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Impasses in the wild: Autonomy support in naturalistic, parent-child outdoor play

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Moments where children encounter problems in their chosen activities represent potentially generative sites for learning, particularly when supportive adults are present to scaffold the learning process. Scholars of autonomy support study these dyadic problem-solving processes in defined tasks, and describe specific types of parental support that have implications for children's future competence as independent learners. In two exploratory case studies, we expand on the study of autonomy support by examining dyadic problem solving in naturalistic, outdoor family play. We apply a situated method of interaction analysis to perform a detailed, micro-longitudinal decomposition of two extended problem-solving arcs, identifying the specific contributions of parents and children. In doing so, we apply additional lenses of problem-solving, debugging, play-based learning, and intergenerational learning to develop a more comprehensive understanding of endogenous, dyadic problem solving. Our findings suggest the presence of inherent tradeoffs between various potential goals and time horizons for children's learning and raise actionable considerations for both future research and practice in collaborative learning spaces.

KEYWORDS

autonomy support, interaction analysis, problem solving, failure, play, intergenerational learning, debugging

Introduction

Meaningful learning opportunities can arise when children encounter obstacles during play. These moments in which discrepancies manifest between goals and outcomes–heterogeneously described in the research literature as problems, impasses, failures, breakdown, and obstacles–can provide generative points of departure for

problem solving processes and skill development (Clifford, 1984; Koschmann et al., 1998; Kapur, 2016). However, in collaborative activities, in which each participant contributes in distinct ways to the problem resolution, what participants gain from the experience might be contingent on how they co-navigate the problem solving process, not solely on whether they arrive at a resolution. In particular, we might ask: Who contributes to the key components of resolving the problem, and how do they contribute? These components include at least identifying and describing the problem itself, postulating causes of the problem, and formulating and enacting possible resolutions (Clifford, 1984; Graham, 1991; Koschmann et al., 1998; McCauley et al., 2008; Murphy-Hill et al., 2015; DeLiema et al., 2022). Moreover, taking a longer time horizon on learning, we might ask: What, if anything, during the problem-solving process might prepare the learner for similar (or distinct) upcoming problems?

Young children, who are newcomers to many of the activities they pursue (e.g., climbing, drawing), often engage in problem-solving processes aided by adults (Vygotsky, 1978) and which unfold in moment-by-moment social interaction (e.g., Keifert, 2021). Parents in these moments face a wide range of options regarding how to provide physical and verbal forms of support to their children. The construct of autonomy support has evolved to specifically theorize about and document the set of options parents face when balancing the child's self-determined choices with their own suggestions for how the child might approach the activity (Grolnick and Ryan, 1989; Whipple et al., 2011). When positioned as a valued approach, autonomy supportive parenting focuses on balancing the child's self-determination with the parent's directed scaffolding, a process that is particularly visible when children notice problems and receive and/or solicit support.

The literature on autonomy support has mainly focused on researcher-designed tasks that carefully define the scope of the problem solving process, such as solving a jigsaw puzzle; these structured settings facilitate the measurement of specific support moves from parents. In contrast, in this paper, we explore open-ended task environments by observing children and their parents in naturalistic, outdoor play, while focusing our analytical attention on moments where children run into problems in their chosen goal pursuits, and where parents and children are faced with moment-to-moment choices about how to engage with the activity and each other. Within this context, we build on the research literature around autonomy support (Grolnick and Ryan, 1989; Whipple et al., 2011), self-determination (Deci and Ryan, 1985), scaffolding (Wood et al., 1976, Landry et al., 2002), debugging (Ko and Myers, 2005; McCauley et al., 2008; DeLiema et al., 2020), play (Burghardt, 2011; Souto-Manning, 2017), and problem solving (Greiff et al., 2013; Shute et al., 2015) to decompose in fine-grained detail what each participant brings to the problem solving process and how these interactions strike a balance between the child's self-determination and the parent's scaffolding.

Ultimately, this research approach can support studies of autonomy supportive parenting (Grolnick and Ryan, 1989; Whipple et al., 2011), productive failure (Kapur, 2008, 2016), and play-based learning (Steen and Owens, 2001; Barab et al., 2010) by more granularly documenting what types of learning arise following problems. We approach this research topic in ways that deeply embrace intergenerational activities (de León, 2007; Marin and Bang, 2018; Keifert and Stevens, 2019; Bang et al., 2020; Keifert, 2020) and we remain open to how a wide range of parenting moves might support distinct types of autonomy. Our long-term goal is to support parents to weigh their options when supporting children's efforts to navigate impasses during play. In the shorter term, this work can help identify research questions and conjectures that are worth pursuing in future studies of autonomy supportive parenting.

Autonomy support, scaffolding, and self-determination

A child's learning process involves a perennial tension between developing independence at a new practice and depending on the help of more expert others (Vygotsky, 1978). Research on scaffolding suggests that by identifying the current state of a child's skill development, and providing the right amount of help or structure, adults can help children work through (potential) failure points to successfully practice an emerging skill and internalize it more rapidly, building toward independence (Wood et al., 1976; Landry et al., 2002). Vygotsky described the socially mediated space where this co-learning occurs as the "Zone of Proximal Development" (ZPD, Vygotsky, 1978), and in doing so also introduced an implied time dimension: more competent others (parents, etc.) support children's *present* problem solving efforts in order to help them become stronger problem-solvers *in the future*.

Other scholars have observed, however, that too much help can inhibit a child's basic need for self-determination: the experience of internally generating and executing one's chosen interactions with the environment (Self-Determination Theory; Deci and Ryan, 1985). Inhibiting that need can dampen intrinsic motivation and negatively impact learning and future performance (Grolnick et al., 2002; Cheung et al., 2016). The study of autonomy support (Grolnick and Ryan, 1989) is about how to thread the needle between supporting the learning process and nurturing the child's fundamental need for self-determination, in a way that ultimately benefits the child's future learning trajectories.

In recent years, researchers have made strides in describing what types of contributions from parents constitute autonomy support. Whipple et al. (2011) have developed a detailed coding scheme for evaluating how parents interact with young children

in researcher-defined, goal-oriented tasks. It includes rating whether parents (a) intervene according to the child's needs and adapt the task to create an optimal challenge; (b) encourage the child in the pursuit of the task, give useful hints and suggestions, and use a tone of voice that communicates they are there to help; and (c) follow the child's pace, provide the child with the opportunity to make choices, and ensure that the child plays an active role in the completion of the task. Parents rated on these dimensions might be instructed to let the child do as much as he/she can, and help only when needed (Meuwissen and Carlson, 2018). This rating system has been employed in several studies (Bernier et al., 2010; Matte-Gagné and Bernier, 2011; Whipple et al., 2011; Matte-Gagné et al., 2013; Meuwissen and Carlson, 2015, 2018, 2019; Distefano et al., 2018), and autonomy supportive parenting has been linked to children's improved executive functioning and academic achievement (Bernier et al., 2010; Fay-Stammbach et al., 2014; Bindman et al., 2015; Distefano et al., 2018; Castelo et al., 2021).

The autonomy support research to date has made a convincing case that an important aspect of dyadic learning is being captured, but significant questions at the intersection of autonomy support and the interactive learning processes remain under-explored (see upcoming sections of the literature review). Rich, data-driven explorations of the interactive learning processes involved in autonomy support could also prompt a more general, bottom-up reexamination of the theoretical foundations themselves.

Failure, problem solving, and time horizons

The autonomy support literature has broadly studied how children and their parents address problems in goal-oriented tasks, but has not specifically considered how moments of failure, and the problem-solving processes they precipitate, surface different potential goal orientations, time horizons, and decision points. By considering these additional dimensions of the problem solving process, we might better understand how particular interactions between parents and children benefit learning.

Literature on the relationship between failure and learning describes how problems necessitate the acknowledgment of a goal orientation and an identification of failure (Clifford, 1984; Koschmann et al., 1998), a causal interpretation (Graham, 1991; Bennett, 2017), and a search for solutions (Murphy-Hill et al., 2015; DeLiema, 2017). The choices children and adults make around each of these dimensions are consequential in that they focus attention (and learning) on particular parts of a rather large problem space (Klahr and Carver, 1988; DeLiema et al., 2021).

Further, within each dimension of this process, a spectrum of goals and time horizons can be foregrounded (Hattie and Timperley, 2007).[1] On one end, the participants may focus squarely on resolving the immediate problem to complete the task, such as fixing a bug breaking a computer program (Freeman, 1964), though supportive adults may also de-emphasize the short-term value of accuracy/correctness (Donaldson, 2019; Russ and Berland, 2019). On the other hand, adults and children may focus on the general skill of debugging–how to identify failures, causes, and solutions–by providing general-purpose tools (e.g., Lee et al., 2018), debugging guides (e.g., Lysecky and Vahid, 2018), or strategies (e.g., Ko et al., 2019). Critically, a focus on teaching debugging strategies and tools might prepare children for a longer time horizon in the discipline, as they may be in a stronger position to handle upcoming, novel problems.

With an eye toward this longer time horizon, the scaffolding and autonomy support literature adopt the stance that thoughtfully calibrated support toward completing the present task can lead to children having higher competence on that task in the future. Consider the following hypothetical from Landry et al. (2002, p. 35–36), in which a parent provides verbal scaffolding to support a child in completing a puzzle:

> *"...when the mother holds up a round puzzle piece and says, 'Find a place in the puzzle that is shaped like this,' the mother is helping the child make an association about how the shape of the object is an important component of the task. This may increase the likelihood that the child will generalize and independently use the verbal concept of 'examining shape' when attempting later non-verbal tasks such as independent play."*

The above example points to support from parents that scaffolds the problem-solving process by drawing the child's attention to the significance of puzzle-piece shape. However, an additional angle on this interaction is worth pursuing: Does this parent's move equally (a) support the completion of the present jigsaw puzzle task, (b) support the ability of the child to solve upcoming jigsaw puzzles, and (c) support the development of generalized problem-solving skills effective for impasses outside of a jigsaw puzzle context? In a parsimonious description of the dynamics that arise when attentive to this longer-term time horizon for learning, Cazden (1997) asserted that some directed scaffolding for a child learning to read "is not a prompt that the child could give to herself the next time, because the prompt depends on the very knowledge of the word that it is supposed to cue" (p. 304). In other words, a scaffold that effectively moves a student toward completing the current task may do very little to prepare the student for upcoming similar tasks, nor for upcoming, novel tasks. In the Landry et al. (2002)

1 DeLiema, D., Kwon, Y., Chisholm, A., Williams, I., Dahn, M., Flood, V., et al. (accepted). *A multi-dimensional framework for documenting newcomers' experiences with failure. Cognition & Instruction.*

example above, the scaffold prepares the child specifically for "examining shape" on upcoming puzzle tasks, and yet more open-ended scaffolds, such as, "Why doesn't this fit?" or "How might you figure out where this puzzle piece goes?" would invite the child to choose which puzzle attributes and problem-solving processes to consider. Would the latter questions foster more general-purpose debugging skills? Perhaps more directly, some scaffolds, such as, "Why isn't this working?" are ones the child could ask herself at a subsequent impasse, even ones outside of puzzle solving; other scaffolds, such as, "Would this piece fit right here?" depend to a greater extent on already having expertise to pick out a relevant puzzle piece and a relevant target.

All three time horizons for learning–resolving the current problem, preparing for similar upcoming problems, and preparing for novel problems–are relevant to autonomy supportive parenting. Each time horizon for learning may be better supported by distinctly different types of scaffolding moves on the part of the parent. An analysis of how learners are specifically gaining practice in a problem-solving interaction, in ways that could benefit them in the future, is likely not complete without considering which of these goals and time horizons are being privileged in a given stretch of social interaction.

Play and naturalistic settings

An additional feature of the existing autonomy support literature is that most studies have focused on researcher-defined tasks, often in lab settings (Grolnick et al., 2002, 2007; Matte-Gagné and Bernier, 2011; Whipple et al., 2011; Distefano et al., 2018; Meuwissen and Carlson, 2018, 2019). To date, only a few autonomy-support researchers have observed open-ended activity for lengthy periods of time (Landry et al., 2002; Bindman et al., 2015). The potential benefits of studying autonomy support in a setting where children are engaged in more open-ended, naturalistic play are numerous. First, children's play is inherently high on self-determination (Salen and Zimmerman, 2003; Gray, 2009; Burghardt, 2011), not only in that children are prone to drive their own activities, but also in that children may choose to enter and exit their chosen play activities (Steen and Owens, 2001), including switching or adopting distinct roles as the play activity progresses (Jurow, 2005; Buchbinder, 2008). As such, it provides a key moment to explore how parents' scaffolding impacts children's self-determination–a central concern of autonomy support. Second, children often use this high level of self-determination to challenge themselves, arriving autonomously at problems within their ZPD (Steen and Owens, 2001; Salen and Zimmerman, 2003; Kiili et al., 2012; DeLiema et al., 2019). This creates an ideal intersection of problem solving and learning, and when adults are present, a potential for autonomy-supportive teaching. Crucially, play-driven spaces can also contribute to learning by lowering the cost of failure (Juul, 2013), and increasing children's experimentation with goals, rules, patterns, and problem-solving strategies (Garvey, 1974; Corsaro, 1979; Colella, 2000; DeLiema et al., 2019). Lastly, these dynamics around self-determination, failure, and experimentation are likely to unfold in the kind of unstructured play (Huizinga, 1944; Caillois and Halperin, 1955) that takes place when children are collaboratively exploring the outdoors (Li et al., 2014; Dinkel et al., 2019), as indicated by studies showing how nature preschools increase students' protective factors, such as initiative and self-regulation (Ernst et al., 2019). These combined considerations, where children are generating their own activities and goals and frequently grappling with unique problems, may create a more productive space for observing the full extent of the problem-solving process, and the different potential goal orientations and time horizons for learning. Moreover, because play is pervasive among children, studying autonomy support in naturalistic play scenarios may provide a perspective that is accessible to parents and educators who reflect on this research.

