a particular shape or in a particular space necessitates that its boundaries are established as a mental image, and that this mental image is shared, activated and maintained in the minds and actions of the participants until the object is in place. To achieve this in a setting of knowledge asymmetry, participants employ multimodal resources such as instructions and requests, pointing and tracing as well as positioning and shaping.

Similar to the establishment and maintenance of interactional spaces, by establishing boundaries to create a material structure in a space, people engage in a basic activity that both requires and enables forms of human sociality (Hochuli and Streeck, 2022). As such, it is part of the cumulative nature of cultural and social knowledge and repertoire as we "inhabit the actions and solutions of our predecessors "(Goodwin, 2017: 247). To investigate such interactions, an approach is needed that acknowledges not only the multimodal nature of interaction, but also the fact that interaction is always spatially situated.

3 Data and methodology

The research presented here is based on related approaches and methodologies that focus on the analysis of meaning-making in interaction. These approaches recognize the organization of talk, embodied actions such as gestures, facial expressions, gaze and positioning, sensoriality, and the material environment in the form of objects and architectures as semiotic resources that interactants draw on for their social interaction as a multicomplex, jointly accomplished enterprise (Hausendorf et al., 2016), They are empirically grounded and based on naturally occurring interactions as data to allow for an emic perspective that essentially aims to reconstruct the unfolding of social interaction from the perspective of its participants (Deppermann, 2001; Sidnell, 2012).

3.1 Methodology

Traditional conversation analytic research focuses on the verbal mode as the primary orientation in interaction. With technological advancements such as easy and affordable video recordings, the visual aspects of interaction have become increasingly relevant for interactional research. While multimodal conversation analytic studies address the interplay of visual and verbal modes of expression, multimodal interaction analysis aims to depart from the organizational primacy of talk to investigate the organization of interaction independent of the relative status of multimodal resources (Schmitt and Hausendorf, 2016: 10). While conversation analytic principles such as the sequentiality of coordinated interaction unfolding in time, the creation of intersubjectivity and the display principle remain relevant, multimodal *space-based* interaction analysis broadens the scope from a focus on verbal interaction to an inclusion of the entirety of semiotic resources that participants employ in the accomplishment of meaningful interaction (Goodwin, 2000). These resources include spaces, in particular architectures and their interiors, that affect the realization of specific forms of interaction and that require knowledge of spatial uses, or *social topographical knowledge* (*Interaktionsarchitektur* and *Sozialtopographie*, see Hausendorf and Schmitt, 2013).

Multimodal space-based interaction analysis acknowledges that face-to-face encounters in which participants share a common here-and-now are situated in a given spatial, and typically architectural, environment. Participants in the encounter achieve this so-called situational anchoring by means of co-orientation, co-ordination, and co-operation (Hausendorf, 2013:277), making use of verbal, gestural, embodied and sensorial resources and environmental affordances (Gibson, 1977). Affordances are those (material) properties that an object or a space offers to potential users, such as a door for entering a bounded structure. Research has shown how objects and their manipulation are integrated into and made relevant for the organization of interaction (Nevile et al., 2014b, and specifically Day and Wagner 2014 and Mondada, 2014b). Thus, objects and architectures provide usability cues (Hausendorf, 2013: 295) as to how objects are to be used and what kind of social action can be anchored in a particular architectural space. The material objects and architectures in a specific environment are available simultaneously, and are made relevant and integrated into the sequential organization of talk-in-interaction (Kesselheim, 2016b; Müller et al., 2013). By investigating architectural spaces with regard to the interaction architecture (*Interaktionsarchitektur*), with regard to their social topography (*Sozialtopographie*) and the interaction space (*Interaktionsraum*) that is created with any by interaction, multimodal space-based interaction analysis aims at discovering the ways in which participants construct and integrate the material and spatial affordances to anchor their interaction in a particular environment (Hausendorf and Schmitt, 2016: 28).

Most of the studies addressing the interplay of interaction and space have focused on the built space, i.e., on architecturally modified spaces as manifestations of culturally transmitted and sedimented interactional orientations (Hausendorf et al., 2016: 7) that are familiar to their regular users (Hausendorf and Schmitt, 2016: 28). However, in unfamiliar spaces, users have to make themselves familiar with the intended uses of the particular architectural setting through the interpretation of usability cues and affordances of the material equipment and spatial layout, and the behavior of regular users (Hausendorf, 2013: 296). For architectural structures that have a past origin, their original creators and users are no longer available for observation or the transmission or socio-topographical knowledge, their "experiences are over and done with, and we can get to know them better only in the sense of picking up more information about them. But the information was, so to speak, already there waiting to be picked up, and it is quite accidental that we have to acquire it bit by bit" (Schütz, 1967: 296). In such spaces, then, users have to rely on their interpretive abilities of the spatial affordances and signs of the past to adapt the spaces to meet their present interactional needs and the situational aims they pursue (Hausendorf and Schmitt, 2016: 44). Even then, because of the fragmentary nature of archaeological and historical evidence and the essential differences between past and modern interpretations, the types of social interaction that were instantiated in a particular past space might only be partially apparent to a modern user (Wilton, 2023).

The study reported on here extends the analysis of architectural spaces as resources for social interaction by focusing on the process of *creating* – or more specifically – *structuring* a particular space through the transformation of material. It thus addresses the phases at which an object or a structure emerges from previously unstructured space and material through joint co-operative interaction with the aim to identify and describe the processes and practices relevant for the creation of past objects and structures. When creating an object or a structure together, means of co-ordination and co-operation are particularly important for the situational anchoring of the interaction. Multimodal instructional activities as a salient practice with specific sequential implications (Ehmer et al., 2021: 673) are employed to organize and distribute the relevant tasks in a temporal and spatial order, creating an incremental sequential process that culminates in the finished product.

Combined with insights from architectural theory (e. g. Hillier and Hanson, 1984) and archaeology (Holtorf, 2013), multimodal space-based interaction analysis is the most comprehensive and suitable approach to investigate the role of instructions in the making of past spaces and object, as it constitutes a tool that extends and complements conversation analytic and multimodal research. It therefore provides the essential prerequisites to integrate this investigation into the wider context of interactional research.

3.2 Data

The project's main data source are audiovisual recordings of various activities within the context of heritage environments. The data presented in this contribution were collected during a stone age immersion project (Example 1) and the building of a Mesolithic shelter (Examples 2–4). The settings are not specifically didactic, i.e., the main objective of the activities is not the unilateral transmission of knowledge and the teaching of particular skills. Rather, the focus is on the joint (re)discovery of past knowledge and practices through explorative crafting activities. Knowledge asymmetries are distributed unevenly among the groups involved, and the roles of instructor and instructed are situationally established and negotiated.

