



# Designing for Common Ground: Visually Representing Conversation Dynamics of Neurodiverse Dyads

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During interpersonal interactions, conversational moves can help people establish *common ground*—a shared frame of reference to support communication. Neurodiverse conversation dyads that include autistic and non-autistic members can experience challenges in creating and maintaining such a shared frame of reference due to differing communication and cognitive styles. We conducted a design study to understand conversational patterns among neurodiverse dyads and then used those patterns to co-design concepts for supporting the creation and maintenance of common ground by those conversation pairs. Our study involved two activities with participants: (1) a paired interview with autistic adults and a trusted conversation partner that used a novel swimlane visual elicitation activity, and (2) a remote design study during which the autistic participants designed a game intended to visualize and support neurodiverse conversation dynamics. We found that communication technology can scaffold neurodiverse dyads in locating common ground by supporting crucial individual and joint decision-making; clarification of language and emotions; and embodied sense-making of identity, relationships, and shared information. This project generated insights related to two distinct aspects of designing assistive Information and Communication Technology (ICT) to support autistic individuals: (1) the ability for visual elicitation activities to help autistic individuals recognize interaction patterns, gain a deeper understanding of other’s perspectives, and imagine more desirable alternatives, and (2) the importance of recognizing and supporting multi-dimensional aspects of communication practices (i.e., social, emotional, sensory) in establishing and maintaining shared points of reference for neurodiverse conversation dyads.

CCS Concepts: • **Human-centered computing** → **Empirical studies in collaborative and social computing**.

Additional Key Words and Phrases: communication, autism, neurodiversity, accessibility, participatory design, visual methods

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## 1 INTRODUCTION

As people communicate with each other, they attend to both the explicit meaning of words and more implicit paralinguistic and nonverbal cues provided by a conversation partner. As theorized by sociolinguistic scholar Clark, this process of establishing *common ground* [21] involves co-creating meaning through a complex negotiation of conversational moves that enable people to engage and coordinate actions through verbal and non-verbal communication practices. When communicative acts are unclear or misinterpreted, people can have difficulty negotiating the intent of the conversation and managing the flow of interaction. Communication partners can also have

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difficulty establishing common ground due to lack of trust [34] or mismatched abilities, such as linguistic spatial abilities—being able to see someone else’s physical or conceptual frame of reference [56].

Computer-mediated communication (CMC) and collaboration technology provide multi-modal channels (e.g., text, audio, visual) and shared digital workspaces that support the joint sense-making and problem-solving described by Clark. These technologies are helpful in some ways, such as making conversational moves, especially non-verbal communication, more visible during remote communication. However, as in face-to-face conversations, when common ground is not adequately established during technology-mediated engagements, communication breakdowns occur and joint problem-solving becomes more difficult.

Our research examines the ways that autistic and non-autistic conversational pairs—neurodiverse dyads—establish common ground. We refer to these pairs as neurodiverse dyads since they communicate across boundaries formed by neurological differences [17]; although neurodiversity encompasses conditions including attention deficit disorder and dyslexia, our study focuses on autism. Their perspectives, behaviors, and interpretations determine how they interact with each other and the meaning they attribute to those interactions. Since autistic individuals are in the minority—around 1 in 54 children in the United States have been diagnosed with autism, according to the U.S. Centers for Disease Control [43]—they must navigate a world in which the vast majority of people they communicate with daily are neurotypical. Neurotypical communication can seem “alien to AS [autism spectrum] worlds” [25, p. 792]. As theorized by disability study scholars, the nature of social interactions depends on “people and places, selves, and spaces, [that] are mutually constitutive, that they come into being relationally, produced and performed in interaction with each other” [25, p. 792]. From the perspective of autistic individuals, social assumptions embedded in interactions can make them feel as if they are perpetually experiencing culture shock and contribute to difficulty trying to find common ground. At the level of speech dynamics, neurotypical speech, the rhythm of exchanges, facial expressions, and lack of precision complicate communication.

We focus our work on face-to-face conversations as a key setting for communication practices of neurodiverse dyads and an integral component of daily life. Our goal is to increase understanding of the factors that contribute to common ground in these face-to-face conversations in order to enhance digital support for technology-mediated interactions of this type. Through this research, we asked autistic young adults (ages 18-33) to identify problems with communication that they have regularly encountered during early adulthood—a time period when they might be experiencing higher expectations for communication skills and are notably taking more ownership of their technology decisions, and adopting technological practices of adulthood. Technology-mediated communication barriers are particularly detrimental for autistic individuals since miscommunication and social tensions contribute to social isolation, reduced agency, and, more broadly, limited education and employment opportunities [18]. To study socio-technical factors that impact how neurodiverse dyads experience establishing common ground, we examined the following research questions:

- (1) During daily interpersonal interactions, how do neurodiverse dyads consisting of autistic young adults and trusted conversation partners conceptualize and experience common ground?
- (2) From the perspective of autistic young adults, what are the crucial elements of a face-to-face conversation that can contribute to common ground?
- (3) In what ways can coordination scaffolds (used to establish and maintain common ground) become more visible during face-to-face neurodiverse conversations, especially in ways that benefit the autistic individual?