Children's contributions to the dyadic learning process

Another area available for deeper exploration lies in attending to what children themselves contribute to their own learning process. The current, predominant measurement tool for autonomy support (Whipple et al., 2011) is concerned with "parenting quality," asking coders to focus on parents' support behaviors in researcher-designed tasks. If used uniformly, this perspective could minimize children's self-directed competence (Deci and Ryan, 1985), including notions of the ZPD as a co-created learning space (Vygotsky, 1978). Indeed, Vossoughi et al. (2021) cautioned educational researchers against the tendency to analyze the learning process via the "false binaries" of adult-centered and child-centered learning, and instead build on their efforts to "adequately describe the complexity and generativity of direct assistance within environments organized around joint activity" (p. 25). Keifert and Stevens (2019) further suggest that adult-centric concepts of inquiry inherently promote a deficit view of children's capabilities and fail to capture children's "own understanding of their own activity" (p. 241). Keifert and Stevens (2019) pursue an analytical approach which captures children's informal, interactional inquiry processes with their parents, and reveals the endogenous skills young children bring to their everyday inquiry, including orienting to phenomena of interest and employing interactive sense-making strategies. Interaction analysis (Jordan and Henderson, 1995), a methodological approach that granularly surfaces the contributions of all participants and seeks to understand their co-created achievements, holds promise for exploring autonomy support from a more endogenous perspective. By recognizing the contributions of both parties,

it may be possible to generate a deeper understanding of how children are developing competence during dyadic problem-solving interactions, and work toward a pedagogical perspective more grounded in how intergenerational learning unfolds.

Present study

In this study, we aim to expand the scope of research on autonomy support to naturalistic outdoor play settings, developing a more granular perspective on how dyadic problem-solving interactions unfold, while considering what each participant contributes to the interaction, and identifying in greater detail what types of goals and time horizons for learning might be foregrounded in each of these moments. To accomplish this, we examine video data in a moment-to-moment manner that allows us to detail the contributions of each participant and decompose their problem-solving processes. We use video data, collected by families, to capture dyads *in situ* where children are in a position to drive their own agenda, and parents can be observed making their day-to-day support decisions. We approach this analysis by attending to participants' observable actions, while maintaining the theoretical lenses of autonomy support and problem-solving.

Materials and methods

Introduction to methods

Video analysis researchers often embrace a "progressive refinement of hypotheses" approach (Engle et al., 2007), in which the continued analysis of a rich data corpus leads to ongoing refinement of the research question, along with multiple rounds of clip selection and refinement of the analytical methods themselves. In this section we describe the overarching methods of data collection and analysis applied to the project, but also provide a detailed account of how this specific pair of exploratory case studies and set of research questions evolved through several steps of refinement from a larger research project.

Research practice partnership

The present case studies were made possible by a larger Research Practice Partnership (RPP) (Penuel et al., 2015). The RPP is a collaboration between the non-profit, Free Forest School (director Anna Sharratt), the director of the University of Minnesota Lab School (Sheila Williams Ridge), a professor of child development (Dr. Stephanie Carlson), an assistant professor of educational psychology (Dr. David DeLiema), and graduate students from departments of Educational Psychology (Ashley Hufnagle) and Human Factors and Ergonomics (Justin Baker). The overarching goals of the RPP are to understand how parents and children navigate play, failure, risk-taking, and agency during naturalistic, outdoor inquiry.

Participants and data

As part of the RPP, we recruited families on email lists provided by a national outdoor family play network, a University Laboratory School in the United States Midwest, and a university child development email list in the United States Midwest. Families on the nationwide play network provided the vast majority of responses (over 1000), while the combined responses from the other lists totaled 43. We disseminated a survey to this sample that asked participants to describe and reflect on their experiences playing outside with their children during the COVID-19 pandemic and whether they would be willing to be contacted for further research.

In two rounds, participants for the video data portion of this study were recruited from the 373 families who agreed to being contacted for future studies and had children in the focal age range (2–8 years).

Seventeen families enrolled and fully participated in the video portion of the study. For the present case studies, we selected two families: "Family 15" featuring a 6-year old female child, an older female sibling (age unknown, out of the requested range), and the mother, age 31 (all identified by the mother as white); "Family 17" featuring a 2.5 year old female child (identified by the mother as white and Djiboutian), the mother, age 32 (white), and the father (operating the camera, age/race undisclosed). We describe the rationale for selecting clips from these two families in greater detail in Section "Selecting and bounding clips".

For each of the two, 2-week data-collection blocks, parents were asked to record video of natural, outdoor play with their children. The specific requests given to the participants were that the activities recorded take place outdoors, that the activities be "unstructured interactions" (i.e., not well-known rule-based games or sports), and that the participating parent be present and visible in the video, either by having a third-party record or propping the recording device on a stationary object. The research team further requested that the parents attempt to capture and share 1–2 continuous activity sequences of 10–30 min in length, during each 2-week data-collection block.

Our process aimed to empower participants by moving away from "surveillance-style" data-collection methods toward a more reciprocal "relationship" with participants in a few ways (Vossoughi and Escudé, 2016; Elliott et al., 2020). First, we requested that parents explain the research to children, and ask for their permission every time they recorded. Second, inspired

by the aforementioned studies, we ensured that parents retained full control over what videos to share, including the option to *not* upload entire videos, to stop and start recording as desired, and to edit out portions of videos before uploading. Based on interviews, we know that all of these options were utilized to some extent by families, though with little observable cost to the data, as complete "main segments" of activities (Erickson, 1982) were visible in nearly every clip. Third, at the end of each 2-week block of data collection, video-cued reflections (VCRs) were scheduled with parents (Tobin et al., 2009; Adair and Kurban, 2019). In these VCRs, researchers conducted semi-structured interviews over Zoom, inviting parents to view their own videos and give a personal account of their dyadic activities (see Interview Protocol in **Supplementary materials**). Parents were invited to identify moments of interest, and to discuss problems and risks their children encountered, their approaches to support, how those problems and risks were navigated, and what the learning implications might be.

The final video data set captured a wide range of outdoor play activities, settings, and camera angles. The two clips featured in the present case studies, one of children experimenting with a home-made rope system at Family 15's home, and the Family 17 child climbing rocks in a public park, are single activity arcs, roughly 3 min each, clipped from longer videos submitted by each family. Each activity arc features a dyad engaged in a main activity segment (Erickson, 1982), with observable goals and problems reaching those goals. For the purpose of this analysis, each activity arc constitutes a case.

Analysis

Overall methodological approach

Interaction analysis (IA) (Jordan and Henderson, 1995; Derry et al., 2010), our primary method of analysis, focuses on the observable facets of social interactions and participants' co-constructed efforts to achieve mutual understanding and engage in activity. Using video records of activity, interaction analysts focus on audible discourse and the social and material resources utilized by participants in constructing their interactions. The *availability principle* (Mondada, 2006) states that the video record should capture what was available to the participants during the interaction, including "documenting multimodal resources (language, gaze, gesture, body displays, facial expressions, etc.) as they are locally mobilized and attended to by participants" (p. 6). Given the value of dialog between parents and children for our understanding of their problem-solving process, we built on extensive track records of research in conversation analysis (CA) (Sacks et al., 1974) and discursive psychology (DP) (Edwards and Potter, 1993; Wiggins and Potter, 2003; Wiggins, 2016). Applying CA transcript conventions enabled us to consider how verbal interactions between parents and children were being constructed to accomplish specific tasks, such as seeking or offering help, and recognize how those patterns were either repeating or deviating in a way that revealed how the participants were managing the task. DP looks specifically at how participants make psychological concepts evident in the course of social interaction (Wiggins, 2016). For example, one might attend to how a child vocalizes or displays with their body an interest in pursuing a task independently; this action makes a facet of the psychological concept of self-determination part of the public interaction between the parent and child (DeLiema et al., 2021).

Finally, in the tradition of video cued ethnography (Adair and Kurban, 2019), we considered parents' own perspectives on their dyadic play activities with children. While we were cautious about privileging parents' interpretations of learning and problem-solving over our empirical approaches to video data (IA, DP), and chose not to make these interviews a primary object of study for these case studies, the VCRs with parents granted them a meaningful voice in determining which moments in the data were worthy of attention (aiding our clip selection process), provided vital family background and context for those moments (such as whether a child had previous experience with an activity), and helped us fill in critical gaps when transcribing dialog and action. By approaching video through each of these analytical lenses and considering the different perspectives they offered, we worked toward a more multifaceted and complex understanding of the interactive learning processes on display, and aimed to iteratively work toward a more multi-perspective account of the data.

During the process of reviewing each submission, conducting VCRs with the parents, and holding preliminary data sessions with the RPP team, we formulated a preliminary, guiding research question (Engle et al., 2007): When and how do parents decide to intervene in moments of children's problem-solving? With this general research question as a starting point, we began an iterative process of analysis and clip selection detailed below.

Selecting and bounding clips

The first challenge was the process of deciding which moments, from the 64 total videos and 29 h of video in the data corpus, contained "parents intervening in moments of children's problem-solving." This process began with roughly a dozen exemplar clips that had attracted our initial attention, and challenged us to create definitions of "a parent intervening" and "moments of children's problem-solving," that we could apply as a search criterion to the rest of the corpus. In the process of identifying over 80 main activity segments in the corpus, a complicated realization emerged. First, because children in our data so frequently pursue goals that appear to actively stretch their skill set, almost *any* moment of their self-directed play could be construed as a moment of problem-solving. Second, because we had asked parents to be in the video frame with their children, and because almost all of

the parents were in continuous dialog with their children during the clips, there were many moments in the data set that could be considered a moment of parental support. This ultimately impacted our research question and our clip selection strategy. We narrowed our research attention to the different *types* of support choices parents made, and how those different choices impacted the child's problem-solving process. Further, to capture a diversity of interactions within a dyad, we decided to focus our clip-selection on longitudinal activity arcs, where children engaged in more extended projects, and parents could be observed making a series of support choices over the course of the activity arc, giving us greater insight into the implications of any given choice, and to the variety of potential responses to any single problem-solving task. This led us toward a case-study model focused on fewer but longer clips, and a set of roughly ten candidate clips that featured extended, complex problem-solving arcs, including the two clips featured in this study, from Families 15 and 17. While traditions focused more squarely on the structures of verbal interaction (CA, DP) often rely on identifying patterns through numerous micro-interactions sampled from across a data corpus, some IA researchers have found that a more longitudinal, case-study approach, focusing on fewer participants in greater depth, can shed new light on complex, multimodal learning phenomena (Marin and Bang, 2018; Keifert, 2021). Given the space constraints of journal submission, we settled on three clips which, based on previous rounds of analysis, prominently featured the autonomy support tensions of interest, and ultimately determined only two cases could be treated in suitable depth with the available space. "Rope," the first clip featured in this study, from Family 15, was chosen for the completeness and complexity of its problem-solving arc, allowing us to analyze an evolving problem-solving negotiation between parent and child, with clear tensions around self-determination and future child autonomy. "Rocks," the second clip we study, from Family 17, in which a child climbs and dismounts a series of small boulders, was unique in our data set in that it featured a dyad navigating multiple iterations of the same task (climbing rocks), allowing us to observe both repetitions and evolutions of participant strategies in solving similar problems.

Creating transcripts

Once we started the process of selecting clips of interest, we began developing written transcripts. We developed these written records of the videos according to conversation analysis conventions originally proposed by Gale Jefferson (see a historical account in Jefferson, 2004), and which have been reified over decades (Sidnell and Stivers, 2012), while including gesture, body movement, and material interactions, inspired by conventions from Mondada (2014) and Goodwin (2018). For instance, in one of our focal clips for this study, a child stands on a picnic table in an effort to reach a rope that is too high for her. Our transcript tracked the changing relative positions of the table and rope, how the participants interacted with and talked about those two resources, and how the objects themselves responded to being manipulated. Our transcripts, like our research questions, evolved with our understanding of the focal phenomenon (Ochs, 1979; Engle et al., 2007). As we became more focused on certain longitudinal play arcs in this study, we spent more time elaborating on a smaller number of transcripts, and transcribing longer stretches of video of a single play arc. The final transcripts for this case study were initially created by the first author, edited in a second round with the second author, then subjected to group validity checks including faculty and students outside of the authorship team. The group transcript sessions were audio recorded and used by the first author to create the final versions of the transcripts.