The context of the first example is a project that explores stone age living conditions in an immersive setting. Groups of about 6–7 participants spend up to two weeks in a forest, using only stone age materials, foodstuffs, tools and clothing. In the setting recorded for this study, participants were asked to equip themselves in the style of Mesolithic (Middle Stone Age) hunter gatherers. This involves the construction of temporary shelters, the use of leather and fur clothing, few or no pottery items and the consumption of uncultivated food, i.e., food that is either hunted, caught or gathered. Participants come from diverse backgrounds, bringing different kinds of knowledge and expertise to the event. Filming was done sporadically and activity-related with a minimally invasive setup to prevent disturbance of the immersion through the intrusive presence of modern technology. In the example discussed here, the organizer and one of the participants are in the process of making a pair of sandals from a piece of rawhide, i.e., untreated but dried skin from a highland cow.

The context of the second setting for examples 2–4 is a hut building project on the university campus (see https://blogs.fu-berlin.de/interactionlab/). A group of students with no prior experience in archaeological reconstruction and from diverse academic backgrounds and nationalities cooperate in the construction of a Mesolithic style hut. They are guided and instructed by a team of three experts in archaeology and ancient technology. Information on the dimensions, orientation and possible materials of a hut common in the European Mesolithic were drawn from archaeological findings of Central Europe (Eickhoff and Petersen, 2003; Wenzel, 2009) and comparable building experiments in research contexts.[1] However, as such shelters do not survive as three-dimensional buildings, but only as traces in the ground, their exact shape and constructional details remain open to imagination (Savani and Thompson, 2019), informed conjecture and, as in this case, experimental reconstruction.

Some of the hut building activities were recorded from three perspectives: an external observer's perspective represented by a static camera capturing the overall scene, and internal observer's perspective represented by a hand-held camera and participants' perspectives represented by headcams. The choice of the three perspectives already reflects interpretive decisions as they represent different types of participation in the interaction as well as different visualizations of the spatial conditions in which these interactions take place (Kesselheim, 2016a). The static camera allows a view of the spatial setting in which the structure emerges, while details of the interaction remain inaccessible because of temporal visual obstruction or inaudibility of talk. Headcams can only give an impression of the basic orientation of a participant's field of vision, as they do not capture details of gaze and eye movement. For the present study, the basic orientation of direction of vision has shown to be sufficient. Furthermore, the use of eye tracing devices was judged to be too obstructive for participating in building activities. However, the participants' perspective is valuable in accessing their perception of spatial arrangements and their own embodied positions and actions in relation to the structure and the other participants. The internal observer's perspective has proven to be the most useful for analysis of the overall organization of an interactional sequence. This is likely due to the fact that the camera is mobile and follows the progress of the interaction by orienting towards the joint focus of attention of the participants. By doing so, the person filming becomes part of the interactional setup, but does not participate in the focal activity (Kesselheim, 2016a: 91; Müller et al., 2013), representing the typical internal observer, a role that is closest to that of the ethnographic researcher (Kesselheim, 2016a: 100). The recordings were transcribed using GAT2 (Selting et al., 2011) and multimodal transcription conventions (Mondada, 2019) (see Supplementary materials).

The transcription of multimodal and space-related aspects of interaction is challenging at best, and in need of improvements both in the notations as well as the kind of illustrations that can be made available in a publication. As will be evident in the examples discussed, large stretches of the interaction are not governed by talk at all, but consist of joint actions accompanied by minimal speech. This relational aspect is not ideally rendered by the type of transcription chosen – while actions are described and illustrated by stills from the videos, the overall orientation of transcribed action is towards the flow of speech. If that is absent, or subordinate to the nonverbal activities in the interaction, the transcription's orientation towards the flow of speech cannot reflect this change in orientation. Nevertheless, a

1 https://www.instagram.com/p/Cy5xJdJsWNN/?igsh=cG9mdjZqNmtmbDg4

combination of GAT2 and multimodal transcription conventions seemed the most suitable, and also widely used, transcription practice.

4 Analysis: making space as a collaborative instructional activity

In the following, the analysis of four extracts shows how embodied actions and verbal instruction combine into coordinated activity to create objects in their spatial dimensions. A particular focus is placed on how a boundary is established through the combination of verbal, gestural and embodied means, and how an orientation to that boundary is maintained until the final product emerges. The joint orientation to a physical boundary interacts with the orientation to the boundaries of the interactional space between participants – while the creation of a (smaller) object has an impact on the structuring of the interactional space in which the object is manipulated, the creation of larger entities such as buildings transcend the immediate interactional space, making the upkeep of a mental image of the entire building even more challenging.

The first extract presents an example of very localized spatial activity: the transformation of a piece of material (rawhide) into an object, similar to the transfrmation of natural material into ingredients during cooking (Mondada, 2014b). The transformation is irreversible, and requires spatial alignment and a joint projection of the final object, its dimensions and its shape, to be carried out successfully. In Example 1, the establishment of a boundary by the tracing of a line on raw material prepares the ground for the creation of a recognizable and meaningful object. The tracing is embedded in an instructional context, i. e. the visualization of the line is not just aimed at structuring imminent next actions that require cooperative behavior for their accomplishment, but also serves to explicate and make understandable the current state of affairs and the overall aim of the project.

4.1 Defining boundaries I: cutting a sole

In the extract in Example 1, two participants cut a sole for a sandal from animal rawhide. PA1 on the left uses a flint blade to do the cutting, PA2, sitting on the right, instructs him on the shape and dimension of the sole-to-be. PA2 is an expert in ancient technology and has made a pair of sandals from rawhide for himself before. PA1 has experience with leather and sewing, but not specifically with the material and tools used here. Prior to the interaction shown here, the participants have discovered that cutting a sole from the rawhide is very difficult if done by one person alone with the tools available. They agree to cooperate in this endeavor, with PA1 holding and cutting the rawhide and PA2 securing the rawhide for easier cutting.

The excerpt (see transcript in Figures 1, 2) starts right after participants have shifted their positions in order to have a better vision and access to the material according to their tasks: PA1 as the primary maker of the sandal and PA2 as his advisor and assistant. PA1's task is to cut a sole to fit his foot from the larger sheet of material, while PA2 assists by supervising the progress and by holding the sheet of rawhide in place by securing it to the ground with his hands and feet. Their interactional space is largely defined by the extent of the material and its affordances for successful manipulation, i.e., the size and shape of the hide and the room needed for cutting movements as well as for securing the hide.

Before PA1 resumes the task of cutting, PA2 intervenes with instructions on where to cut the remainder of the outline of the sole (line 08). He indicates the danger of the sole becoming too narrow by demonstrating the shape of the heel on the material with his fingers (line 10), visualizing that the emerging width is too narrow for a heel. PA2 provides additional information and explanation for his suggestion to cut the sole larger than the cut-so-far suggests (lines 09–17). His reasoning is accompanied by a gestural depiction of his left hand resembling a moving foot (lines 15–16), an "abstract motion" (Streeck, 2008: 295), where the hand is not actually linked to the object (the sole), but carries out a motion abstracted from both the foot (which it depicts) and the focus of the task. In fact, to separate the gesture from the current focal point, i.e., the location of sole and foot, he turns his left arm and his gaze towards his back, thereby moving the demonstration out of their joint interactional space, or o-space, into an area behind him, almost venturing into what Kendon (1977) calls the r-space. This is the area beyond the o-space area where "the acoustical signals projected into the o-space dissipate rapidly, where the olfactory and thermal output of the interacting individuals fades away, and where the people in an F-formation keep their possessions and props" (Ciolek and Kendon, 1980: 260). His body torque suggests that this reorientation is to be only temporary to create a separate demonstration room from the cutting activity.