Through our design research project, we found that neurodiverse dyads desired: (1) making interactions clearer, (2) explicitly representing emotions in ways that were easy to share, and (3) increasing independence and agency. Based on our findings, we discuss two distinct aspects of designing assistive information and communication technologies (ICT) to support autistic individuals: (1) the ability of visual elicitation and game design activities to provide a means for autistic individuals to describe current communication patterns and imagine more desirable alternatives and (2) the importance of recognizing and supporting multi-dimensional aspects of communication practices (i.e., social, emotional, sensory) in establishing and maintaining shared points of reference for neurodiverse conversation dyads.

## 2 BACKGROUND

Our research builds upon prior research on interpersonal communication technology for autistic individuals and human-computer interaction (HCI) research related to the principles of Clark's common ground theory.

### 2.1 Communication Technology for Autistic Individuals

Technologies specifically designed for the communication needs of autistic individuals tend to focus on teaching and supporting verbal communication, literacy, and social-emotional skills [40]. The nature of autism as a spectrum condition implies that people experience a combination of high- to low- needs depending on their neurology and environment. In turn, autistic individuals may use a range of specialized software and appropriate mainstream technology according to their communication and social preferences. For example, an autistic individual who is nonverbal or minimally verbal may use augmentative communication aids that translate text and image input to speech output and also engage in social media [19, 69].

The multi-modalities of communication channels available through texting, gaming platforms, online social media, and video conferencing offer valuable communication options. However, when using communication technology, autistic adults can experience many of the same stressors encountered in face-to-face settings [67]. Social-emotional cues generated by neurotypical people can seem complex and often ambiguous to autistic people. Some autistic people experience hyper- and hypo-processing of sensations (such as heightened sensitivity to bright lights, loud sounds, and clothing texture). Differences in sensory processing and motor control can contribute to “not being able to trust, feel, or control their bodies as they would intentionally prefer,” as described by autistic self-advocates [16, p. 1]. These experiences can be heightened while communicating via technology. For example, autistic adults can experience difficulties with technology-mediated social norms at every stage of video calling, including preparing, initiating, maintaining, and ending calls [67]. Some autistic adults have described attempting to improve their experiences by adjusting or resisting video calling technologies. For example, they describe turning off video cameras so they can freely stim—repetitively moving one's body—a practice that can draw negative attention from neurotypical conversation partners even though stimming is a positive means of kinesthetic sense-making and self-soothing [36].

Along with these sensory and movement behaviors, autistic individuals can experience similar hypo- and hyper-sensitivities to emotions [71]. The two images in Figure 1 show emotional taxonomies and representations that have been used as tools to help people with autism recognize and name emotions (e.g., [33]). It is important to note that both digital (e.g., a software tutorial, serious games, AI systems) and non-digital (e.g., a picture board) affective encoding systems are typically built to mirror or represent the emotional state of a user, creating a relatively flat projection of complex internal states, often using rudimentary physical cues mapped to generalized

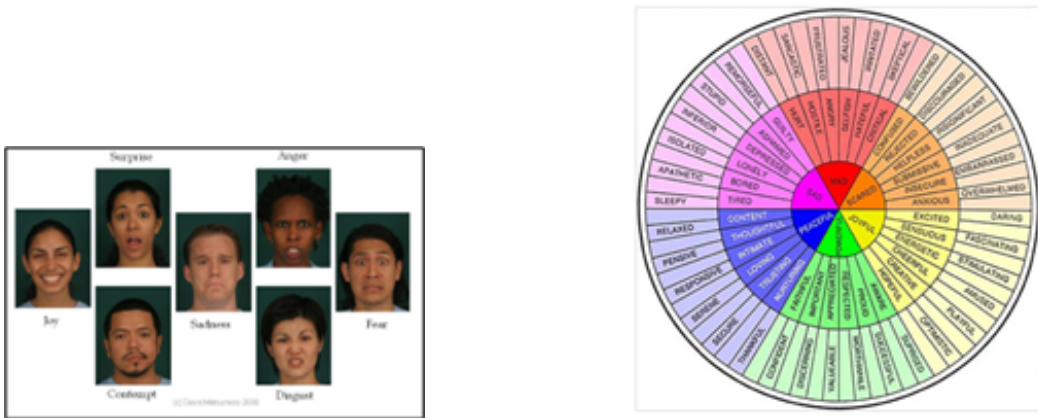


Fig. 1. (Left) Facial expressions of emotions (joy, surprise, sadness, anger, fear, contempt, and disgust) [46, 47]. (Right) Feeling wheel of emotional states [61]. Copyright: Fair use.