Conducting data analysis sessions and developing claims

The lead researcher on our team organized data sessions in which multiple faculty and student researchers discussed and critiqued the transcripts and claims coming from the data. As the research question and transcripts developed, these data sessions were held multiple times, in different phases of the research, and with different groups of researchers both within and outside of the authorship team.

Certain categories of evidence were particularly relevant to our analysis. Understanding and recognizing typical play structures (Burghardt, 2011) helped us to identify goals (climbing onto the rock), emerging problems (difficulty getting onto a rock), parent support (physically presenting a hand for the child to hold), and the initiation or completion of activities (starting to climb or moving toward the edge to dismount). Observable breakdowns in the interactional problem-solving process, such as pauses, questions, sudden repetition, or changes in direction or orientation drew our attention to potential task difficulties, and to how the participants responded in those moments (Clifford, 1984; Koschmann et al., 1998). Paying attention to co-participation patterns (Goodwin, 2002) and the spatial organization of interactions (Goodwin, 2002; Kendon, 2010; Marin and Bang, 2018) helped us identify the general structure of cooperative problem-solving, and recognize the contributions of each participant to generating or deviating from that problem-solving structure. As an example, both of our clips involved children in moderately risky situations involving heights, and the various positions and postures of the parents implied different degrees of availability and/or intention to support that risk-management process.

As our data sessions evolved and we targeted questions of autonomy support through an interactional, problem-solving lens, our central, guiding research questions were established: (1) *How is the problem-solving process unfolding (in terms of how failures and difficulties are being publicly treated, causes*

being identified, and solutions being pursued)? (2) *What types of problem-solving skills are, in practice, being privileged, and by extension what time horizons for skill-development are being promoted?* and (3) *Who publicly steers the course of action (including by initiating lines of inquiry or reasoning around problems, directing attention to features of problems, and exercising power to make decisions)?*

Reviewing research and refining hypotheses

These established research questions led us to further examine the concept of autonomy support (Grolnick and Ryan, 1989), which provided a lens for our continuing scrutiny of the data. The rating system created by Whipple et al. (2011) was productive in pushing our analysis toward more granular questions of timing (e.g., when is the "appropriate" time to intervene?; what is the "child's pace?"), the child's skill level, and what learning processes are actually being scaffolded by various support moves. These questions, however, proved difficult to answer definitively when viewing our naturalistic data, and pushed us to employ the lenses of scaffolding (Wood et al., 1976; Vygotsky, 1978), Self-Determination Theory (Deci and Ryan, 1985), problem solving (Greiff et al., 2013; Shute et al., 2015), debugging (Ko and Myers, 2005; McCauley et al., 2008), and intergenerational learning (Marin and Bang, 2018; Bang et al., 2020). Synthesizing these different threads of research provided leverage in addressing the complicated ways in which autonomy support concepts manifested in the naturalistic play interactions in our data.

We recognized that the key tension present in autonomy support–the balancing act of intervening to support children's learning for future benefit while also supporting their self-determination in the moment–could be analyzed in a precise, moment-by-moment manner if we embraced those tensions, considering that each moment may represent a series of trade-offs (e.g., *which participant is leading the action in a particular moment perhaps without input from the other participant* and *which learning goal or time-horizon is being privileged over and above others*). The result was a 3 × 3 plot that helped us think about each moment along these two axes of potential trade-offs (**Figure 1**).

We employed the above plot as a sensitizing concept–a lens to guide us in empirically viewing events without being too narrowly prescriptive (Blumer, 1954; Keifert and Stevens, 2019). It helped focus our analysis around questions of who led each aspect of the problem-solving process, and ultimately drove us to create more detailed transcriptions identifying what each participant was contributing. We did not assume that any single moment of interaction could only be categorized in one of the boxes in our plot, but instead utilized the plot to question the assumption, noted in our review of Landry et al. (2002), that any particular moment of a problem solving process can *equally* support multiple goals and time horizons for learning.

While viewing our two focal clips in a bottom-up manner, through the lens of these conceptual trade-offs, and keeping the problem-solving and debugging literatures in mind, we identified six specific problem-solving components that were useful in analyzing the participants' contributions in our longitudinal clips. We do not assume that all of these components are linear or necessary in the problem-solving process.

[CHOOSES/PURSUES GOAL]: A participant makes evident intention to pursue a goal or initiates the process of the goal pursuit itself.
[PROPOSES STRATEGY]: A participant generates a possible strategy or solution for achieving the goal being pursued.
[ASSESSES]: The participant is not in direct pursuit of the goal and devotes attentional resources to evaluating a potential course of action toward the goal.
[IDENTIFIES CAUSE]: A participant describes what they consider a cause of a problem that arose during a goal pursuit.
[ENACTS STRATEGY]: The action of implementing or carrying out a strategy or solution for achieving the goal.
[CEASES STRATEGY]: The participant stops active pursuit of strategy.
[CC → XXX]: A meta-tag for our coding, the "CC →" indicates a course change, that the participant is proposing or enacting a new strategy for pursuing the goal.

Using this framework, we examined when these constructs occurred in our clips and who (parent, child, or both) provided the contribution. To visualize this analysis, we produced a matrix (example, **Figure 2**) which contains each of the problem-solving components in the *x*-axis, and specific moments or events (and lines in the associated transcript) on the *y*-axis. A colored dot (blue for the child, orange for the parent) indicates which participant contributed that action, and when, in reference to the transcript. A co-enaction of that contribution–when both participants contribute to the same problem-solving component–is indicated by partially overlapping dots within a cell, or by a purple dotted line connecting two dots across cells. A course change [CC → XXX] is indicated by an arrow inside of the dot. The end result is a matrix which provides a decomposed, moment-by-moment representation of what each participant contributed to the entirety of the problem-solving interaction.

The above approach structured our primary video analysis for this study, guiding us on what details to transcribe from the video, what questions to ask as we moved through our analysis of the video, and what to "count" as each participant's contribution. Once that step was completed, we returned, in a discussion of our analysis, to the complex questions at the intersection of autonomy support and problem solving. By engaging in this granular, moment-by-moment analysis through lenses of autonomy support, problem solving, and debugging, and giving

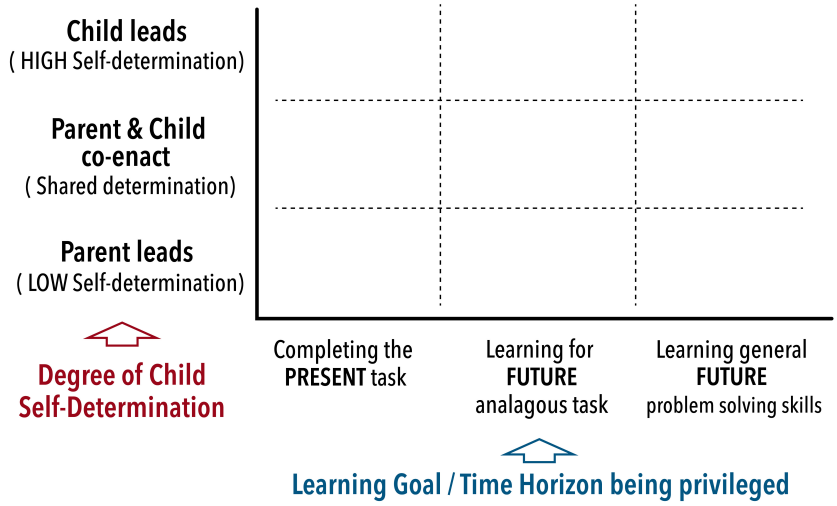


FIGURE 1
A 3 × 3 plot to prompt our analysis of each problem-solving arc. The categories on the *y*-axis prompt us to consider which participant leads the interaction, while the categories on the *x*-axis prompt us to consider what goals and time horizons are being given priority.

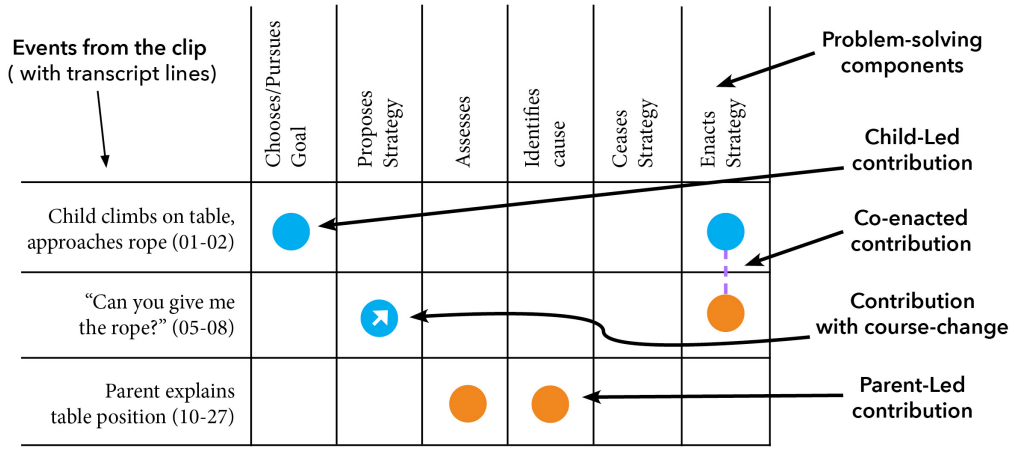


FIGURE 2
A sample portion of the decomposed analysis matrix.

credit to each participant for their contribution to the interactive process, we pursued a more comprehensive understanding of how children's learning and self-determination are being supported in a complex, dyadic interaction.

Results

In this section, we analyze each of the two focal clips, first applying the decomposition analysis outlined in the previous section, then proceeding with a discussion of the implications of our analysis for the core questions autonomy support. Transcripts of the video clips are included for reference, as are the aforementioned matrices for visualizing the primary analysis. The transcripts feature select still images (edited in a sketch-artist style for anonymity), with speech and action bubbles indicating which moments in the transcripts they correspond to. The bubbles' arrows descend from the point in the speech or action that specifically overlaps with the still frame.

Clip #1, "Rope"

Description of the activity and background

The clip featured here is drawn from a longer video featuring two siblings ("Rae," 6 years old, female, "Sib," older, but age unknown, female) playing in the family's backyard, while the mother ("Mom," 35 years old, female), is engaged in a series of

efforts to support Rae and Sib. In the focal activity, Rae attempts to access a rope that is strung across the family's property, but which is too high for her to reach from the ground. From the VCR, we know that the father had just recently installed the rope system for the children to play on, and that the video shared with us captures the first day in which the children have a chance to use it. Preceding the clip of interest, Rae had been playing on the *swing* attached to the rope system, while her older sibling, who was able to reach the rope from the ground, had been hanging on the rope and attempting various hanging moves. Mom, observing that Sib's head had come close to hitting the picnic table, moved the picnic table further from the rope (see **Figure 3** for layout of the physical space). Immediately preceding the focal clip, Mom negotiated a transfer of swing privileges from Rae to Sib, in part by suggesting that Rae engage in timed runs up and down their jungle gym, and then instructed Rae to wait while she pushed the Sib on the swing. While Mom prepared to push Sib on the swing, Rae, who is shorter than Sib, and could not reach the rope from the ground, climbed up on the picnic bench and attempted to get ahold of the rope. Our focal clip begins as Rae approaches the rope. Next, we will analyze the interaction between Mom and Rae in terms of what each party contributes to the act of accessing the rope, considering the components of the problem-solving process detailed in the method section.

Preliminary analysis: Decomposing the problem-solving process

Rae requests help

Because Mom had proposed a different activity (Rae doing timed runs on the jungle gym while Mom attended to Sib's push request), it is clear that Rae chose the activity of playing on the rope, and chose the means of accessing the rope by climbing up on the picnic table [CHOOSES/PURSUES GOAL, ENACTS STRATEGY] (see **Figure 4** for complete transcript). We also see Rae stop her forward progress at the end of the table and gaze toward Mom (F4:01–02), changing course. Rae repeatedly requests that Mom help her access the rope: "`>Can you ↑give↑< me:: the ro::pe. (0.5) Can you give me the ro:::pe.`" [CC → PROPOSES STRATEGY] (F4:05–09).