During PA2's explanations, PA1 places his foot on the sole-to-be, thereby projecting the emerging combination of body part and final product to visualize their fit. With the foot now in place, PA2 traces the remainder of the sole's outline to be followed for the final cutting process, accompanying an explicit instruction to "go outwards a little" (line 24–25). Once PA1 has resumed his working position, PA2 repeats his instruction to make the cut wider, using deictics (*this*) to accompany another tracing gesture that outlines the cutting line to follow (lines 33–34). PA2 then watches while PA1 resumes the cutting along the previously traced outer boundary of the sole.

As the sole emerges as a distinct and therefore more detached and mobile object (see transcript in Figure 3), both participants realize that cutting along the imaginary line is becoming more difficult. At that moment, PA1 requests help from PA2 to hold the sole in place for the continuation of the cutting (line 37). To finish the task, both participants take hold of the sole part of the material while securing the remaining material with their feet. While PA1 keeps cutting along the traced imaginary line with the flint knife in his left hand, his right hand keeps readjusting the grip in coordination with PA2, who uses both his hands to hold the emerging sole pulled tight for easier cutting (line 39). These microadjustments, which are fine-tuned between both participants, show clearly how they both are simultaneously orienting towards the imaginary outline that PA2 had traced earlier in an environment that featured PA1's foot as a tool for orientation and which is now absent. With the final cut, the sole emerges as a distinct and recognizable object out of the more amorphous mass of the raw material. This moment is recognized and appreciated by the participants in lines 40–46, when PA2 checks the flexibility of the sole and comments on its quality (*quite a shoe*, line 41) and its aesthetics (*looks pretty fancy from this side*, line 44).

Participants' actions are in line with their respective roles and the knowledge asymmetry connected to them: PA2 as the more experienced craftsperson is "doing being a teacher" by giving

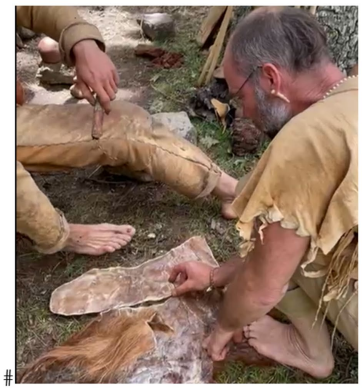
```
(08) PA2: ‡*°and make ‡SURE+ it's not=*
           *points at hide---------->*
            °at hide->08.15
     pa1                ->+
          ‡at hide------------------->
(09) PA2: *because this is not=
          *points with thumb and index finger at heel area on hide->
(10) PA2: your #HEEL;*
          ---------->*
     fig        #  figure 1
(11) PA2: *you KNOW,
          *points at hide with index finger->
(12)      ‡(-)+(-)*
     pa1      +stands up->
          ‡at hide->
     pa2        ->*
(13) PA2: *i think ‡we will need to go+* more ((coughs))
          *traces line of heel on hide with finger*
     pa1                             ->+...>
                ->‡
(14) PA2: (-) we need a lot of SPACE back there.
     pa1  .......places foot on hide->14.27
(15) PA2: *because° it's not* (-)
          *moves LH to the left*
          ------->°to his left->
(16) PA2: *äh it's it's gonna MOVE you know=
          *moves left arm back and forth->
          ------------------------------>
(17) PA2: you're gonna MOVE around*° on it;
                                    ->*
                                     ->°at hide->17.27
(18) PA1: YEAH-
(19) PA1: i think i made it [too too] BIG you see,
     PA2:                   [coughs]
(21) PA2: yah too big is oKAY;
```

FIGURE 1
Example 1: Transcript 1a.

instructions and explanations, but he also provides local assistance that allows PA1 as the less experienced craftsperson some autonomy: while PA1 is fully concentrated on the task at hand, keeping body posture and gaze oriented towards the focus of activity, PA2 limits himself to securing and adjusting the material. In this division of labor, it is acceptable for PA2 to comply with requests for help by PA1, as they clearly both show commitment to the joint project (Zinken and Rossi, 2016). This commitment manifests itself also verbally: in his explanation for the need to cut a wider shape for the sole, PA2 uses the personal pronoun *we* when talking about the overall design and

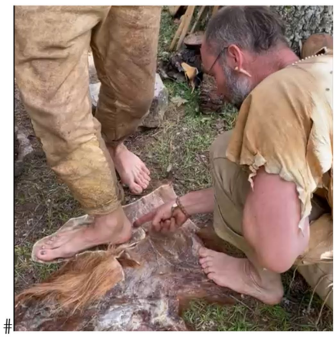
```
(22) PA1: *yah?
     pa2  *...>
(23) PA2: but just that you THINK ä:h?*
          ..points at heel end of hide*
(24) PA2: *RAther go:-
          *traces line of heel on hide with finger->
(25) PA2: go #OUTwards a little;
          -------------------->
     fig      #  figure 2
(26) PA1: (-) o*[kay];
                                          ->+moves foot away from hide+
     PA2:       [bet]ter° have it too f- too+* too too WI:de;+
     pa2      >*                            *LH touches right shoulder->
                    ->°upwards and away from hide->
(27) PA2: than*° ä:[:h too] NARrow.
          --->*moves closer to hide->
          ,,,,>°at hide->28.36
     PA1:           [too short.]
(28)      +‡2.0
     pa1  +sits down->
           ‡at ground->
     pa2  ->
(29) PA1: BLImey;+‡
               ->+
                ->‡
     pa2  ->
(30)      +‡4.0+*
     pa1  +puts knife at hide+
           ‡at hide->32.36
     pa2  ----->*
(31) PA2: *there's i would i would+ go THIS;
          *shapes line on hide with index finger->
     pa1                          +moves right hand away from hide->
(32) PA2: like like+ THIS;*
                         ->*
     pa1          ->+.....>
(33) PA1: yeah;+
          takes hide with right hand+
(34)      +26.0+‡°
          +cuts hide with knife+
              ->‡
```

FIGURE 2
Example 1: Transcript 1b.

manufacture of the object, while the instructions for cutting are directed at PA1 as the person mainly responsible for the execution of the task. This responsibility is further evidenced by the different types of speech PA1 employs: he produces comments that seem to be primarily self-directed (*blimey*, line 31), other-directed displays of understanding of PA2's instructions and suggestions (e.g., lines 19, 22, and 29) and overt agreements with PA2's comments (e.g., lines 18, 26, and 35). All of these serve to stay in touch with both the task and with

PA2 in order to keep the joint orientation and the joint plan active between them.