and nameable emotions. Often, this involves mapping these taxonomies to a digital interface or display, a form of affective visual encoding (e.g., [52]).

HCI researchers have explored designing emotion and communication learning tools to be more immersive and collaborative, especially in the areas of gaming and collaborative tasks. Co-located gaming environments can provide opportunities for players to coordinate tasks, pursue shared goals, and engage in self-directed verbal, text-based, and non-verbal communication. Video games can show positive demonstrations of collaborative strategies, which increase the awareness of the other player when active participation is required [49]. Video games can be a more engaging learning experience; however, it is a design challenge to organically connect emotional expression and identification within the game narrative [6]. Groups of neurodiverse children exhibit verbal and non-verbal communication skills while engaging in joint photo-taking on tablets [63] and multi-touch activities on tabletops (e.g., [45, 49, 59] Silva-Calpa et al. proposed a collaborative game for people with autism based on a conceptual tool, ‘StrateCSA’, which identified three dimensions important for encouraging the learning of collaborative processes: “cooperation (actions of the participants within the workspace), communication (conversation through the exchange of spoken, written, physical or gestural messages), and coordination (management of participants, activities, and resources)” [59, p. 1].

Researchers interested in leveraging emerging technology for this community have explored scaffolding autistic individuals’ communication styles with additional social and emotional context. For example, technology can provide real-time feedback about a person’s vocal prosody [14] or emotional expressions [7]. Researchers in the field of affective computing leverage these taxonomies when building technology to help people, both neurotypical and neurodiverse, communicate more effectively with each other, including supporting a range of social and emotional experiences. Social robots and emotion artificial intelligence (AI) interfaces are examples of this type of interactive affective computing system. Some of these systems assess and monitor a person’s countenance for precise facial markers, including the shape of eyebrows and position of lips, in order to map these markers to specific emotions, such as surprise or happiness [48]. The classification of visual facial features as discrete emotional states is integral to the interactive functionality of this type of affective computing system. Other examples of similar technology—designed for mainstream, non-autistic individuals—include vehicles that detect and respond to the driver’s emotions [29, 38]

and mental health care chatbots designed to enhance well-being and self-compassion [41]. However, some researchers have noted limitations in current emotion detection technology and stressed the need to build more inclusive technology grounded in the communication and social goals of autistic people [7].

Further limitations have been identified related to a lack of involvement of autistic individuals in the design process for these technologies. In a literature review of HCI games and play designed for neurodivergent individuals (non-inclusive to autism, including dyslexia, attention deficit disorder, etc.) Spiel et al. found that the focus of this research is typically on children and young adults [64]. Most of the research focused on systems that were designed *for* rather than *with* neurodivergent participants. Games with a medical framing, described as having therapeutic or diagnostic underpinnings, were the largest category of games, as compared to games designed from the social model of disability or self-guided play. Due to the concentration of medically-framed and educational games and the limited involvement of neurodivergent people in the design of these games, Spiel et al. state that HCI games currently fail neurodivergent individuals and argue for more inclusion and support for self-determination.

## 2.2 Common Ground Theory

Clark describes the interactive aspect of communication as *joint action* [21]. A joint action involves two or more people working in coordination. In the process of participating in joint action, both conventional and non-conventional moves will take place. Conversational moves are ways people engage and coordinate actions during an interaction, such as proposing and engaging on a topic. These moves include discrete verbal and non-verbal expressions and can keep, or hinder, the flow of conversation. How participants interpret, react to, and embody these interactive moves contributes to the dynamic and *interdependent* nature of joint activities.