Mom, having just completed pushing Sib on the swing, responds to Rae's request by explaining that she had "`moved< th-the table >so it wouldn't be so< close`" (F4:10–11), identifying the cause of the current problem as the distance between table and rope, which itself was caused by Mom's recent action of moving the table so that it wouldn't "so close" to where Sib had been swinging on the rope [IDENTIFIES CAUSE]. Mom then elaborates on her explanation, adding "`so >you wouldn't be able< to ↑get↑ it`" (F4:24–27) indicating her assessment that the new table position creates distance Rae cannot overcome [ASSESSES]. During this elaboration, Mom starts to pull the rope toward Rae, and Rae reaches with one hand to meet it [co-ENACT the child's proposed STRATEGY] (F4:17–20). Rae quickly pulls her hand back down when the co-enacted attempt fails, stomps her feet and audibly whines, while Mom partially retracts her pull of the rope [co-CEASES STRATEGY] (F4:22–23). Rae laments the situation and reasserts her initial desire: "`but I WA:::nt to.`" [CHOOSES/PURSUES GOAL] (F4:30). Mom agrees to continue helping with Rae's goal: "`>okay< I'll move it ↑back↑ over (0.3)`

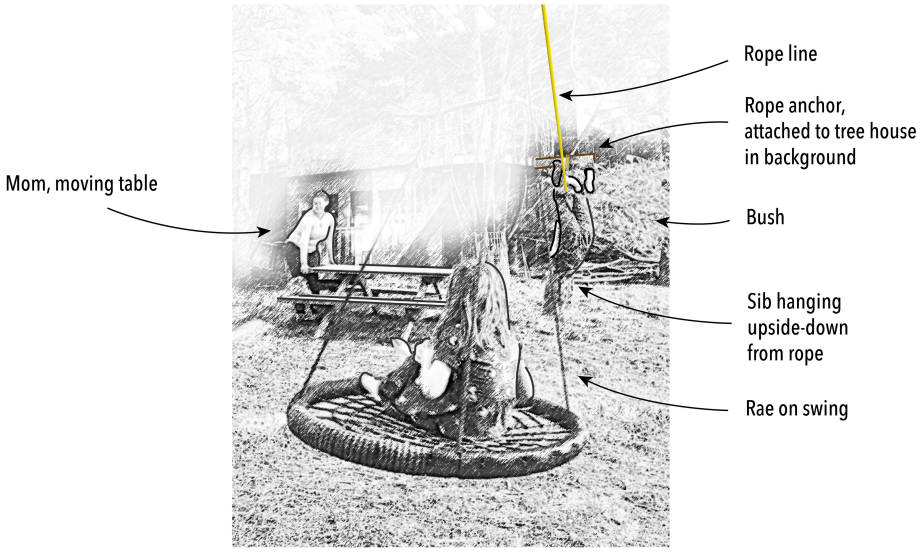
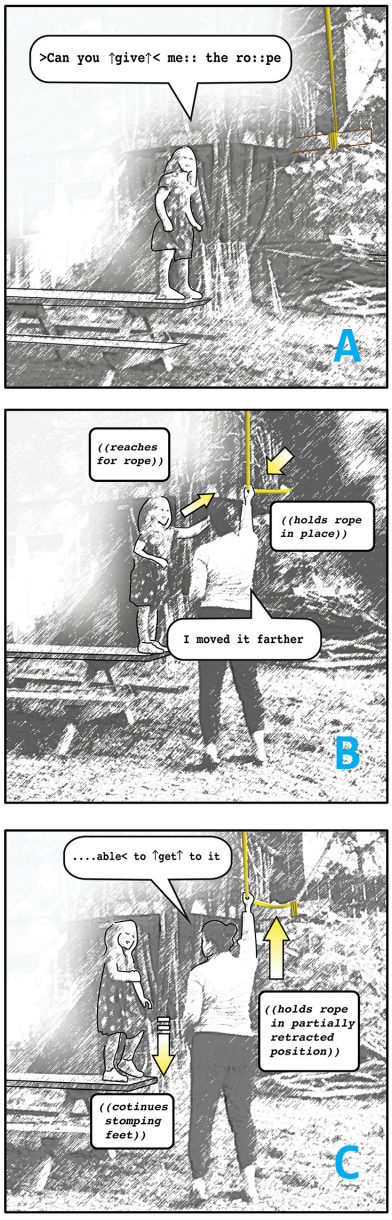


FIGURE 3
Layout of Family 15's yard space.



01	Rae:	[*((climbs up on picnic table, approaches rope, walks to end of*]
02		*table top))*]
03	Mom:	[*((pulls back swing while looking over her shoulder toward*]
04		*Rae, runs through foreground to push swing))*]
05	Rae:	[*((stops at end of table, turns toward Mom))*]
06		[>Can you ↑give↑< me::]
		A
07	Rae:	[the ro::pe. (0.5) can you give me the ro:::pe.]
08		[*((steps toward edge of table, rocks*
09		*side-to-side, holding hands down by waist))*]
10	Mom:	Oh >I ↑kinda↑ moved< th-
11		[the table >so it wouldn't be< so close]
12		[*((walks back toward Rae))*]
13	Rae:	[*((tip-toes forward until feet hang over edge of table))*]
14	Mom:	*((reaches toward rope, looks up at rope, back to Rae, up at*
15		*rope))*
16		U::m [(1.5)]
17		[*((grabs the rope, pulls it toward Rae))*]
18	Rae:	[*((reaches for rope))*]
19	Mom:	[I moved it farther] B
20		[*((holds rope in place))*]
21	Mom:	[away]
22	Rae:	[*((pulls hand back down quickly))*]
23	Mom:	[*((partially retracts her pull of the rope))*]
24		[so >you wouldn't be]
25	Rae:	[HM ↓m::↓]
26		[*((stomps feet on table, while stepping back from edge))*]
27	Mom:	[able to< ↑get↑ to it]
28		[*((holds rope in partially retracted position))*] C
29	Rae:	[*((continues stomping feet))*]
30	Rae:	[But I WA::Nto]
31		[((*returns to edge of table, toes over edge,*
32		*spreads arms and tilts head*))]
33	Mom:	>Okay< I'll move it ↑back↑ over (.3)
34	Mom:	[just hop off]
35	Rae:	[*((turns toward side of table))*]
36	Mom:	for (.3) (for a sec)( )
37	Rae:	[*((jumps down with two hops))*]
38		[whee yay ↑YAY↑]

FIGURE 4
Rae requests help.

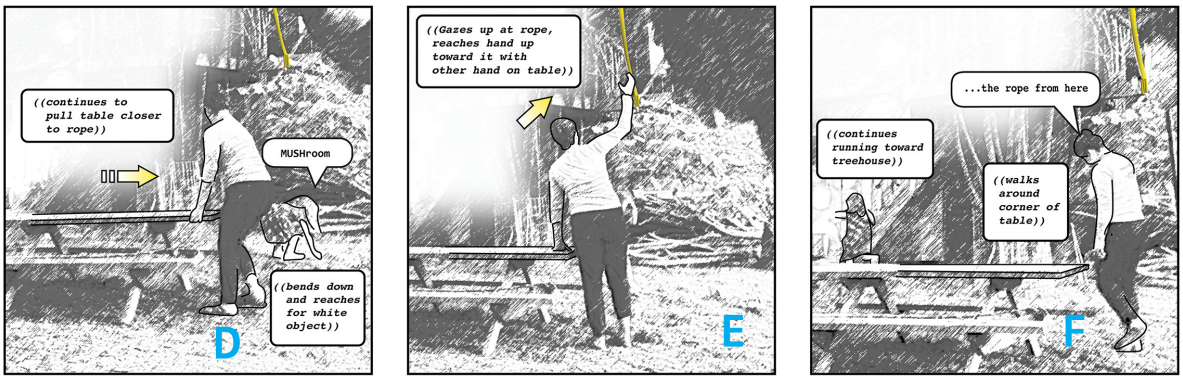
`just hop off for (0.3) (for a sec)`" [CC → PROPOSES STRATEGY] (F4:33–36).

Mom moves the table

Mom moves the table [ENACTS STRATEGY] (see Figure 5 for complete transcript), and then checks the relative rope position with a reach and a gaze [ASSESSES strategy] (F5:39–51). Finally, she asks Rae, who is now in another part of the yard pursuing a different activity, whether she can "`reach the rope from here`," inviting Rae to make her own assessment of the table move (F5:55–57). Rae replies, albeit very quickly ("`SURE`"), and from a different part of the yard [co-ASSESSES strategy] (F5:63–64).

Rae gets the rope with mom's help

Rae returns to the table, while mom lingers at the other end of the table, walking toward Sib, but monitoring both siblings (F6:68–76, see Figure 6 for complete transcript). Rae jumps back up on the end of the table, reaches for the rope with both hands [ENACTS STRATEGY], looks back to Mom to declare that she "`CA:n't`" and pulls her hands down [CEASES




```
39  Mom:   ((picks up edge of table, [leans back and starts to pull))]
40  Rae:                             [((turns back toward Mom))      ]

41  Mom:   [((continues to pull table closer to rope))                    ]
42  Rae:   [((turns away from mom, [bends down and reaches for white object))]] D
43                                 [MUSHroom                              ]

44  Rae:   [This is what I                                ]
45         [((reaches second time for object and grabs it))]
46  Mom:   [((completes move and releases table))         ]

47  Rae:   [nee:d                                  ]
48         [((stands up and turns toward tree house))]
49  Mom:   [((turns toward rope))                  ]

50  Mom:   ((Gazes up at rope, reaches hand up toward it, with other hand on table))
51         [((looks back down at Rae while retracting hand))]                        E
52         [↑okay (.7)                                    ]

53  Rae:   [((turns and starts running back toward treehouse))]
54         [>>mush[room mushroom<<   ]                        ]
55  Mom:          [>can you< reach   ]
56                [((starts walking))]

57  Mom:   [the rope from here                  ]
58         [((walks around corner of table))    ]  F
59  Rae:   [((continues running toward treehouse))]

60  Mom:   [((starts to walk along far side of table))]
61  Rae:   [um                                       ]

62  Mom:   [((continues to walk along far side of table))]
63  Rae:   [((looks back at table from tree house))     ]
64         SURE

65  Rae:   [((walks into treehouse ))]
66         [bo::wl                   ]
```

FIGURE 5
Mom moves the table.

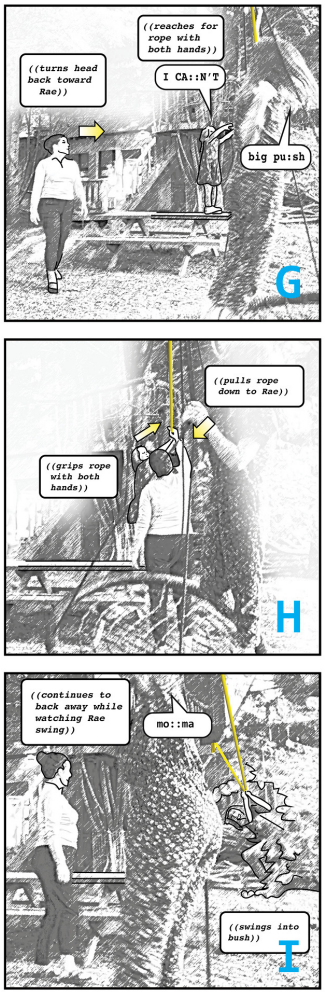
STRATEGY] (F6:70–81). Mom responds more or less on cue, pivoting, walking over and bringing the rope down to where Rae can reach out and grab it, and Rae reaches out, grips it with both hands, and pulls the rope toward her body [CC → co-ENACTS STRATEGY] (F6:80–86).

Finally having a solid grip on the rope, Rae proceeds to explore a variety of hanging and swinging activities. Mom observes the first few moments, and laughs as Rae swings into a tree (F6:101).

Discussion of the analysis

Self-determination on this task

The first takeaway with respect to autonomy support is that Rae exercises self-determination in choosing the activity, and the overall means of pursuing it, and that Mom supports these choices even when a significant obstacle emerges (see **Figure 7** for visual representation of the analysis). Mom had proposed a different activity, but when Rae chooses to pursue the rope instead, Mom



67 Mom: *((reaches opposite end of table, pivots back to face rope and Rae))*

68 Rae: [*((runs back toward table from treehouse))*]
69 Mom: [*((gazes at Rae, gazes back at rope while pivoting toward Sib))*]

70 Rae: [*((steps onto first level of table*]
71 Mom: [*((starts walking toward Sib while gazing at rope))*]

72 Sib: can [you give]
73 Rae: [*((steps onto top surface of table))*]

74 Sib: [me another]
75 Mom: [*((turns head toward Sib, back to rope, back to sib, while*
76 *continuing to walk slowly toward Sib))*]

77 Rae: [*((reaches for rope with both hands))*]
78 Sib: [bi[g pu:sh]]
79 Rae: [I CA[::]N'T] G
80 Mom: [*((turns head back toward Rae))*]
81 Rae: *((quickly pulls both hands down))*
82 Mom: *((pivots and starts walking toward Rae))*

83 Sib: ↑>can you gimme< another big
84 [push↑]
85 Mom: [*((grips rope], pulls rope down to Rae))* H

86 Rae: *((grips rope with both hands,* [*pulls down))*]
87 [heh ↑he↑]

88 Mom: *((backs away from Rae))*

89 Rae: [*((jumps up and tucks legs))*]
90 Sib: [mo]

91 Sib: [::ma] I
92 Rae: [*((swings into bush))*]
93 Mom: [*((continues to back away while watching Rae swing))*]

94 Sib: [>can you gi<[mme ano:ther]
95 Rae: [*((swings back, lands one foot on table))*]
96 [↑WHEE::↑]
97 Mom: [*((faces Rae and watches her swing back))*]

98 Sib: [big ↑push↑]
99 Rae: [*((tries to untangle other foot from bush branches while balancing*
100 *on table with first foot))*]
101 Mom: [he ↑HE↑ hehe]

102 Mom: [*((pivots away from Rae and table))*]
103 Rae: [good pokey vi:nes.]
104 [*((successfully untangles foot from bush))*]

FIGURE 6
Rae gets the rope with mom's help.

supports that choice and Rae's overall strategy of using the table as her base of support. When the table distance problem emerges, and Mom explains it, Rae responds, tellingly, by simply re-asserting her self-determined goal: "but I WA::nt to" (F4:30). Mom agrees to continue supporting Rae's goal, and the payoff is that Rae is ultimately afforded over two and a half minutes of self-directed exploration on the rope; during this stretch of time, Rae never lets go of the rope, and even continues to use the table with her feet, kicking off it and standing on it.