The analysis has shown that task at hand is space-related in two ways:

- Establishing and maintaining an interactional space which accommodates the material to be worked on and allows adequate movements and unimpeded vision for cutting;
- Establishing and then orienting towards the imaginary cutting line as the outer boundary of the sole by holding and moving the material in a finely coordinated way so that it stays under tension.

Their joint coordinated actions are visible manifestations that their orientation towards the imaginary outline is active and their attention is focused on the task at hand. As stated before, this is particularly important in settings in which the manipulation of material is irreversible – in the case described here, once the piece of hide is being cut into a sole, and this action cannot be undone. When dealing with materials that can potentially be transformed in a multitude of ways, participants "orient to the fact that these actions are irreversible, as shown by them stopping their action while asking a question or enacting it in the air rather than on the object itself. (…) They also treat that particular shaping of the object as excluding other ways of preparing it once it has been cut; in this way, errors in transforming ingredients in the kitchen are treated as irreparable. This irreversibility of action has structuring effects on the progressivity of the work of following instructions" (Mondada, 2014b: 216–217). PA1 makes sure that the irreversibility of cutting the hide into a sole does not result in

```
(35) PA1: +‡(1.5) *(if) if you* (.) grab THAT bit +*yeah,+*
          +touches hide------------------------->+takes hide at heel end+
           ‡keeps eyes on hide->37.41
     pa2          *.......takes end of hide*         *readjusts grip*
(36)       +8.0+
     pa1   +cuts hide+
(37)       +(.)+*(.)*+(.)#*(.)*3.3+(.)+
     pa1   +readjusts grip+cuts hide+lets go of hide+
     pa2        *readjusts grip RH*readjusts grip LH*
     fig                    #                        figure 3
(38) PA2: *o+KA:Y.*
          *holds hide and bends it in the middle*
     pa1    +moves foot closer to body putting right arm on knee->
(39) PA2: *quite a SHOE+* huh;+‡*
          *thumbs press on hide*drops hide*
     pa1   ------------>+moves head towards hide+
                        ->‡
(40) PA2: ‡((snorting sound))
     pa1   ‡at hide->>
(41) PA1: *(.)*quite a SHO:E;*
     pa2   *picks up hide*turns hide to the furry side*
(42) PA2: pretty FANcy °from *this side actually;*°
                              *wriggles hide------>*
                       ->°at PA1------------------->°
(43) PA1: °yeah *yeah yea:h-
     pa2         *stands up->>
          °at hide->>
(44) PA2: ((laughs))
```

FIGURE 3
Example 1: Transcript 1c.

a dysfunctional product by placing his foot on the hide for orientation, and reassuring himself with the instructor that allowing ample room for cutting is the right way to proceed. PA2's actions equally focus on the task of making sure that the finished product has the right shape and dimensions to be a functional product. His verbal and gestural instructions aim at the establishment of an outline, i.e., a boundary of the final object that clearly separates the object from the remainder of the unshaped material. A joint orientation to this boundary is essential for the successful transformation of the rawhide.

The success of the project is evaluated positively by both participants in their final comments, initiated by PA2 and ratified through repetition and positive agreement by PA1. The evaluation of the outcome of compliant action after a request is common as a typical feature of the *IRE* sequence (*initiation – response – evaluation*, Mehan, 1979) in instructional settings, and marks the end of the joint activity. In the case of the sole, the emergence and completion of the object is accompanied by gestural activity. While the shape of the sole gradually evolves from the initial tracing of its outline in the finely coordinated cutting process, the end of that process and its evaluation as well as the completion of the final product is indicated through the handling of the sole by PA2: he takes it into both hands, bends it to test its flexibility as a crucial feature of a sole, then drops it between himself and PA1 with a gesture of release (line 41). The object is now ready to be used further, it is complete and has all the necessary features of a functional and aesthetic sole and is thus "established as an object with certain intelligible, known-in-common, and currently relevant properties" (Streeck, 2009: 75).

In the example above, participants created an artefact with a particular function and aesthetic quality out of raw material. This ability to transform is inherently human, from the first handaxe to complex machines, from the first handprint to intricate artworks; and exploring the beginnings, or at least some earlier phase of such transformational activity, is a social endeavor driven by human curiosity and creativity. Moreover, artefacts usually combine functional as well as symbolic uses, as Hillier and Hanson (1984:1) state: "Invariably, artefacts are both functional and meaningful. Insofar as they are the first, they are of practical use; insofar as they are the second, they are of primarily social use, in that they become a means by which cultural identities are known and perpetuated." In the extract discussed above, this is evident in the functional check of the sole's flexibility combined with aesthetic appreciation by PA2 (lines 40–46).

4.2 Defining the boundaries II: creating a circle

As noted above, buildings serve the additional function of providing a continuous boundary between an inside and an outside, structuring previously unstructured space into areas by physical, i.e., material, manifestation, that are usually more permanent than the boundaries established through interactional formations. In the following extracts, we observe three instances of boundary establishment during the building of a Mesolithic style hut, executed by a team of experts in ancient crafts and novices as their helpers.

The first excerpt to be discussed starts at a point in the building process where the rough dimensions of the hut, its center and its orientation have been agreed upon by the building team. To help her with marking a circle as the outline of the future hut, PA1 uses a string of the length of the radius which is pinned to the center point of the designated area. By rotating the length of string around the pin in the middle and scraping a line into the grass with a sharp tool, the outline should emerge. Just prior to this activity, PA1 enlists the help of PA2 to mark the emerging line with sand to make it more visible (see transcripts in Figures 4, 5).

When giving her instruction in line 01, PA1 is positioned as standing on, and therefore marking with her body, part of the outline of the hut (line 2). Her verbal instructions are minimal and reduced in linguistic complexity, as is typical for settings in which a language is used as a lingua franca (Cogo and Pitzl, 2012). With a minimal outward move of her arms she indicates and shapes the circle that is to serve as the basic boundary between the inside of the hut and the surrounding area. In doing so, she uses a gestural "picture" (Streeck, 2008: 285) that provides clues to PA2 what the end product should look like, and in particular, where in space the end product should be located. This is achieved with minimal gestural effort: only very short strokes of both hands indicate the location, shape and dimension of the circle to be marked. The interpretation of the gesture as indicating the shape and position of the circle relies on the bodily posture of PA1 – her body marks part of the circle, with her arms and hands used as extensions to visualize a round shape. As the gesture is ephemeral, the participants' task is to keep the interpretation of the gestural picture active until the structure it depicted emerges in some material, and more permanent, form. In contrast to the first example, where participants oriented towards an imagined rather than a drawn line, the participants in the hut building use aids in supporting the maintenance of the mental image of the overall structure. PA1 decides to use a simple measuring aid (stick and string) and marking material (sand) to create the circular shape. The chosen methods and materials are very simple and easily available both in the past and in the present; by using them, participants draw on established and reliable practices for measuring and marking and objects whose properties "constitute solutions found by others to systematic tasks and problems" (Goodwin, 2017: 247). The marking itself is clearly only temporal and ephemeral, and is meant to be transformed into something more sustainable in the immediate future.