Clark states that in order for conversation partners to engage in joint actions, they need to establish and maintain *common ground*. According to Clark, some coordination practices related to establishing and maintaining common ground are well-codified (i.e., court proceedings) and some are more loosely prescribed (i.e., chance encounters). We learn these practices by observing and participating in communicative acts over time. Common ground is constituted of three parts. *Initial common ground* refers to the prior knowledge, beliefs, and assumptions that are taken for granted by participants performing the joint activity. *Current state of the joint activity* is what participants understand to be true about the present state of the action being undertaken. Finally, *public events so far* refer to the various indicators of what has already occurred during a conversation, from converging vocabulary to the position of bodies in space. These events are part of the shared history of the participants and reflect the arc of the joint action. These three common ground aspects enable conversants to work towards specific goals (both public and private, individual and shared). In our work, we connect Clark's emphasis on the co-constructed nature of common ground with the concept of *interdependency* from Disability Studies and assistive technology scholarship [8]. In this context, interdependency acknowledges that people's lives are entangled with each other and with technology, and by understanding our mutual dependence, we can design assistive technology that meets both individual and group goals.

Another inspiration we draw from Clark is that each component of common ground—initial common ground, the current state of the joint activity, and public events so far—could take a physical form and is not limited to verbal expressions. Clark pays particular attention to the material nature of *external representations of the current state*. He uses a game of chess as an example, where the board and the pieces are the external representation of the current state of the game. The idea of external representation highlights that the activity of establishing and maintaining common ground can and often does have a physical form, whether it plays out on a material “stage” like

a board game, or takes the form of gestural cues such as mirroring physical postures, or other non-verbal signs of mutual orientation. We built on this idea of social interaction as gameplay in the framing of our co-design sessions.

### 2.3 HCI Communication Research Informed by Common Ground Theory

Clark's conceptualizations of language use and common ground have been cited among influential HCI theories, including distributed cognition and activity theory [50]. Clark's theory is important for HCI and CSCW researchers because it frames language as an integration of social practice and individual information processing [50]. HCI researchers have used this lens of common ground to examine face-to-face conversations involving spontaneous visualization [62], text chat for large, distributed groups [11], online and phone communications between consumers and sellers [34], and workplace collaboration [23]. Covertino et al.'s research on distributed emergency management planning emphasized that establishing common ground in a digitally mediated workplace is tightly dependent on coordinating tasks and producing work outputs [23]. In contrast, our research focuses on the dynamics of interpersonal communication, notably face-to-face conversations. Face-to-face conversations "test, reformulate, and add to our common ground" because they develop a history of joint actions, private lexicons of words, use of gestures, and externalization of ideas captured as imaginary "air whiteboards" [50, p. 276-277]. However, for individuals with autism, this process can be more difficult and non-intuitive when it comes to perceiving the social acts of others, ascribing meaning, generalizing from one context to another, and executing social behaviors. In looking more closely at face-to-face conversations, we hope to provide insights regarding critical factors to consider when designing and deploying any type of system for neurodiverse users.

In fact, Clark's theory is noted as being able to "make practically relevant predictions for the design of facilities to electronically mediate communication" [50, p.265]. Researchers have used principles of common ground to examine human-to-machine interactions involving chatbots, digital help systems, and virtual agents (e.g., [28]). In research investigating effective conversations with conversational agents, researchers highlighted the importance of establishing common ground as a key attribute that emerges over the course of an interaction [22]. Greenspan et al. researched technology-mediated interpersonal communication between potential homebuyers and sellers to examine issues of trust [34]. They found that disruptions to both common ground and emotional attunement can negatively impact the level of trust between buyers and sellers and consumers communicating via a PC and phone system.

Our project draws on this work at the intersection of interaction design, computational linguistics, and computer-mediated communication to better understand the experiences and priorities of neurodivergent users. Although we draw on these examples of games and other ICT, the goal of our work is to examine interpersonal communication at a relatively basic level and to consider the impacts of engaging more directly with neurodivergent users throughout the design process. This approach has implications for contexts, including supporting digitally-mediated collaborative tasks or introducing games with specific therapeutic or learning outcomes while also serving as an example of inclusive design practice.

## 3 THEORETICAL FRAMING FOR CONSIDERING SOCIAL INTERACTIONS AS GAMEPLAY

In the Background section, we discussed HCI research that resulted in games for neurodivergent users. For our project, rather than focusing on the design of a specific game, we leveraged the *process of game design* to provide participants with a concrete space for exploring material and social aspects of communication acts. In the previous section we also summarized Clark's common ground theory; here, we describe how, using the metaphor of conversations as gameplay, we

Table 1. Integrated Common Ground and Gameplay Framework

Common Ground Concept	Gameplay Concept
Social interaction partners	Gameplayers
Setting of interaction (physical & conceptual boundaries)	Frame of game
Grounding (establishing background)	Capabilities of the players; active player
Social practices	Rules of game
Initiating	Initial configuration of the game board, game pieces, and rules
Roles people take on during interaction	Roles players take on during game
Proposition	Setting up choice in game
Engagement and coordination (moves to establish tasks, negotiate, accept, reject, clarify, reflect)	Making game moves; game mechanics
Communicative acts	Game mechanics
Closing interaction	Ending game

connect theoretical constructs of common ground with concepts from game design practice. These analytical connections are used to support a novel integrated framework (Table 1), which we use as the basis for our design activities and analysis.