Learning/preparing for similar tasks in the future

It is evident at multiple points that Mom is interested in Rae's ability to pursue this activity independently beyond the immediate moment. In fact, the first moment where we see Mom resist Rae's immediate strategy is in proposing a solution that will allow Mom to remove herself from the equation. When Mom initially attempts to pull the rope to the child, and it becomes apparent that a simple tug will not resolve the gap, Mom in principle has many options: She could tug the rope harder. She could lift Rae up so that Rae can reach the rope. She could prompt critical thinking about other

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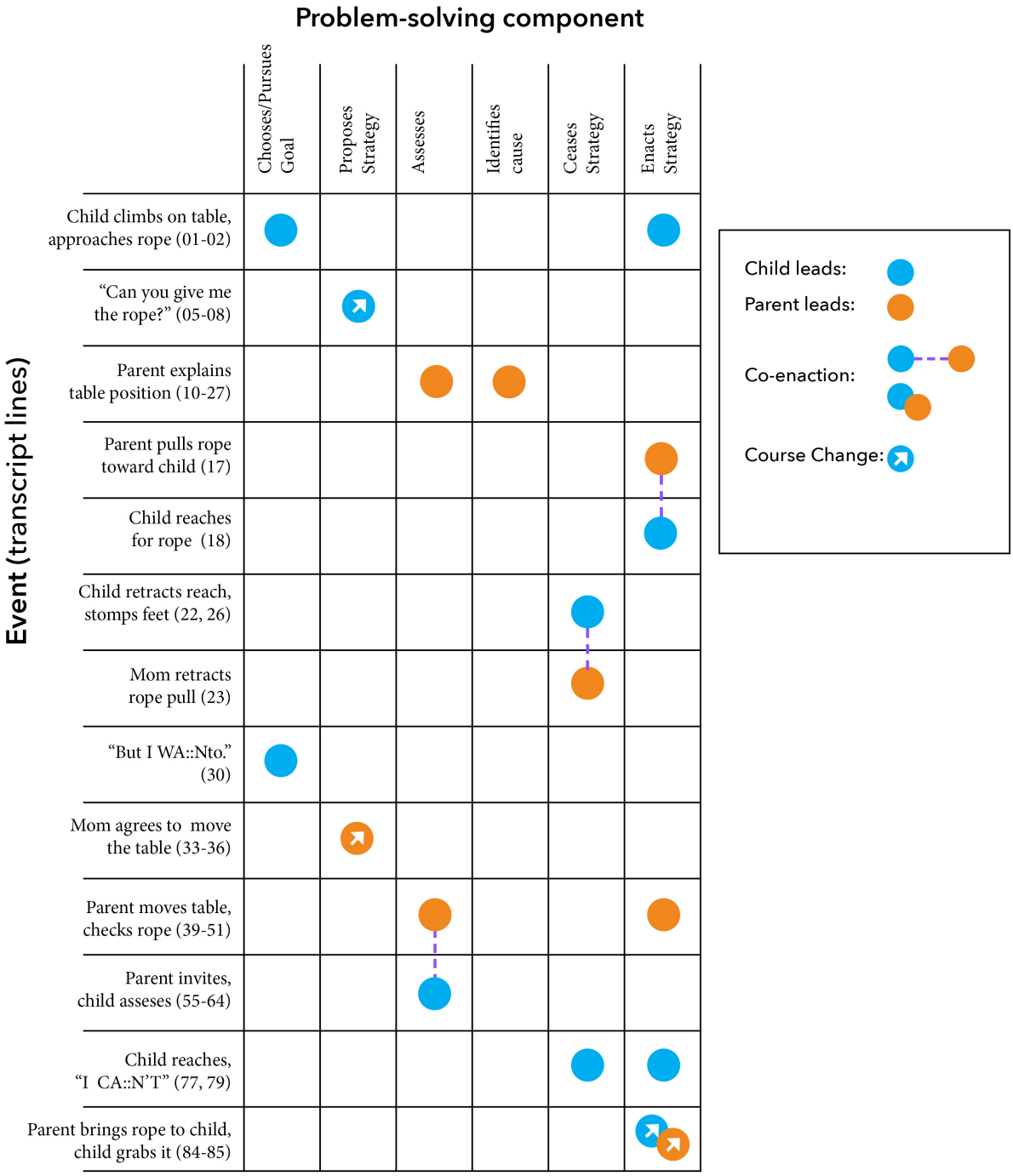


FIGURE 7
Matrix for visualizing our decomposed analysis of the "Rope" clip.

ways that Rae could solve the problem. She could propose that Rae choose a different activity. Her choice, though, is to adjust the backyard's physical infrastructure so that Rae can access the rope, in the way Rae initially intended, and which would not require Mom's continued assistance. This intention is evident when Mom moves the table, checks the new distance, and then asks Rae "`>can you< reach the rope from here`" (F5:55–57). After Rae acknowledges that she can reach the rope, Mom walks around the table and is on a clear walking trajectory toward the swing, where her other daughter is playing; Mom is signaling that she does not anticipate needing to help Rae reach the table. When

Rae gets back on the table, Mom is still nearby enough to respond if the approach to providing independent access fails. Though moving the table does not fully solve the problem and Mom is needed to bring the rope down, the table is now close enough that Rae is able to hold onto the rope and use the table as a continuous support while hanging, swinging, tugging, and exploring the many affordances of the rope system. By the end of the activity arc, Rae has used the picnic table to access the rope and experienced some of the difficulties of bridging that gap. She has also accumulated several minutes of exploration with the rope system itself, and on both accounts should be better prepared for future explorations of the rope system.

Generalized problem solving

While Mom pulls significant weight (literally, moving the table) in the problem-solving process, Rae contributes to the general problem-solving process in a number of ways, and shapes the overall process itself. It could be said, from an autonomy support perspective, that Mom passed on an opportunity to question or push Rae to solve the problem independently in a different way, one that did not require any physical help at any point from an adult. On the other hand, Rae's original strategy of using the table to elevate herself, and then having a taller person help with the remaining distance, provides a generative start to the problem-solving process. Consequently, this initial strategy shapes the entire solution search going forward. By engaging with Rae's overall framing of the solution space, performing physical tasks that Rae is likely not strong enough or big enough to accomplish, Mom outwardly demonstrates the costs and benefits of the approach Rae initiated, allowing Rae to directly experience the relevant factors of height and distance. After moving the table, Mom continues to directly involve Rae in tracking the strategy, asking if she can reach the rope, and it is Rae who ultimately declares the table move inadequate, when she gets back on the table and still can't reach the rope. From a generalized skill perspective, Rae generates a strategy for a problem, shaping the overall solution space, recruits help in solving the problem within that space, and assesses the collaborative effort until the problem is resolved. All of these are general problem-solving skills of broad future value.

Clip #2, "Rocks"

Description and background of the activity

In this clip, a child (female, 2.5 years old, "Jaz") climbs and dismounts a series of rocks in a public park. Negotiations ensue where the child pursues these climbing and dismounting tasks with varying levels of competence and requests for assistance, while the mother (female, 32 years old, "Mom") offers occasional physical assistance, and both parents (including father, male, age unknown "Dad") encourage and comment. Through the VCR, we learned that Family 17 regularly wanders through the park featured in the clip, and that Jaz often enjoys getting on and off of this specific series of rocks.

Preliminary analysis–Decomposing the problem-solving process

Rock #1

Though the recording does not capture the majority of the first rock climb, we catch the final act as Jaz appears to be standing up from an all-fours climbing posture (F8:01, see **Figure 8** for complete transcript). The fact that Mom has not yet arrived on the scene, combined with evidence of how all ensuing rock climbs unfold, suggests that Jaz has chosen and successfully climbed onto this initial rock herself [CHOOSES/PURSUES GOAL, ENACTS STRATEGY]. Later in the clip, we see her successfully climb rocks of similar and even larger size, and we never see Dad depart from his filmographer role to physically assist. Combined, these observations support the deduction that Jaz chose and climbed the first rock largely independently.

The dismount process on the first rock establishes a baseline sequence Jaz and Mom (mostly) repeat going forward: (1) Jaz announces her intention to "jump-a that rock," pointing and gazing at a different rock [CHOOSES/PURSUES GOAL] (F8:17–20), and Mom responds, in this case, by re-voicing Jaz's preference ("y'gonna jump to that one?") (F8:24). (2) Jaz appears to assess her options for getting down from the current rock, squatting down and feeling around the surface of the rock with her hands [ASSESSES] (F8:21–26). (3) Jaz stands back up and requests help, reaching her hand out toward Mom, and asking "Can I hold my hand?" [CC → PROPOSES STRATEGY] (F8:28–32). (4) Jaz declares she's going to "jump (0.5) jump jump jump" (F8:36–39) which is followed by a complex co-execution of the dismount, with Mom offering her hand to be held, while she provides a countdown and steps away to initiate the timing of the dismount process. Jaz appears to bear the majority of her own weight as she steps down from the rock, losing her balance a bit as she reaches for Mom unsuccessfully with her other hand, but remains upright [co-ENACT STRATEGY] (F8:37–48).

Rock #2

Immediately after landing and achieving her balance, Jaz turns in the direction of the other rocks to her right, announcing "I'm gonna (0.7) I'm gonna (0.7) here," [CHOOSES/PURSUES GOAL] (F9:01–07, see **Figure 9** for complete transcript) and eventually squaring herself up to the edge of the next rock in the row. Mom says ">go for it<" and alongside this verbal affirmation of Jaz's self-determination, remains a few steps away with hands in her pockets (F9:08–10). While Mom maintains an observational posture, Jaz places her hands on the rock and methodically climbs her way up, negotiating an uneven rock

01 Jaz: [*((Bent over with both hands and feet on rock, moves RF in line with left))*]
02 [s:rong]

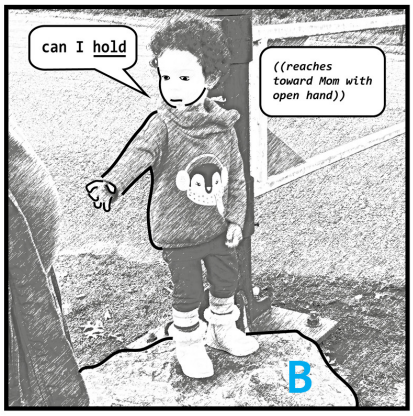
03 Jaz: [*((stands up))*]
04 [up ↓high↓]
05 *((looks down, slowly swivels around.* [*looks up))*]
06 [hi::gh]
07 *((turns head to look at Dad))*
08 Dad: (.) so so high.
09 Jaz: *((looks up, points up,* [*traces pointing gesture from her left to right))*]
10 [(.) WA::y up HIGH]
11 *((retracts gesture and returns gaze forward))*
12 Dad: that's ↑air↑plane
13 Jaz: *((gazes at Mom, who is walking toward them from across street))*
14 Mom: *((walks past Jaz with hands in pockets, and out of frame))*

15 Jaz: [*((looks down, spreads arms and moves them around))*]
16 [who:a (.) they're slipping]

17 Jaz: [*((gazes at and points to another rock))*]
18 [I jump-a]
19 *((retracts point gesture))*
20 that rock
21 [*((squats down))*]
22 Dad: [ooh::.]

23 Jaz: [*((feeling around the rock surface with hands))*]
24 Mom: [y'gonna jump to that one?]

25 Jaz: [I AM] A
26 [*((continues to search rock surface with hands))*]
27 *((stands back up))*
28 [*((reaches toward Mom with open hand))*]
29 [can I hold] B



30 Jaz: [*((retracts reach slightly then extends directly to grasp*
31 *Mom's hand))*]
32 [my hand?]

33 Mom: [mm-hmm]
34 [*((places hand under Jaz's forearm))*]

35 Jaz: *((gazes down))*
36 [I'm gonna jump (.5) jump]
37 [*((takes small steps toward edge of rock))*]

38 Jaz: [*((leans and gazes over the edge of the rock))*]
39 [jump jump]
40 Mom: [o::ne two]

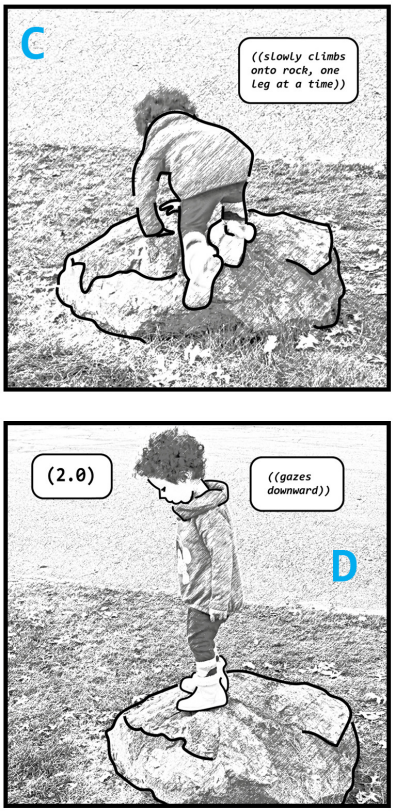
41 Mom: [↑three BO:::M]
42 [*((starts to step away))*]
43 Jaz: [*((reaches toward Mom with free hand))*]

44 Jaz: *((retracts hand, dismounts with left foot, touches down with*
45 *left hand, while mom continues to hold right arm))*
46 [*((stands up, proceeds to next rock))*]
47 [I got o:::ff]
48 Mom: [*((release grip on Jaz's arm))*]

FIGURE 8
Rock #1.

surface with multiple hand and foot placements [ENACTS STRATEGY] (F9:11–14).