The requested action is immediately carried out by PA2, who trickles the sand in coordination with PA1 scratching the line into the ground (line 09). Here, we have a preparatory multimodal instructional sequence and then the joint coordinated action as adjacency pairs. While maintaining the interactional space by orienting towards each other and their joint activity, participants simultaneously orient towards the emerging line as a defined element in their material surroundings. They clearly respect it as a boundary: they avoid stepping on the marked line and move their bodies such that the emerging line is segmentally integrated into their interactional space as a focal area of joint attention. While both participants move rhythmically and in finely coordinated steps along the emerging line, PA1 keeps commenting on her progress and the recurring difficulties in handling the string and the scraper (lines 11–17). Similar to PA1's comments in Example 1, her talk can be interpreted as the attempt to keep PA2's attention on the task, to make available PA1's perception of the activity to PA2 in order to maintain the cooperative mode until the task is accomplished. Her comment comparing the possibility of precise measurement in the present and the past of Mesolithic people (line 15–17) shows how the participants' overall orientation is on the re-creation of a past object; they are aware of the explorative nature of each of the steps in the building process as they are trying to recover them.

4.3 Defining the boundaries III: joining the roof

Further on in the building process, the outline of the hut has been marked more permanently with a shallow ditch and has been equipped with hazel rods standing upright, with gaps of equal distance between them. The task is now to shape the roof of the hut by joining two opposite rods at the center, thereby creating a domed top. In analogy to the demarcation of the outer boundary of the hut on the ground as a separation between a *here* and a *there*, shaping the roof of a building creates a boundary between an *up* and a *down*, between an *above* and *below*, in which considerations of symmetry for stability play an increasingly important role.

At the beginning of the extract (see transcripts in Figures 6–8), PA1 has positioned herself on a ladder which is placed in the assumed center of the hut. She has been given one of the hazel rods and is now waiting for PA2 to bend the opposite rod towards her so that she can join them with leather straps.

(01) PA1: ‡((NAME)) would YOU take (.) the sand,
‡looks at PA2----------->

(02) PA1: +and i_ll #show how,@
+points at ground moving hands in circle->
-->

fig # figure 1

(03) PA2: *mHM,*
nods
pa1 ----->
----->

(04) PA1: the ‡the CIR+*cle,+*
---------->+bends down+
--->‡looks down------>>
pa2 *bends down*

(05) PA1: +*and you,
+moves scraper and string in a line ->
pa2 *takes sand from bag---------->

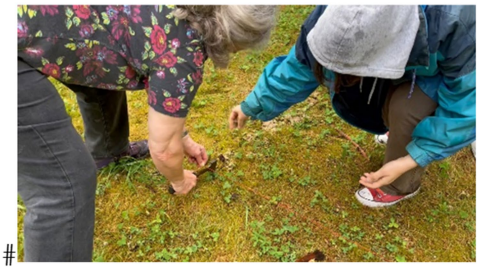
(06) PA1: you (TAKE the sand) okay?
-->
pa2 -->

(07) (3.0)+
pa1 -->+
pa2 -->

(08) PA1: +whoops.+*
+readjusts string+
pa2 ------->*

(09) +*(5.0)
pa1 +steps back, moving scraper and string->
pa2 *trickles sand on line of circle------>

FIGURE 4
Example 2: Transcript 2a.

(10) PA1: #naja-
ah well
------->
pa2 ------->
fig #  figure 2

(11) PA1: *n bisschen weiter außerhalb,+
a litte bit further outside
---------------------------->+
pa2 *moves bag closer and takes sand-->

(12) PA1: +HOA!?+
+loses string+
pa2 ------------->

(13) PA1: +dieses DING,+
this thing
+readjusts string+
pa2 ----------------->

(14) +(8.0)
pa1 +steps back moving scraper and string-->>
pa2 ->*trickles sand----------------------->>

(15) PA1: i think- (--)

(16) the mesolithic- (2.0)

(17) were not so exact too; [he he]

(18) PA2: [<<:-)>hmhm>]

FIGURE 5
Example 2: Transcript 2b.

As in the drawing of the circle, participants engaged in the shaping of the roof already share an understanding of the steps to be taken to complete the task. In line 01, a multimodal initiation of a request containing a minimal verbal contribution (*und jetzt*) and a minimal gesture towards the next rod activates the shared knowledge and understanding of the steps, their sequence and their execution for both PA1 and PA2. In that sense, the utterance *und jetzt* accompanying the directional movement of the arm could also be seen as a kind of running commentary, making the joint work explicit and mutually accessible. This is also evident in the fact that PA2 completes PA1's incremental request (*der und der gegenüberliegende*) himself while carrying out the action (line 02–03). It is evident that the co-operative action is held together by the joint handling of the material, which quite literally connects the participants in a spatial arrangement that poses challenges for the establishment and upkeep of the F-formation. PA1 is positioned on top of a ladder, which elevates her above PA2. The actions necessary to join the hazel rods require the management of interaction across varying distances as PA2 walks away from PA1 to take hold of the rod, then returns with it for joining by PA1.

Once the rods are joined, the joint becomes the common focus of attention and orientation. PA1 carries leather straps around her neck: these make her identifiable as the main performer of action while at the same time indicating what the next action will be – the tying together of the rods at the top of the structure. The ladder on which PA1 is standing to receive the rod is positioned in the designated middle, but this needs to be verified as the domed shape gradually emerges. Both for joining the rods and the verification of the middle PA1 enlists the assistance of PA2 and PA3. Her request to PA2 and PA3 for checking on the middle is

```
(01) PA1: ‡*°und jetzt,
          and now
          ‡at opposite rod->
     pa2   *walks to rod->
           °at rod->
(02) PA2: +DE::R und der gegenüberliegenDE,+‡*°
           this one and the opposite one
                                          ->*
                                          ->°
     pa1  +moves right arm in direction of opposite rod+
                                         ->‡
(03)      +‡*°(3.5)+(1.5)
     pa1  +holds out arm+grabs rod and moves it towards other rod->
           ‡at rods->
     pa2    *moves rod to PA2->
            °at opposite rod and rod held by PA1->
(04) PA2: #joa-+‡*°
          ----->*
          ------>°
     pa1  --->+
             ->‡
     fig                                  figure 1
(05)      ‡*°(3.5)°
     pa1  +hand to ground+hand to rod+
     pa1  ‡at ground->
     pa2   *moves to edge of circle->
           °alternately at ground and rod join°
(06) PA1: ‡*°@&§(--)&can you have a LOOK?‡*°@&§
          ‡at ground-------------------->‡
     pa2   *rubs palms------------------->*
           °at PA3 ---------------------->°
(07) PA1: [+‡°&§WHETher‡ it's in the middle (.) ‡§#here?]+‡°&
           +points at ground moving hand in circle------>+
            ‡at PA2---------------------------->‡at ground‡
     pa2     °at PA1-->‡at ground below PA1--------------->°
     fig                                  figure 2#
```

FIGURE 6
Example 3: Transcript 3a.

carried out both verbally, using a question format (line 06–07), and gesturally by pointing to the ground with one hand, the other holding the two joined rods in place. PA2 complies immediately, realizing that PA1's position cannot be maintained for any length of time. He uses his own body posture for orientation, which he adjusts to a position from which he feels able to judge the middle point. He makes this orientation visible to himself and others by using his arms joined in the middle of his own body and raising them as high as possible towards the joined rods (line 08–11, and Figures 3, 4). His gaze alternates between the ground and the roof (line 07–08), indicating repeated checks of his orientation. He thereby traces an imaginary line from the center point on the ground to the center point in the emerging roof. This line enables him, PA1 and PA3, who observes the activity while walking towards PA1, to jointly verify and ratify the center of the overall structure. PA3 shows his agreement and support by his assisting action of grasping the rods at both sides of the designated joint. This enables PA1 to continue with the next step of tying the rods together with leather straps.