One way Clark proposed to conceptualize common ground is to consider gameplay as a metaphor for social interactions. Clark described common ground as comprising: (1) initial common ground, (2) the current state of the joint activity, and (3) public events thus far. He used the game of chess to illustrate these aspects of shared space. The initial common ground is the presumptions players have about the rules and etiquette for chess, which allows them to interpret the chess board and pieces and place themselves physically at the game table. The current state of the activity is represented in concrete form as the game board and location of the game pieces that have not been captured. The public events so far are the record of the players' moves that led to the current state. A benefit to using Clark's conceptualization of joint action and common ground is that it can be applied at varying analytic levels, from a group, a pair, or the perspective of one person. Specifically, our work focuses on applying common ground to understand social interactions from the perspective of an autistic individual in conversation with a non-autistic individual.

In order to create elicitation activities for our study, we extended this conceptualization using fundamental game design principles. Games are performed within specific frames or settings. The frame "is what communicates that those contained within it are 'playing' and that the space of play is separate in some way from that of the real world" [55, p. 94]. The setting can be established in space and/or time (i.e., a game board or a set amount of time to complete a task). The setting for a game also has a modal aspect, which can be physical, digital, or a combination. Gameplay participants bring into the setting information that they know or can surmise about each other. To engage in the interaction or game, all of the participants follow the rules of the game. These include establishing the goal of the interaction, the pathways through the game, the ways to take turns or pass on a turn, etc. Predominantly, gameplay rules are concrete and are often provided in a set of gameplay instructions.

In gameplay, the players interface with each other through these game mechanics, such as rolling the dice, moving a token, or saying game-specific commands. As Salen and Zimmerman explain, "Meaningful play in a game emerges from the relationship between player action and system outcome; it is the process by which a player takes action within the designed system of a game and

the system responds to the action. The meaning of an action in a game resides in the relationship between *action* and *outcome*" [55, p. 34] (italics added). An important component of meaningful play is that participants have choices and can readily observe the consequences and outcomes: "When a player makes a choice in a game, the system responds in some way. The relationship between the player's choice and the system's response is one way to characterize the depth and quality of interaction" [55, p. 61].

We can elaborate on how we conceptualize the interactions at the core of gameplay as a means for establishing common ground (Table 1). As an interaction begins, the participants gather in a common setting or the frame of the game. The participants become grounded in each other and the game, informed by knowledge about backgrounds, culture, what they have in common, roles, and relationship dynamics. In a conversation, grounding may be expansive or tightly scoped, with the conversants unsure of what attributes are relevant to the current interaction. However, in a game, the boundaries of the grounding-related attributes are often more succinct and knowable. Roles can change as interactions progress and power dynamics and motivations change. To construct their moves, participants engage in communicative acts, or in gameplay governed by the game mechanics (analogous to the social norms that guide conversations [66]. Through the course of an interaction, the participants engage in a flow of activities: initiating, engaging in topics and rounds of turn-taking, and coming into conflict and/or alignment. There can be a reshuffling of resources as the shift in power moves from player to player. Note that while in gameplay, rules are typically concrete, in social interactions, social practices can be more nebulous and harder to confine to a specific set of norms.

The sum of all these moves can be described on the one hand as meaningful play and on the other as the creation of common ground. Eventually, the interaction or game comes to a concluding state. The end state of a game is typically clearly defined and based on measurable and concrete factors. In contrast, the conclusion of a joint communication activity can end on uncertain grounds, with unspoken or unclear expectations of continued dialog and actions that extend beyond the setting of a specific interaction. We leveraged this divergence between gameplay and conversation outcomes as a way to encourage participants to invent ways that games could more closely emulate unresolved outcomes of conversations with their partners. Next, we describe how, starting from theory, we operationalized our integrated framework through a series of elicitation activities and deductive, iterative analysis.