The dismount cycle begins as Jaz is standing up on the top of the rock and asks if she "can have my ↑hand↑ for jumping?" [CHOOSES/PURSUES GOAL, PROPOSES STRATEGY] (F9:15–16). Mom responds very quickly, interrupting Jaz's gesture toward the next rock, saying "↑I >>think↑ you can<< jump off this one by yourself" [CC → PROPOSES STRATEGY] (F9:17–20). Jaz pauses and looks down for nearly 2 s, appearing to assess the proposed solo effort, and then looks back up and gestures for Mom's hand again [ASSESSES proposed solution, CC →




```
01 Jaz:   ((Walks past Mom))
02        I'm gonna [(.7)                          ]
03                  [((turns toward row of rocks))]

04 Jaz:   [((pivots toward rock #2)) I'm gonna (.7)]
05 Mom:   [((pivots and follows Jaz's path))       ]
06
07 Jaz:   [here                                                ]
08 Mom:   [((stops a few feet away from Jaz, with hands in pockets))]

09 Jaz:   [((hovers over rock))]
10 Mom:   [>go for it<         ]

11 Jaz:   [((leans forward, places both hands on top of rock))         ]
12 Mom:   [((walks behind Jaz, a few feet away, to other side of rock))]

13 Jaz:   ((slowly climbs onto rock, one leg at at time))  C
14        [((carefully elevates to standing position))]
15        [can I have my ↑hand↑ for jump              ]

16 Jaz:   [ing?]
17 Mom:   [↑I  ]

18 Mom:   [>>think↑ you can<<      ]
19 Jaz:   [((raises hand to point))]

20 Mom:   jump off of this one [by yourself    ]
21 Jaz:                        [((lowers hand))]

22        [(2.0)             ]  D
23        [((gazes downward))]

24 Mom:   o::h-[↑oh↑                                    ]
25 Jaz:        [>need a hang on<                        ]
26             [((raises hand toward Mom with finger point))]

27   Mom:   need >a little< [hand?                          ]
28                          [((extends open hand toward Jaz))]
29   Jaz:                   [((reaches hand toward Mom))     ]
30         ((gazes at Mom's hand, then downward while grabbing hold of it))
31         [a ha:nd                                          ]
32         [((tip-toes toward edge of rock while holding Mom's hand))]

33   Mom:   [((stands about two feet away with arm and open hand extended for holding))]
34   Jaz:   [((leans torso forward with arms out, circles free arm for balance))       ]
35         [I go back                                                                  ]

36   Jaz:   [((steps down with left foot, then right foot, continuing to hold Mom's hand))]
37   Dad:   [HE hehe                                                                     ]
38   Mom:   [O::::h                                                                      ]

39   Mom:   [((pivots and maintains hand connection as Jaz steps away from rock))                ]
40   Jaz:   [((gains balance and walks away while maintaining hand hold for two additional steps))]
41   Dad:   [heh heh                                                                             ]

42   Jaz:   [((releases Mom's hand and gazes and moves toward adjacent rocks))]
43   Dad:   [↑good↑ job, Jaz                                                  ]
```

FIGURE 9
Rock #2.

PROPOSES STRATEGY] (F9:21–26). Mom, after prompting this additional consideration, affirms the request ("need >a little< hand?") and offers her hand (F9:27–28). On the dismount itself, Mom's physical support is limited, offering an open hand from an extended arm, while Jaz tip-toes to the edge of the rock and steps down largely on her own [co-ENACT STRATEGY] (F9:30–42).

Rock #3

Jaz once again walks directly to her next target [CHOOSES/PURSUES GOAL] (F10:01–03, see **Figure 10** for complete transcript), but the climb begins with a possible miscommunication. Jaz gestures with her hand to a piece of ceramic litter just discarded by Mom, which Mom appears to interpret as a request for hand hold, and offers her hand

01 Jaz: *((Walks past mom, turns toward rock #3))*
02 *[((raises right hand to point at rock))*]
03 [do: ↑that↑]
04 Mom: *[((follows a few feet behind with hands in pockets))]*
05 >>You can do<< ↑that↑ one too

06 *((Parents discuss potentially dangerous ceramic fragment on rock*
07 *surface, Mom moves it))*

08 Jaz: Momma put [it]
09 *[((starts pointing toward where Mom put the fragment))]*
10 [awa:y]
11 Mom: *[((removes hand from pocket))]*
12 *((presents open hand toward Jaz's pointing hand))*

13 Jaz: *((Places hand in Mom's hand, lifts right foot toward rock,*
14 *[doesn't find foothold, tries again))]*
15 Mom: *[((steps closer to Jaz,*]
16 *removes right hand from pocket, takes another step toward Jaz,*
17 *grabs Jaz under arms, lifts and places her on top of rock))* **E**

18 Jaz: *[((gazes out, then down))]*
19 Mom: *[((steps away from rock))]*
20 Jaz: *((gazes down and then left, pivots to left))*

21 Jaz: *[((Points forward with right hand, gazes forward))]*
22 [Oh Jaz wants to-can-]

23 Jaz: *[((Turns to Mom, extends hand toward Mom, gazes down))]*
24 [can mama (.3) Can m-=]

25 Mom: [=>here let's go down this way<] **F**
26 *[((steps and points toward lower end of rock,] presents her open*
27 *hans toward Jaz as she walks toward toward end of the rock))*

28 Jaz: *((takes Mom's hand))*
29 Both: *((walk together holding hands))*

30 Mom: [O::ne two three]
31 Jaz: *[((series of small preparation steps at edge of rock))]*
32 *((jumps, leading with left foot, holding mom's hand,*
33 *[lands on two feet))]*

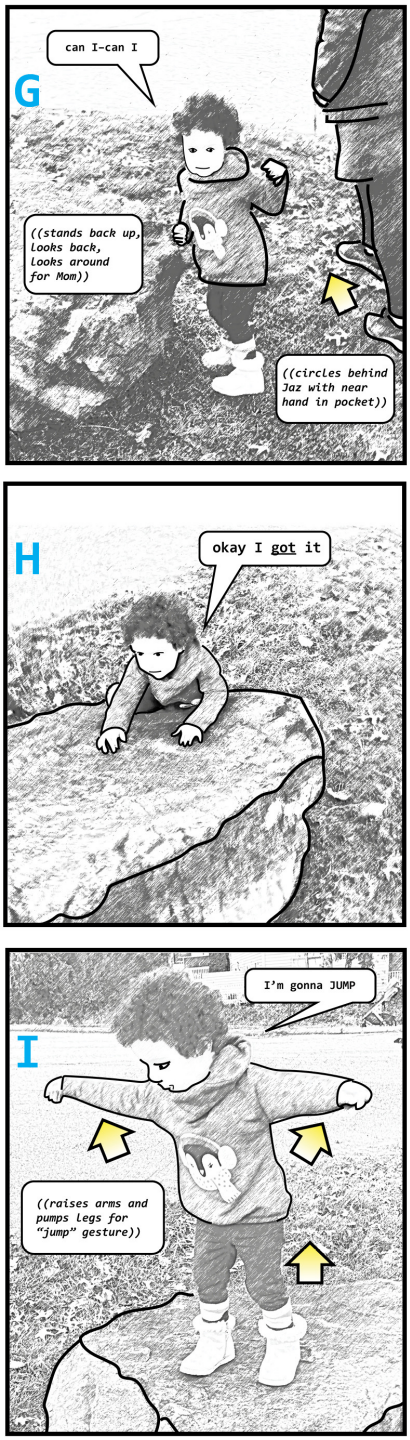
FIGURE 10
Rock #3.

[PROPOSES STRATEGY] (F10:08–11), which Jaz takes. Jaz visibly struggles to gain footholds on the rock despite this support [CO-ENACT STRATEGY] (F10:12–13). Mom escalates her intervention, first stepping closer to Jaz and giving a bit more of a pull to her hand, then eventually just grabbing the child under the arms and lifting her entirely onto the rock [CC → ENACTS STRATEGY] (F10:14–16).

On top of the rock, Jaz can be seen to look down and around her before gesturing to her next destination, and again asking for Mom's hand. Based on previous evidence of this cycle and behavior, we interpret this as the child looking for a way down and deciding she needs help to pursue her next goal [ASSESSES, CHOOSES/PURSUES GOAL, PROPOSES STRATEGY] (F10:17–23). Mom, who had resumed her observational stance after lifting Jaz, responds by pointing to a lower edge of the rock: "here let's go down this way" [CC → PROPOSES STRATEGY] (F10:24–26). The dismount itself is a now familiar partial support move. Mom offers a relatively passive extended hand, and counts off for timing, while Jaz negotiates the edge of the rock, jumps, and lands largely on her own leg strength, with Mom providing a little help for balance, but possibly also making that balance more challenging [co-ENACT STRATEGY] (F10:29–33).

Rock #4

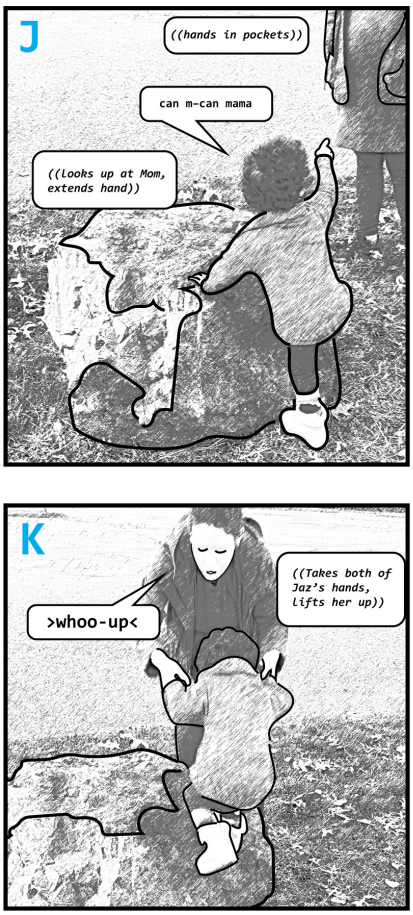
After approaching Rock #4 and leaning her torso over the top of it [CHOOSES/PURSUES GOAL] (F11:01–04, see **Figure 11** for complete transcript), Jaz turns back to look for Mom and begins to seek help: "can I-can I" [PROPOSES STRATEGY] (F11:07–08). At this moment, Mom




```
01 Jaz:   ((lands from Rock 3 jump,
02        [starts running toward Rock 4, points at it))]
03        [I'M gonna jump off ↑there↑ now              ]

04 Jaz:   [((leans torso onto rock))]
05 Mom:   [o:kay                    ]

06 Mom:   [((circles behind Jaz with near hand in pocket))     ]
07 Jaz:   [((stands back up, looks back, looks around for Mom))]
08        [can I-can I                                        ] G

09 Jaz:   [((turns other direction and locates Mom))  ]
10 Mom:   [((maintains distance, left hand in pocket))]

11 Jaz:   ((jumps in place excitedly, then leans back onto rock and
12          reaches with right hand))
13        [((gazes up at Dad))  ]
14 Mom:   [((pockets free hand))]

15 Mom:   [↑you↑ >can] do this< Jaz
16 Dad:   [heh heh   ] haha haha
17 Jaz:   ((throws right leg up on the rock))
18         okay I got it H
19 Dad:   >oh you GOT IT, Jaz<
20 Jaz:   ((effort grunt))
21 Mom:   you GOT it
22 Jaz:   [((effort grunt))                ]
23        [((face down on the rock while she pulls the rest
24        of her body up onto the surface))]
25        ((gets right leg fully up on the rock, then pulls left foot
26        up, then to all fours, then stands up))
27        ((stumbles a bit, walks toward opposite end of the rock, and
28        looks down toward the ground))
29        I'm gonna
30        [JUMP                                          ] I
31        [((raises arms and pumps legs for "jump" gesture))]

32        ((gazes up at Mom,
33        [briefly extends and retracts hand))]
34        [can mama                          ] (.5) mama mama

35 Mom:   [((walks to Jaz, extends open hand))]
36        [hand?                              ]

37 Dad:   [come here                                  ]
38 Jaz:   [((reaches out and grips Mom's extended hand))]

39 Dad:   [(.3)                        ]
40 Mom:   [hold yer hand               ]
41        [((extends other hand to Jaz))]

42 Dad:   [come here mama                                 ]
43 Jaz:   [((reachest out and grips Mom's other extended hand))]

44 Mom:   o:ne two [three BO:::M                          ]
45                 [((holds both of Jaz's arms while Jaz jumps))]
46 Jaz:            [((leaps off with both feet, lands safely))  ]
```