The request to check for the middle has both a local and a global function: the determination of the middle affects the local action of binding the rods together. This needs to be done immediately, as the rods cannot be held indefinitely. At the same time, determining the middle affects the overall success of the project: as the first joint prepares

```
(08)      ‡*°@(1.0)*@&§

     pa1  ‡at PA2->
     pa2   *takes step back and puts palms together*
            °at rod joint->

(09) PA2:  *&§more [or LESS,]*

           *steps forward and raises arm*
           ->
     pa1   ->

(10) PA2: *@&§yeah,‡§

          *points at rod joint->
          ->
     pa1          ->‡
     pa3    &walks to PA1 and PA2->


(11) PA2: ‡§i think the mid‡dle is‡ like #right here,*°
                                                    ->*
                                                     ->°
     pa1  ‡up at rods---->‡at PA2>‡at rods
     pa3  ->
           §at rod joint->14.20

     fig                          figure 3#  

     fig                          figure 4#  

(12) PA1: *‡°Okay;°&

           ‡at leather straps->
     pa2    °at ground°
     pa3  ->&

(13)      *°(2.0)‡&(2.0)

     pa1  *takes leather strap from shoulder and ties it around joint->>
          ------>‡at rods->>
     pa2  *walks to edge of circle
           °at rods held together by PA1 and PA4->>
     pa3           &holds rods together each side of joint->>

(14)      *(2.0)

     pa2  *walks around PA2 and PA4->
```

FIGURE 7
Example 3: Transcript 3b.

the orientation of all further joints, its execution is essential for the final shape, delineation and stability of the hut – as such, determining the middle can be seen as instructing a vital step in the overall building process. The duality of the check can also once again be seen in the fact that functional and aesthetic aspects guide spatial decisions.

4.4 Defining the boundaries VI: shaping the entrance

In order for a building to be useful, its inner space needs to be accessible, or, as Hillier and Hanson put it, in order for the area enclosed by a boundary to be "part of an effective system of space, the boundary must have an entrance" (Hillier and Hanson, 1984: 73). Thus, we need to modify our basic observation made when discussing Examples II and III: the boundary of a building as a site of social activity not only separates a *here* from a *there*, or an *above* from a *below*, it must also be permeable in a way that allows a connection between the outside and the inside. The entrance thus has multiple properties: it defines a permeable section of the structure's boundary while being defined by a boundary itself, i.e., the entrance needs to be shaped in order to be a useful and meaningful feature of the hut.

In the following extract (see transcripts in Figures 9, 10), PA1 (in blue clothing) as the instructor indicates with an arching gesture the dimensions, shape and position of the entrance of the hut. The position has so far only been marked by a gap in the circular ditch on

(15) PA1: Okay;*#
pa2 ---->*
fig #  figure 5
(16) (1.0)
(17) PA1: Okay;§(.)
pa3 ---->§at ground->>

FIGURE 8
Example 3: Transcript 3c.

(05) PA1: ‡+°•**gehn wir #HI:ER-**•
we go here
+shapes entrance arch with hands->
‡at hands->
pa2 °at PA1->05.12
pa3 •at PA1->05.11
fig #  figure 1
(06) PA1: •**(-)**+**(--)**+‡
--->+steps back+
->‡
(07) PA1: ‡+**einmal von UNten einmal von Unten.**+
once from below once from below
+points at ground of right and left entrance+
‡at ground->
(08) PA1: +**und binden die‡ Oben;**+
and tie them up above
+traces arch with hands+
->‡at PA3->08.13
(09) PA1: +**im KREIS zusammen,**
together in a circle
+holds arms in crossed position->
(10) (-)+**(-)**
pa1 -->+
(11) PA3: @**aa:h,**@•
@nods@
------>•
(12) PA3: •**wie son (.)** @°**#Iglu;**
like an igloo
@shapes semi-circle with arms->
->°at PA3->
pa2 •at PA1->
fig #  figure 2
(13) PA3: im +°**GRUnde;**+‡@
basically
----,,,,,,,,,,@
->
pa1 +nods--->+
->‡
pa2 --->°at PA1 and hut->13.18

FIGURE 9
Example 4: Transcript 4a.

```
(14) PA1: ‡ja.•
          yeah
          ‡at hut->
     pa3  --->•
(15) PA3: +*•Okay;*•
          okay
            •at ground•
     pa1  +shapes hole of entrance with arms->
          ->
     pa2   *nods->*
(16) PA1: •und HIER als eingang+ ne,
          and here as an entrance right
                                ->+holds up arm in middle of entrance
          ->
     pa3  •at PA1 and hut->
(17) PA1: so ungefähr in #DER höhe-
          around this height
     pa1  ->
          ->
     pa3  ->
     fig                  #  figure 3
(18) PA1: dass ‡wir DA raus•kommen;+
          so we come out there
                                    ->+
             ->‡at ground->17.25
     pa3                 ->•at ground->
(19) PA3: +[ja:-]°
          yeah
          ->
     pa1  +points at ground of left entrance
     pa2  ------>°
```

FIGURE 10
Example 4: Transcript 4b.

the ground as the result of a conscious decision by the experts based on archaeological evidence of the typical orientation of Mesolithic shelters towards the south-east.

In this extract, we once again see how a preliminary multimodal instructional sequence establishes the boundary to be created, both by the instructor and the instructed. PA1 shapes the lines of the entrance into the air at the position where the arched top of the entrance is supposed to be (line 5), while PA3 (in brown shirt) repeats this shape with his arms in front of himself (line 12). From PA3's perspective, the arch that he forms with his joint arms in front of his body mirrors the dimension and shape of the arch previously depicted by PA1. Because of PA3's distance to the structure, his gesture is not situated in the exact place of the future entrance, but it is projected onto the point in the structure where the future entrance is to be located (line 12). Thus, PA3's repeating gesture shows an understanding of the instructional action by PA1 that makes the joint imaginary structure explicit and available for orientation. It is thus an essential step in the overall progression of the activity, sequentially situated between the instructional and compliant action.