#### 4 METHODS

We employed participatory, multi-modal methods to study the mechanisms for establishing common ground and probe the potential value of making conversational social norms more material and visible as a means to support the communication practices of autistic young adults. Participatory design is aligned with our commitment to interdependency and calls by HCI researchers to meaningfully include neurodiverse users in design practices [9, 31] in ways that extend power to people impacted by technological changes in their organization and environments [15]. Co-design involves creating opportunities for participants to produce designs, not just provide feedback on concepts presented by researchers. We engaged participants in two activities: (1) paired interviews with the primary participants and a trusted conversation partner of their choosing, and (2) participatory design in which the primary participants created physical games intended to support face-to-face conversations and then shared their designs with a partner. Both activities involve externalizing mental and social processes, which is a valuable component of collaborative design because "externalizations (1) create a record of our mental efforts, one that is "outside us" rather than vaguely in memory, and (2) represent artifacts that can talk back to us [57] and form the basis for critique and negotiation" [5, p. 88].



#### 4.1 Primary Autistic Participants and Secondary Trusted Conversation Partner Participants

Our primary research participants were autistic adults (15 in paired interviews; 13 in design activity) aged 18-31 years old. We summarize participant demographics and use pseudonyms to protect the anonymity of our participants (2). We invited primary participants to invite a routine, trusted conversation partner to be in the paired interview and to engage in the final step in their game design activities. They selected family members, romantic partners, friends, and instructors. We refer to their invited partner as a secondary research participant and the pair as a communication *dyad*. Note that our recruiting strategy, activity design, and data analysis focuses on the experiences of autistic young adults in the context of their interactions with secondary participants. The data about the secondary participants is reported to augment the data of autistic participants and to construct an understanding of the dyad, from the perspective of the autistic participant. We take this approach to forefront the experiences of autistic individuals to differentiate from, and counter, the majority of ICT design and research on neurotypical people.

We recruited autistic young adults with the assistance of local autism organizations, community college autism programs, the Atlanta chapter of Autistic Self Advocacy Network (ASAN) [3], and The Asperger/Autism Network (AANE) [2]. Due to the COVID-19 pandemic, all engagements with participants were remote. We conducted the paired interviews over Zoom or Facetime from February-April 2020. There were 15 pairs (30 individuals); each individual received a \$50 gratuity. The 15 primary participants comprised 9 male, 5 female, and 1 non-binary individual. Secondary participants were their parents, grandparents, spouses, brothers, boyfriends, and instructors. Next, we conducted the remote design activity from July-September 2020. There were 13 primary participants (7 male, 4 female, and 2 non-binary individuals). Seven primary participants were in both the paired interviews and game design activity, which was the research team's original intention. However, some participants were no longer available due to the COVID-19 pandemic, so we conducted a second wave of recruiting. Primary participants received a \$75 gratuity. Each primary participant shared their game design with a conversation partner as their final design step. Due to the short duration and engagement with secondary participants, they were not given a gratuity. Design instructions and kits, described in detail below, were physically mailed to participants.

#### 4.2 Elicitations Part 1: Paired Interviews with Swimlane Activity

Paired interviews were conducted with each pair of primary and secondary participant present. The overarching goal of the paired interviews was to gain an understanding of how neurodiverse dyads perceive, co-construct, and reflect upon conversational interactions with each other. Over the course of the interview, which ranged from an hour to one-and-a-half hours, the researcher inquired about their relationship, the nature of their joint activities, and their perceptions of their similarities and differences in terms of how they behave or think. Among other questions related to the nature of their relationship and typical topics of discussion, the researcher asked them to describe the ways they communicate with each other-including with the use of technology, if they tend to know how the other is feeling, and the types of communication breakdowns they experience with each other.

Next, the researcher led each pair through a novel swimlane visualization activity designed to surface and capture the public and private goals of the dyad, as well as document tactics they deploy for establishing common ground. We grounded this exercise in an actual recent conversation that took place between the dyad. To represent the dyad's interaction episode, we created a swimlane diagram, a business analysis technique for modeling cross-unit processes in a multi-column flowchart format [39]. We discovered that swimlane diagrams are useful for depicting

Table 2. Research Participants

Name	Age, Gender	Education, Occupation	Secondary Participant	Research Activity
Alana	28, Female	Bachelor degree, Bus driver	Wife	Interview
Chase	19, Male	College transition student	Mother	Interview
Ethan	20, Male	College transition student	Instructor	Interview
Jack	18, Male	College transition student	Mother	Interview
Jesse	26, Male	College transition student	Grandmother	Interview
Mitchell	19, Male	College transition student	Instructor	Interview
Sam	20, Male	College transition student	Father	Interview
Alec	26, Male	Master of Music, Musician	Brother-in-law	Interview, Design
Caylee	18, Female	College Transition student	Mother	Interview, Design
Daniel	18, Male	College transition Program	Brother	Interview, Design
David	19, Male	College transition student	Parents	Interview, Design
Emily	28, Female	PhD Statistics, Software engineer	Boyfriend	Interview, Design
Kendall	25, Female	Bachelors, Advocacy	Husband	Interview, Design
Michelle	31, Female	Bachelors, Software engineer	Parents	Interview, Design
Sarah	28, Female	Medical degree, Human Resources	Boyfriend	Interview, Design
Charlie	31, Non-binary	Bachelor degree, Advocacy	Friend	Design
Paul	31, Male	Bachelors, Software engineer	Roommate	Design
Rahul	18, Male	High school degree	Sister, Parents	Design
Steve	18, Male	Undergraduate college student	Parents	Design
Tanish	24, Male	Bachelors, Software engineer	Brother	Design