FIGURE 11
Rock #4.

is maintaining her distance with one hand in a pocket and the other hand resting at her side, and Jaz stops looking toward Mom, looks toward the rock, and hops on her toes in place [CC → co-CEASES STRATEGY] (F11:06–10). We interpret this as a joint negotiation in which mom indirectly resists the child's proposed solution and the child responds by ceasing to pursue a strategy she has just proposed. Jaz then leans back onto the rock [CC → ENACTS STRATEGY]



01 Jaz: *((moves to next rock, places both hands on it, starts to lift*
02 *right leg onto it))*

03 [I'm gonna try this]
04 Mom: *[((takes two steps back))]*
05
06 Jaz: [(2.0)]
07 *[((leans on rock with two hands and*
08 *right foot, bends ground leg))]*
09 Mom: *[((puts hands in pockets))*]

10 Jaz: *[((looks up at Mom, extends hand, looks down at rock))]* J
11 [can m-can mama]
12 *((drops right foot back to ground))*

13 Mom: *((Takes step toward Jaz, removes hands from pocket,*
14 *[extends open left hand, takes additional step in))]*
15 [hold your hand]
16 *((leans down with both hands extended))*

17 Jaz: [hold my hand]
18 *[((places right foot on the rock, pushes))]*

19 Mom: *((takes both of Jaz's hands, [lifts her up))]* K
20 [>whoo-up<]

21 Jaz: *[((Jaz's arms remain in Mom's hands as she lands on top of the*
22 *rock, walks to the edge, looks over))]*
23 Mom: *[((starts to back away))*]

24 Jaz: wanna jump
25 *((leads with left foot))*
26 *[((pushes with right, stays connected to Mom's hands as she*
27 *completes jump and lands on two feet))*]
28 Mom: *[((steps away from rock while holding Jaz's arms))]*
29 woo:

FIGURE 12
Rock #5.

(F11:11–12). After seeing the child initiate this self-directed effort, Mom pockets her free hand and vocally reinforces the child's solo effort, saying "↑you↑ >can do this<, Jaz" [PROPOSES STRATEGY] (F11:14–15). Jaz climbs and struggles (complete with effort grunts), and gradually mounts the rock while both parents offer encouragement and reinforce her independent capability [ENACTS STRATEGY].

Once on top, Jaz again performs a visual scan around her, announces her intention ("I'm gonna JUMP") [ASSESSES, CHOOSES GOAL] (F11:27–31), looks up and requests the hand hold [PROPOSES STRATEGY] (F11:32–36), which Dad revoices ("come here (0.3) come here mama"), and Mom offers to "hold yer hand" (F11:37–42). The dismount involves a stronger intervention from Mom, relative to previous rocks. Mom offers both hands for support, and appears to lift Jaz further away from the rock's base on the jump, perhaps helping the child avoid a part of the rock that protrudes into the likely landing area [co-ENACT STRATEGY] (F11:35–46).

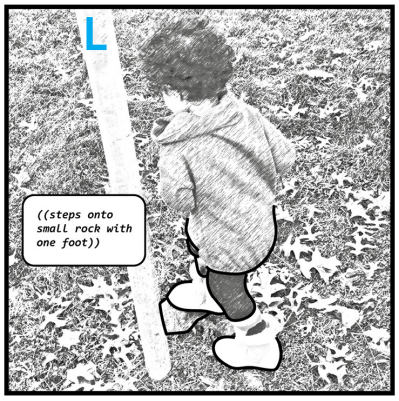
Rock #5

Jaz moves quickly to the next rock, leaning on it with both hands and declaring that she's "gonna try this" [CHOOSES/PURSUES GOAL] (F12:01–03, see Figure 12 for complete transcript). With both hands and one foot up on the rock, Jaz attempts to push off with the grounded leg, but fails to make vertical progress [ENACTS STRATEGY] (F12:06–08). Jaz subsequently turns to Mom and gestures for help [CC → PROPOSES STRATEGY] (F12:10–12). Mom provides significant support as she pulls Jaz up with both hands, and colors the action with a ">whoo-up<," while Jaz uses her legs to walk up the rock [CO-ENACT STRATEGY] (F12:14–21).

Once on top of the rock, Mom and Jaz never manage to untangle their hands before Jaz starts walking to the opposite edge of the rock and says "wanna jump" [CHOOSES/PURSUES GOAL] (F12:25). The double hand-hold persists, with a bit of re-gripping, and results in another combined effort to dismount. Jaz pushes off with her legs, but Mom provides a considerable lift and helps her land softly on the grass [CO-ENACT STRATEGY] (F12:25–28).

Rock #6

After dismounting Rock #5 and scanning around her, Jaz announces "I think that's a:ll of them" (F13:07, see Figure 13 for complete transcript). Mom adds "you




```
01 Jaz:   ((stands up from landing squat, turns around,
02         [points back at rock, walks toward it))]
03         [can I (.5) (  ) this one              ]

04 Dad:   hehe [he he  ]
05 Mom:        [ye-↑ah↑](.5) you can go on all of them

06 Jaz:   ((visually scans left-right-left))
07         I think that's a:ll of them
08 Mom:   you did so many rocks
09 Jaz:   ((moves around last big rock, [points at small rock))]
10                                      [oh how 'bout this rock]
11 Mom:   OH yeah
12 Jaz:   now watch this (  )                    L
13         ((steps onto small rock with one foot, pushes off other foot
14         to "jump" off of it))

15 Dad:   hehe he he
```

FIGURE 13
Rock #6.

did so many rocks," (F13:08) reinforcing that this is Jaz's accomplishment. Jaz then locates one very small, nearby rock, and proposes it as another target ("oh how 'bout this rock") [CHOOSES/PURSUES GOAL] (F13:10). The rock is far too small to present a climbing/jumping challenge, but Mom plays along ("OH ya") (F13:11). Jaz approaches the rock and places one foot on its small, uneven surface, before placing the same foot on the grass and performing a jumping maneuver by pushing off the ground and then landing in a fashion that mimics previous jumps [ENACTS STRATEGY] (F13:13–14). This final, less complicated rock maneuver, completes the sequence according to Jaz, Mom, and Dad, and shows Jaz's interest in having her parents "watch" (F13:12) her independent effort to leap off the rock.

Discussion of the analysis

Self-determination on this task

Jaz exhibits self-determination in multiple aspects in this activity, and the parents often provide support for that self-determination (see **Figure 14** for visual representation of the analysis). First, Jaz initiates the activity before Mom arrives, and leads the establishment of an overall activity contour: climbing and "jumping" off of each rock, and also identifying which rocks to pursue. Both parents can frequently be heard revoicing Jaz's self-narrated actions and choices, from choosing rocks (">>You can do<< ↑that↑ one too") (F10:05) to requesting physical support ("hold yer hand") (F11:40), communicating a shared understanding of Jaz's goals. The parents also frequently posture themselves physically as observers of Jaz's rock climbing activity, until cued to support physically. On several occasions, Mom stands a few feet away, with both hands in her pockets, while Jaz navigates a rock. On Rock #4, in a somewhat contrasting moment, Jaz signals for physical assistance, and Mom briefly removes a hand from her pocket before retracting it and maintaining her distance, which appears to prompt Jaz to retract her own gesture for help before Mom utters an encouraging ">↑you↑ can do this<" (F11:15). Dad, documenting the action behind the camera, maintains a physical distance at all times, limiting his contributions to laughter, revoicing of Jaz's intentions, and encouragement. When it comes to physical support, Jaz's cues are often, though not always, honored. However, even in moments where the parents resist Jaz's preference for help and prompt her to assess the task further (Rock #2 dismount, where Mom verbally proposes that Jaz can do it without help; Rock #4 climb, detailed above), they support Jaz's ultimate assessment of need if that is the outcome of her evaluative process. Even further, despite the potential for the cycle to become predictable or habitual, Mom maintains her observational posture on almost every climb or dismount until cued to do otherwise, creating a space for the child to make a meaningful decision at each potential impasse. There are exceptions (Rock #3 climb–in which Mom mistakenly perceives a request for help; Rock #5 dismount, where their mutual handhold never ceases), but those moments provide contrast to the overall environment of self-determination co-created by Jaz and her parents. Another possible exception is the varying degree to which Mom physically supports the climbs and dismounts, once the decision of general need has been established. In some cases, the physical support is minimal, in others maximal, and the type of support on offer appears to be largely Mom's decision.

Learning for similar tasks in the future

As an affordance of the overall environment of self-determination, Jaz gets to practice many skills relevant to future rock climbing. We see her struggle and proceed with caution at some junctures, but ultimately climb three of the five rocks with no physical assistance. On Rock #4, both parents encourage her to climb solo after she initially seeks help. In addition to climbing, we often see Jaz negotiating her balance atop the

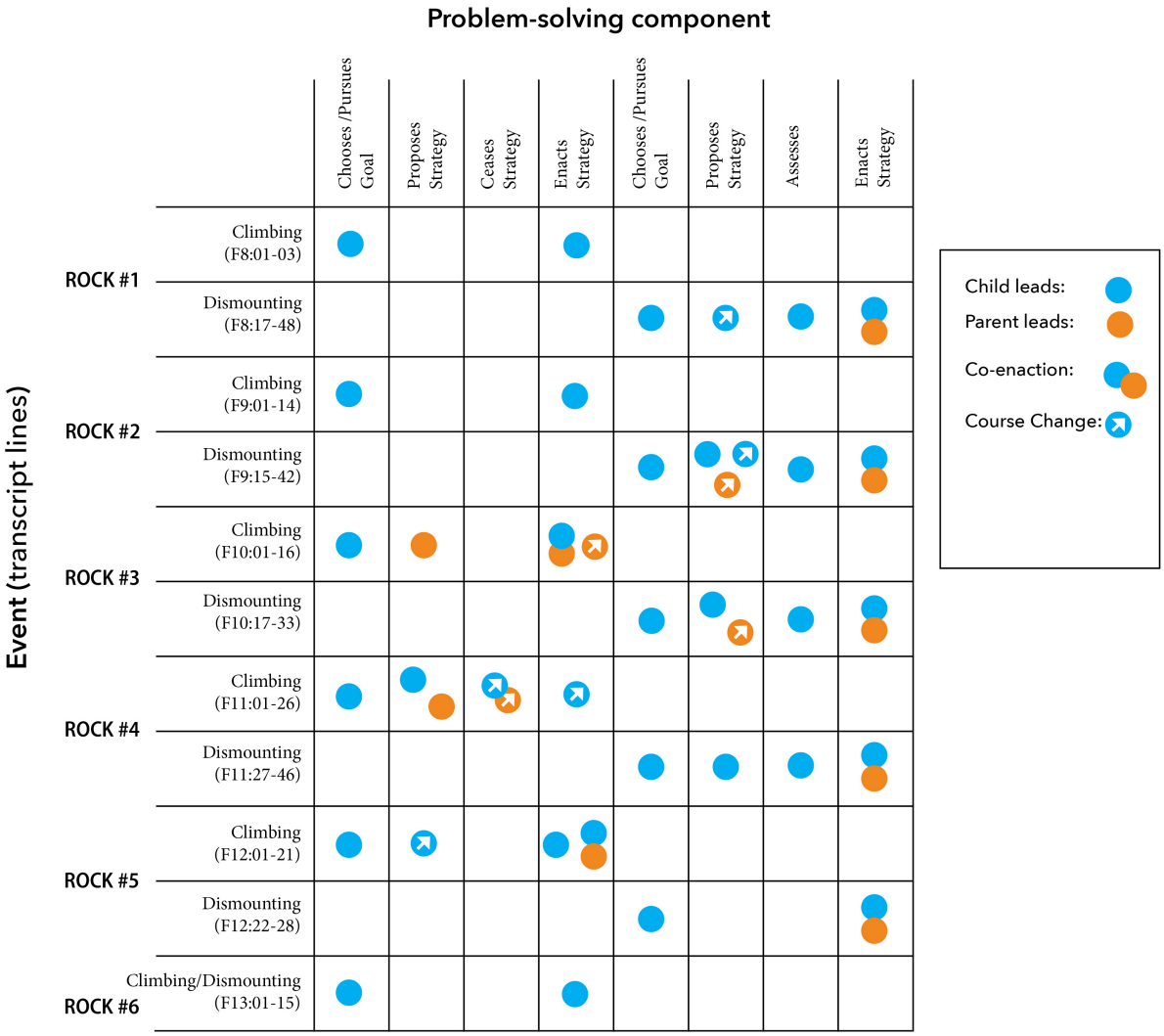


FIGURE 14
Matrix for visualizing the decomposed analysis of the "Rocks" clip. Events in the *y*-axis are collapsed vertically so that the climbing activities and dismounting activities are seen together in a single row for each rock.

uneven surfaces of the rocks, even playfully narrating "who:a (.) they're slipping" (F8:16) on Rock #1. In a more subtle moment of support, Mom responds to a request for dismount help on Rock #3 by leading Jaz down the slope to a lower end of the rock, but offers only a passive hand, creating a space where Jaz is supported if needed, but still has to navigate the slope largely under her own power. Along similar lines, Mom displays a pattern of preserving challenges even when she assents to the request for help. On the dismounts from Rock #'s 1 through 3, we see Mom offer a passive version of the "hand holding" Jaz requests, extending an open hand while maintaining a bit of distance from her child, allowing Jaz to grab onto it while stepping down and negotiating the landing and balancing largely on her own. On the first rock, Jaz can be seen to reach for an assist with her other hand as mom is stepping away, leaving Jaz to grasp at air, and partially lose her balance. There are also instances where Mom takes over more of the meaningful work on climbs and dismounts, but those serve to contrast the ways in which Mom's support actions preserve skill-building experiences for Jaz. Overall, it is apparent that Jaz is gaining practice that will support her future competence in this and similar rock-navigating activities.