Mondada observes that instruction and compliant action are often not adjacent: "After an instruction has been initiated by the chef and an instructed action has been projected, the next action is often not an instructed action following the instruction. Instead, the action with the objects is often suspended and a trainee initiates a question-and-answer sequence" (Mondada, 2014b: 211). In the above example, PA3 responds to the instructor's explanations not with immediate compliance, but with a display of understanding that takes up the gestural depiction of the spatial structure. This display serves as an affirmation of the joint imagination of the shape of the structure-to-be. Such displays of understanding as affirmation or reassurance are typical for settings in which the transformation of the objects/materials is potentially irreversible (see the discussion of cutting the sole above). We can identify the shaping gesture as a "gestural 'picture'" (Streeck, 2008: 285), showing "*what the referent is like*" (Streeck, 2008:

```
(07) PA4: °•&§(-)&§das heißt #DEN °jetzt hier runterbiegen=•
          this means bending this one down now

           &left hand grabs rod&holds rod with both hands->
            §at rod§at PA3->
     pa2  °at ground------------>°up at tip of rod->
     pa3  •at ground------------------------------------>•
     fig                          #                      figure 1
(08) PA4: @•ja?°@•&
          yeah

          ->
          ->
     pa2  ---->°
     pa3  @.......picks up rod@
           •at PA4•
(09) PA3: °•&(-)j:a.@&
          yeah

          --------->@
           •at ground->
     pa2  °at PA3, PA4 and hut->09.17
     pa4    &bends rod slightly->
          ->
(10) PA4: @O&der? (-)&(1.5) @§(-)
          or

          ->&bends rod&holds rod with both hands->
                        ->§at rod and ground
     pa3  @walks with rod towards entrance@...>
(11) PA3: §machen wir [&am BESten]&(.)@zu ZWEIT.(.)@•§
          we better do it together

          moves rod to ground-------->@........sticks rod in ground@
                                                 ->•
     pa4                ->&left hand lets go&
                                                  ->§
(12) PA4:                [ah okay-]
                          ah okay
(13) PA3: @•&§(3) GEnau-=
                  exactly

          @bends rod->
           •at rod->
     pa4    &bends rod with both hands->
             §at rod->
```

FIGURE 11
Example 4: Transcript 4c.

286), or, in this case, what the referent *is supposed to be like* once it has been accomplished. As in Example II, with minimal gestural effort the instructor achieves an interpretation which is shared by the participants, and maintained and oriented towards throughout the construction process.

The final extract (see transcripts in Figures 11, 12) shows the phase of the building activity in which the arch of the entrance is being shaped by bending two hazel rods from opposite sides to cross each other at the top of the entrance and be secured at each side of the entrance with leather straps. The transcript sets in at the point at which the bending of the first rod is identified by PA4 (in brown shirt) as the next step to be executed. Before proceeding, PA4 reassures himself that bending the rod into an arched shape is in fact the next step with a question directed at PA3 (in blue clothing, lines 07–08). He indicates his readiness to carry out the action immediately by grabbing the rod with both hands and starting to bend it downwards, but holds it in place until PA3 ratifies the action (line 09). While continuing to bend the rod, PA4 sees PA3 adding the second rod to the right side of the entrance. PA4 realizes that the bending action would have to include both rods simultaneously and stops in his movement (line 10). At the same time, PA3 intervenes with a suggestion to carry out the action together, to which PA4 signals acceptance and understanding (line 11). Here, the need for cooperation in the building process is made very explicit: the

```
(15) PA4: &•ja-@(2.5)@
          yeah
     pa3       @moves rod in ground@
                •at ground->
     pa4  &holds rod->15.23
          ->
(16) PA3: SO:• ist §das§ doch •prima,&
          this is fine like this
     pa3  -->•at PA4------->•at rods->16.21
     pa4  -------->§at PA3§at rods->
(17) PA3: @(4.5) genau: jetzt kannst du's zu§SAMMEN§binden-°
          right you can tie it together now
     pa2                                                  ->°
     pa3  @holds rods->17.22
     pa4                                  ->§at PA2§at rods->17.48
(18) PA3: *°(32) ah das HÄLT. (also-)
                 ah this will hold (so)
     pa2  *tying knot->
           °at rods and leather strip->
(19) PA2: mhM;
          ->
          ->
(20) PA3: joa das nur dass der nich WEGkann;
          yeah only so it can't move
     pa2  ->
          ->
(21) PA3: das PASST schon;*°•
          that'll do
     pa2                ->*
                         ->°
     pa3                  ->•
(22) PA3: *°•gut.*@§
          good
     pa2  *stands up*
           °at PA3 PA4 and hut->
     pa3  -------->@
            •at hut->22.
     pa4         ->§
(23) PA3: @und jetzt DEN& noch,•*°(1)°*(8)*°&@#(3)*°
          and now that one as well
          @.....................bends rod@holds rod->
                                •at arch->
     pa4              ->&bends rod-->&holds rod->
     pa2                        *walks to leather strips*takes leather strip*
                               ->°at leather strips°at hut°at leather strips°
     fig                              figure 3    #
```

FIGURE 12
Example 4: Transcript 4d.

comment in line 11 can be read as a local request for cooperation, followed by an explanation (line 14) that displays PA3's exclusive knowledge about handling and shaping hazel rods. The compliant actions include the joint positioning of the rods as an arch to shape the entrance and the binding of the rods by PA2 (in red shirt) with leather straps. During the execution of the task, the instructor directs the other participants in their actions (lines 17, 20 and 23) and evaluates the progress and the outcome of joint efforts (lines 13, 16, 21 and 22). PA4 and PA2 as the ones complying to the instructions display their understanding with minimal backchanneling signals (lines 15 and 19). Their orientation towards the arched shape of the entrance is also evidenced by participants' visual checks of the emerging shape (lines 14 and 23) to make sure that both rods align.

In contrast to Example 2, where the marking of the boundary on the ground was clearly meant to be temporal, the actions and instructions in this sequence are aimed towards establishing the entrance as a permanent opening with a defined boundary. The tying secures the rods in a way that conforms to the initial visualization of the entrance, but additionally meets the requirements of stability. The forces at play are visible in the way PA1 and PA3 grasp the rods that have to be tied together – it needs three hands to keep them in the place that the tying is supposed to secure (line 23). The affordances of

the material require orientational work by the participants to maintain a common focus of attention on the point of joining, while keeping the overall structural dimensions in mind that extend beyond their very small-scale o-space.

As Streeck notes, the action of gestural depiction itself can be a sequential and incremental process when virtual objects that have been established before gesturally are marked or otherwise manipulated (Streeck, 2008: 294). Example 4 has shown how a depicting gesture is repeated several times during the construction process to keep the virtual image of the arch active and maintained into the building activity which, again in incremental steps, yields the final structure in its projected position. The incremental steps of the building process are structured by instructional and compliant actions that are grounded in locally relevant repertoires of knowledge.