actions of multiple actors engaged in a joint activity. To do this, we designed a three-column template, with the column on the left used to capture information about the primary participant, the right column reserved for the secondary participant, and the wider center lane used as a shared space for what the pair felt they expressed together. The information in each of the lanes was separated into the *internal states* (senses, emotions, and social goals or moves) of the participant on the outermost column and the *external states* (verbal and non-verbal expressions and moves) on the innermost column. A template for the swimlane is shown in Figure 2 along with a sample completed diagram based on a fictional conversation between two people (Ethan and Tom). The swimlane diagram captures images (and, optionally, text) selected by the participants as they recall an interaction episode. The images serve as metaphors for interaction tactics and internal, embodied emotional states.

The research team curated a collection of images used in the swimlane activity from visually rich descriptions and metaphors provided by autistic adults during previous interviews where they

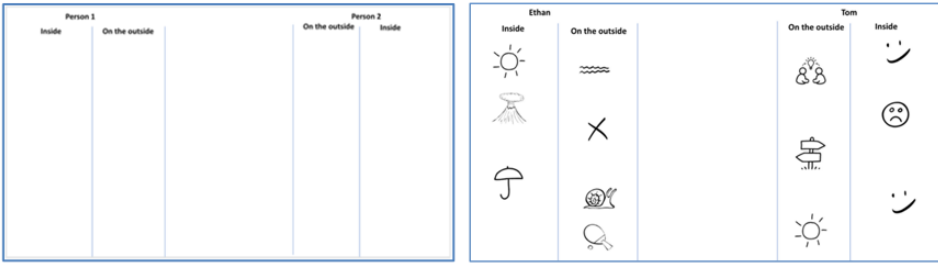


Fig. 2. (Left) Swimlane template. (Right) A completed sample swimlane diagram that was shown to participants at beginning of the activity. This example diagram captures a conversation between fictional Ethan and Tom, flowing from top to bottom. For each participant, their internal states appear in the outer lane, and external states appear in the inner lane.

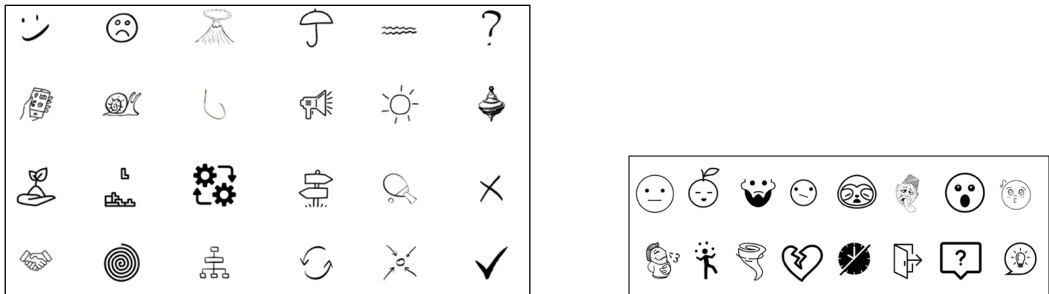


Fig. 3. (Left) The initial common ground icon catalog. (Right) The additional icons added by the participants.

discussed social, emotional, and sensory influences on their interpersonal interactions [citation omitted for blind review]. For example, in our prior research, autistic young adults described feeling anger as rising within their body, so the researchers included an image of a volcano in the icon catalog. In addition to drawing on personal and idiosyncratic imagery, this collection critically engaged with traditional representations of emotions (Figure 1).

We conducted a design review of the image icon with our research team, which included a person who identifies as autistic, to provide feedback on the images. Based on this review, we established selection criteria as follows: images needed to (1) represent sensory, emotion, social, and/or autism traits, (2) be black-and-white for uniformity and to eliminate color bias, and (3) be composed of simple strokes that evoke a hand-drawn feeling, implying that the images are not set in stone and open for interpretation and adaption. Using this criterion, the research team selected 24 of the most relevant images as an initial visual vocabulary (Figure 3). We selected 6 images for each category of emotions (top row for visual language), sensorial experiences (second row from top), social interactions (third row from top), and common autism traits (bottom row) to be included in an icon catalog. We designed our swimlane activity to present the icon catalog as an initial, fluid vocabulary for them to respond to and adapt to make it more resonant to them.