Generalized problem solving

An additional consequence of the environment of self-determination the family creates is that Jaz also gets practice and some parental scaffolding with more generalized problem-solving skills. As previously noted, Jaz shapes the overall activity, generating goals and sub-goals, deciding what tasks and challenges are worth pursuing, and garnering her parents' support for taking on each new climbing and dismounting challenge. Part of this co-authored empowerment is that Jaz

often gets to lead the decision of when help is warranted, assessing each challenge. While she climbs smaller rocks (#1 and #2) without seeking assistance, her initial struggles on rocks #4 and #5 lead to her initiating requests for help. In these moments where Jaz determines a need for help, Mom sometimes assents immediately, and other times prompts further assessment. On the rock #2 dismount, Mom's resistance to a help request ("↑I >>think↑ you can<< jump off this one by yourself") (F9:17–20) is subtly beneficial. Mom had agreed to help in a similar circumstance on the previous rock, and Jaz seeks to continue that pattern immediately upon mounting Rock #2. Mom's resistance re-opens the decision space, prompting Jaz to look down and assess her need for help more thoroughly. This pattern of visibly assessing her situation before seeking help with the dismount is one that Jaz adopts and continues to practice on Rocks #3 and #4, ultimately co-creating space for practicing a broadly valuable evaluative skill. Similarly, on the Rock #4 climb, Mom provides indirect resistance to Jaz's proposal to hold hands with Mom on the climb; Jaz abandons the proposal, faces the rock, and climbs it on her own. Experiences like this provide a general-purpose problem-solving experience, in which Jaz encounters a situation she treats as requiring a particular support, before successfully navigating the problem without that support. Because of Mom's indirect resistance to pursuing Jaz's first proposed course of action, and Jaz's willingness to abandon that approach and try something else, Jaz experiences problem solving as malleable: a particular strategy can be productively abandoned in pursuit of another.

Discussion

This study began centered on the question of how and when parents intervene in children's naturalistic problem solving and grew in complexity as we iteratively examined outdoor family play data. In moments where parents and children were clearly navigating problems that had arisen in play, it proved difficult to categorize to a level of precision constructs typically used in the autonomy support literature, such as whether the parent intervened at the *appropriate moment* or whether the *instructions* or *suggestions* provided by the parent were autonomy supportive and in what ways. The approach demonstrated in our analysis, with its granular attention to each participant's contributions, arose out of our iterative effort to identify which problem-solving contributions could be attributed to the child or the parent. The result is an analytical approach that makes it tractable to describe problem solving in social interactions, and also suggests a more expansive way forward for addressing difficult questions around scaffolding, self-determination, and autonomy support in intergenerational learning.

One advantage of the framework and analysis shared in this paper is that it can allow researchers to granularly track how specific moves from parents support specific facets of problem-solving growth in children, with implications for the child's future autonomous skills. Although not capable of supporting rigorous causal claims, this study's fine-grained coding scheme and attention to multiple time horizons could inform what researchers choose to measure as dependent variables and what parenting actions they predict will lead to those outcomes. For example, in experimental work, one could measure as outcomes the child's self-determination to continue pursuing similar tasks, the child's capacity to handle similar upcoming impasses, or the child's capacity to use recently learned problem-solving strategies on novel impasses. Crucially, these facets of autonomy could be examined relative to specific parenting practices that prioritize task completion, skill development in the task at hand, and/or general problem-solving strategies. In the two play arcs examined in this paper, we are catching actual investments in problem solving growth; these are the ways that parents invite children into the process of assessing the efficacy of particular strategies, considering alternative strategies, recognizing the problems themselves, etc. A central question for future research is whether these investments bear fruit for the child in subsequent problem-solving contexts. Micro longitudinal interaction analyses could throw light on these dynamics, for example, by tracking whether Rae's mother's efforts to involve Rae in assessing the efficacy of a problem-solving strategy leads Rae to enact the strategy herself in new contexts (For a possible methodological paradigm, see Keifert (2020) longitudinal analysis of domains of value and family practices). Experimental work, in which parents provide particular types of support (e.g., skill development in the focal task vs. general purpose problem solving strategies), would throw light on whether these strategies sow the seeds for different types of autonomous problem solving at various time scales.

Our case studies also suggest an inherent multidimensional nature to the problem-solving process, and a presence of tradeoffs between different potential learning goals and time horizons that render the evaluation of an intervention at any single time-point challenging. In "Rope," for example, Mom could have resisted Rae's request for physical help, nudged her child to generate new solutions that did not involve Mom's physical assistance, and thereby challenged Rae to practice generalized problem-solving skills. However, as we documented, the path chosen by Mom did foreground the child's self-determination in that moment, grant Rae the experience of shaping the problem-solving process at multiple impasses, and aimed to afford her physically scaffolded, independent access to the rope for extended exploration. All of these short-term outcomes carry potential future benefits, but it is quite unclear whether these were the "best" of the many potential support interactions, or whether a singular best choice even exists given the reality of these trade-offs. Our case studies point

to a need for more precise theoretical development around specific benefits and costs of foregrounding any particular time horizon or learning objective and more granular categorizations of behavioral interactions that experimentalists could examine in relation to the costs and benefits identified by qualitative work. It also suggests that more longitudinal research is needed to understand how adults and children balance these different priorities across time to develop a diverse suite of problem-solving skills, which may aid children's later self-directed inquiry. Understanding autonomy support at these more precise and multidimensional levels could provide a more thorough and usable roadmap for parents and practitioners to support children's development long-term.

Our approach, combined with our naturalistic, outdoor play data, also proved fruitful in addressing the tendency of problem-solving frameworks to privilege adult-centric, deficit views of children's inquiry. Autonomy support's tenets were developed largely in lab-based settings, employing tasks where many structures and goals are already defined for the participants (Grolnick et al., 2002, 2007; Matte-Gagné and Bernier, 2011; Whipple et al., 2011). In determining the trajectory of their own naturalistic play, however, the children in our clips frequently defined their own goals, shaped their problem-solving approaches, and led decisions about when to initiate and terminate various courses of action. By approaching this data in a bottom-up fashion while also considering key problem-solving concepts, we found that we could document their endogenous styles and refine our categories to catch their contributions more accurately. It also drew our attention to the subtle ways that parents recognized and responded to those child-generated processes with their own calibrated, co-problem solving behaviors. In short, this approach may provide a way to document endogenous, dyadic pedagogy that is less reliant on adult-centric views of inquiry, and more grounded in the myriad ways that children learn in concert with trusted adults.

Failure as a focal point also proved particularly generative in surfacing how moments of difficulty are ripe for foregrounding a number of valued possible learning goals. In such moments, self-determination is at stake, and goals–whether the child's or the parent's–are likely to be backgrounded or foregrounded. Given their pivotal status in the problem-solving process, moments of failure and difficulty also surfaced as ideal junctures to observe the support choices that parents make. Before dismounting Rock 2, for example, Jaz makes an initial request for a hand hold, but Mom interjects, suggesting "↑I >>think↑ you can<< jump off this one by yourself" (F9:17–20). This parenting move interrupts a pattern established on the previous rock (where Jaz seeks and immediately receives a hand hold), and introduces an additional tension to the problem of how the child is going to get down from the top of the rock. Jaz remains silent for two full seconds while looking down and further assessing the situation, before ultimately repeating her request. The outcome (child dismounts with hand hold) is ultimately in line with the established pattern, but the parent's skill for capitalizing on the tension of a moment of need by building in *more* tension, and nudging the child to critically evaluate, is notable. It also demonstrates that parents (as well as researchers) recognize these subtle impasse moments as opportunities to expand children's repertoires. Taking cues from these case studies, and from this behavior we observe in parents, we predict that researchers could learn a great deal by adopting a bottom-up approach for examining naturalistic data and zeroing in on moments of failure and the different ways that participants both help to create and resolve them.

Finally, the situated, multimodal approach afforded by IA gave us the needed tools for tracking the ways the physical environment shaped the interactions in our focal clips. It is impossible to analyze "Rope" without giving proper attention to the role and position of the picnic table, and how Rae and her mother treat it as a resource for achieving Rae's goal of grabbing the rope. By additionally engaging with parents in a shared analysis of the videos, it also opened the door to a greater understanding of how parents were thinking about these situated, environmental interactions. As this study makes visible, children's naturalistic play is often rich with problem solving interactions that are not verbalized by the participants. This combination of methods represents a promising way for researchers to capture learning in these informal contexts.

Limitations

This study has a few limitations around its analytical approach, central constructs, sample, and research design. On the analysis side, by following the principles of discursive psychology and interaction analysis (Jordan and Henderson, 1995; Wiggins, 2016), our approach primarily focused on the observable, public record of parent-child interactions, and was thus unable to attend to the child's private experience or awareness of self-determination and autonomy (c.f., Vossoughi and Escudé, 2016; DeLiema et al., 2021; Keifert, 2021). An additional limitation of the study was the focus on constructs surrounding problem solving (e.g., noticing problems, proposing causes, generating solutions) to the exclusion of other constructs central to the autonomy support literature, such as the timing of support and the flexibility of parent support. Prior experimental work has demonstrated that these practices are central to understanding autonomy-supportive parenting (e.g., Whipple et al., 2011; Meuwissen and Carlson, 2015, 2018, 2019); future work should continue to examine how these practices can be observed in unstructured, naturalistic parent-child interactions. Additionally, our study only sought families who typically spend time outdoors and who participate in an outdoor education non-profit; both criteria limit the generalizability of the sample. Future work should aim to ameliorate this threat to external validity by sampling

from more socioeconomically, culturally, and ethnically diverse families. A final limitation of our research design was the focus on just two extended activity arcs. Future researchers could build on this work by either applying this framework to a greater volume of data, expanding the understanding of endogenous, dyadic problem solving styles, or by pursuing a longitudinal approach, documenting the evolution of problem-solving practices, relative to different types of parental support, over longer time horizons.

Conclusion

With our motivation to better understand dyadic, intergenerational learning interactions, we studied two extended activity arcs that occurred while parents and children attempted to resolve problems that arose naturally during unstructured, outdoor play. Our iterative method of interaction analysis led us to first apply the concept of autonomy support, and when we encountered practical and theoretical limitations of the existing research, we applied additional lenses of problem solving, debugging, and intergenerational learning. We ultimately arrived at a novel approach for decomposing problem-solving interactions in a way that captured the respective contributions of each participant in a detailed way, and facilitated our understanding of what both the child and the parent added to the learning process. We also examined problem-solving strategies across multiple timescales to begin to illuminate which contributions serve the child's self-determination in the present and which might offer benefits for the child's self-determined competence in the future. Our analytical approach raises possibilities for expanding the theoretical understanding of autonomy support in naturalistic settings, and methodological questions about how to measure aspects of the concept going forward. Finally, our analysis highlights the benefits of viewing families and their learning interactions *in situ*, utilizing detailed methods of analysis that allow educational researchers to view learning in a bottom-up fashion, facilitating the observation of endogenous, interactive practices of the participants, and ultimately providing users of educational research with actionable considerations for developing and evaluating pedagogical practices.

Data availability statement

The datasets presented in this article are not readily available because original video data supplied by participants for this study cannot be suitably anonymized for public availability. Transcripts and images included with the article represent the primary data generated for this study. Requests to access the datasets should be directed to JB, bake1059@umn.edu.

Ethics statement

The studies involving human participants were reviewed and approved by Institutional Review Board, Office of the Vice President for Research, University of Minnesota. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

All authors contributed to the direction and goals of the RPP and the overarching study, and contributed to data analysis sessions. AH designed the surveys, interview protocols, and overall data collection strategies with consistent feedback from DD, AS, SC, and SR, provided validity checks on coding and analysis, and contributed writing as third author. DD, AH, and JB conducted participant interviews and collected video data. JB and DD conceived the featured case study and led data analysis. JB led writing of the manuscript and creation of transcripts and figures, with ongoing contributions and feedback from DD. SC, AS, and SR edited the final manuscript.

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in the JB's dissertation, which is due to be completed in the 2022–2023 academic year.

Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.885231/full#supplementary-material

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