The creation of a structure that extends beyond situated interactional spaces show how the constant re-figuring of orientations towards each other is necessitated by the tasks to be carried out (e.g., holding, adjusting, securing, provision of materials) and the affordances of the materials (extent to which they can be bent, the need to secure them in a particular position etc.). Despite this very dynamic situation in terms of interactional positioning, the imaginary boundary of the entrance remains a stable feature of orientation for the participants.

5 Summary

The data yields instances of instructional action at the interface of expert-nonexpert interaction that aim at the establishment of boundaries in three-dimensional space. The analysis focused on transforming raw material into an object in the case of Example 1, and the creation of a building exemplified by three activities within the building process: the drawing of the initial structural boundary of the structure, the initial joining of the roof, and the shaping of the entrance (Examples 2–4).

Gestural, embodied, verbal and spatial means work together to structure a previously unstructured area, either as material as in Example 1, or as space, as in Examples 2–4. Such structuring activities have been described in various contexts that require joint attention to a shared space, such as demonstrations. The *Demonstrationsraum* described by Putzier (2012), the *ecology of the demonstration* as analysed by Mondada (2014b) as well as the *clearing* as used by Streeck (2008) all share the function of structuring a space for joint attention and interaction. The analysis of the craft and building activities in this study has shown how such structuring necessitates the establishment and maintenance of a *shared* and *situated* visualization of the object or space-to-be.

5.1 Instructions and visualized boundaries

The data show that instructions in these particular settings are necessarily multimodal and involve a combination of verbal as well as embodied actions in the joint manipulation and transformation of materials and space. When planning a boundary, participants' instructions can incorporate or be accompanied by embodied depictions (Clark, 2016) of the future shape of the space to be created in the position where the structure or object is supposed to emerge. By depicting a future structure within a particular space, participants employ the multimodal resources of imagination-oriented deixis (Bühler, 1934/2011: 149, Stukenbrock, 2014), a form of transposition to refer to non-present entities. Thus, instructions employ means to create a joint mental image of the space-to-be and the object or building to be created as a bounded and defined entity in the interactional space and beyond. Participants orient towards the joint mental image until the object or structure is finished and becomes permanently available as a material object in the environment. The joint image constitutes a necessary intermediate step between the previously empty and unstructured space and the final material product. The implementation of steps in the production of object and building indicates the level of irreversibility of the transformation: in Example 1, participants make sure that the projected line for cutting is clearly defined through verification and repeated deictic referencing, as the cut cannot be reversed once it is done. During the hut building activity, the creation of boundaries shows various levels of permanence: while the circle on the ground is only temporal, the assembly of the roof and the shaping of the entrance are clearly aimed at some permanence.

It has been shown that the establishment of boundaries is a co-operative human activity that enables patterns of social interaction (Hochuli and Streeck, 2022). As Ciolek and Kendon (1980: 0253) note, to "carry out any activity, one must have a domain, a bounded world, within which one can be sure of the pattern of events and can readily comprehend the relationships between the actions one takes and the consequences of those actions." By structuring and engaging with the material space and its affordances, participants create architectures that support interactional formation, so that "some of the task of unambiguously defining the "hereness" of their exchange is taken over by the physical features of the place in which they are standing" (Ciolek and Kendon, 1980: 253), i.e., participants create and use the built space as an interactional resource (Hausendorf and Schmitt, 2016).

5.2 Making space, knowledge transmission and cumulative action

The above observations allow some more general considerations of the significance of joint crafting and building activities for the organization of human sociality in the present as well as in the past. As postulated by space-based approaches to the analysis of social interaction, a building is a domain of social knowledge and allows inhabitants as owners of this knowledge to control the space defined by the building and to use it according to their interactional objectives. Buildings imply graded levels of access and authority, from the inhabitant with full access and authority to the visitor as a stranger granted access to the building to the stranger with no access and no authority to enter the building (Hillier and Hanson, 1984, 146–147).

Participants in that sense enact a fundamentally social process of structuring the material space for social purposes. By doing so, they draw on underlying principles of spatial organization based on two premises:

> "first, that human spatial organisation, whether in the form of settlements or buildings, is the establishment of patterns of relationships composed essentially of boundaries and permeabilities of various kinds; and second, that although there are infinitely many different complexes of spatial relations possible in the real world, there are not infinitely many underlying sets of organising principles for these patterns." (Hillier and Hanson, 1984: 53-54)

The joint creative activity therefore is an exercise in discovering how modern human's actions are guided by their predecessors' actions

and how these actions generated objects and solutions that accumulatively form the cultural knowledge and resource that spatial organization provides for human interaction.

As I have argued elsewhere, in their interactions, participants activate two realities: the reality of the current activity in the present, and the reality of predecessors' past in which they developed solutions for their social actions: "Because of the fragmented nature of archaeological evidence, past objects are not necessarily sedimented "solutions of our predecessors" (Goodwin, 2017: 247) with an unbroken tradition of knowledge accumulation and transfer. Instead, modern users have to employ strategies in their joint engagement with past materiality that allow for the negotiation of authenticity, intended use, and personal experience in understanding the purpose of the object in question" (Wilton, 2023). In these particular settings, the experts are the ones holding knowledge believed to have been available to predecessors with respect to the materials and tools used to create products that are equally attributed to said predecessors. In the instructional actions, novices are initiated into the solutions that the experts present as that of predecessors – the (re)discovery and transmission of past knowledge and skills that are shown to have validity for actions in the present. By (re)creating past objects, they accumulate knowledge through joint explorative activities in which instructions serve to transfer knowledge and to coordinate cooperative actions towards a common achievement.

The creative processes become shared intercorporeal experiences (Szczepek Reed, 2021; Kesselheim and Brandenberger, 2021) in which knowledge and resources of the past are recovered, transformed and used to structure current and future actions. Even if modern and past experiences can never be assumed to be the same, they are similar in that they are essentially human: "any experience of my predecessor is open to my interpretation in terms of the characteristics of human experience in general" (Schütz, 1967: 295). Mutual co-presence and coordination is merged with interaction with predecessors, by not only using, but primarily recovering their solutions to fundamentally human challenges. As Goodwin (2017: 249) notes, "while attaching unique importance to the forms of experience and knowledge that emerge when we are in a state of co-presence with others, Schütz (1967:109) also draws attention to how within the midst of this we encounter objects we have inherited from actors who are no longer present which we re-use for our current projects." These insights are relevant not only for an interactional, but possibly also evolutionary perspective on human building activity as a social enterprise, demonstrating that "co-operative, accumulative transformations are a general feature of human action" (Goodwin, 2017: 251).

Data availability statement

The datasets presented in this article are not readily available because the original data is to be used exclusively by the researcher and her team. Requests to access the datasets should be directed to antje.wilton@fu-berlin.de.

Ethics statement

Ethical approval was not required for the studies involving humans because none of the issues relevant for an ethics check by the institution's ethics committee applied to this research. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

AW: Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2025.1519009/full#supplementary-material

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