In Clark’s terminology, we focused the activity on *joint actions* and *signals* that people use to establish common ground. These are joint actions from Clark’s conceptual framework, along with interactional moves that participants described in the individual interview, which are represented in our icon catalog:

- Initiate interaction

- Close interaction
- Ground (establish background and commonalities)
- Coordinate (negotiate, establish tasks, become aligned in what we will do)
- Proposition (offering a topic or position)
- Engage with proposition
- Withdrawal (disengage)
- Deflect, negotiate, accept, clarify
- Accept, disagree, exhaust the topic

These are common autism communication traits that may arise during interpersonal interactions, which are represented in our icon catalog:

- Use scripted conversation
- Verbal or physical stimming
- Deep dive into special interest (fixate)
- Distracted (attention elsewhere)
- Perseverate (repeat action or utterance)

The researcher introduced the swimlane activity by letting the participants know that they would, together, recall a recent interaction with each other and create a visualization of that conversation. The researcher explained that we were using a framework called “common ground” for this activity - which means that our interactions are not only what we say aloud to each other, but also the deeper meaning of our words, actions, emotions, and how we feel in the physical space. The researcher showed and described an example visualization of two people sharing with each other about a hard day at school (Figure 2). The researcher asked the pair to come up with an example of a recent conversation that raised some different opinions, goals, or difficult emotions. Examples included sharing difficult news, talking about a controversial topic, or trying to reach a decision. Participants provided details about who started the interaction and where it took place. They then took turns describing what they did, said, and felt, as the conversation flowed. As they walked through the conversation, the researcher prompted them to choose an image (from Figure 3) that represented how they felt inside and how they thought they presented themselves externally.

Participants were invited to augment the proposed icon catalog by selecting additional images from The Noun Project [1]—an initiative to build a global, unifying, and free visual language. In the remote context in which this activity took place, the researcher facilitated by populating swimlanes with icons selected by participants, from top to bottom, to represent changes over time as the episode progressed. Once completed, the researcher asked the participants if the visual was a fair representation of their conversation, and changes were made as necessary.

The swimlane visualization tool was designed to capture a fairly high-level representation of conversation episodes. Participants described interactions in terms of dialog, actions, and feelings, at different levels of abstraction, moving from the phrases they said into what they were trying to accomplish. For instance, someone might describe feeling angry and wanting the conversation to end, equating this with standing up from a table. In another case, someone may not have wanted to state a controversial opinion, so they did not complete the end of their sentence. The goal of this activity was not to capture the low-level signals of exact dialog and physical movements but to represent significant dialog and details along with higher-level dimensions of the conversation through abstracted icons. By using and expanding on the collection of images we provided, participants had an opportunity to generate new metaphors and expressions about their actions, intentions, and internal states.

### 4.3 Elicitations Part 2: Game Design Activity

Envisioning design research activities centered around creating a game to support neurodiverse in-person conversations in ways desired by autistic adults. Participants were asked to consider a proposition that conversations are somewhat like a game. Using gaming as a structure throughout the remote design activities had three benefits. First, gaming was a familiar concept for participants, given that autistic individuals perceive play [68] and gameplay [30, 53, 70] as beneficial to developing social skills, demonstrating expertise to others, and building community. Second, it provided a stable scaffold for elicitation prompts used in prior research with autistic participants [12] and was friendly to the remote format of design activities. Third, it enabled the research team to explicitly build on Clark's work as an analytic basis by connecting game design concepts to common ground concepts. Our game design activities were meant to help participants externalize the ways they conceptualize their interpersonal interactions, as well as the rules they perceive in how interactions work. Through these design activities, participants introduced ways to make choices, actions, and outcomes more explicit in social interactions, similar to how they are explicit in games.

*4.3.1 Operationalization of Integrated Common Ground and Gameplay Framework.* We operationalized our integrated common ground and gameplay framework (Table 1) into participatory design prompts as follows:

- **Initiation:** As interaction begins, participants gather in a common setting—the frame of the game, in gameplay terms. The setting is established by space and/or time, along with a material aspect, which can be physical, digital, or a combination. Participants bring into the setting grounding information that they know or can surmise about each other based on backgrounds, culture, commonalities, roles, and relationship dynamics. See Table 3.
- **Social Practices:** To establish meaningful play, participants have choices and can readily observe consequences and outcomes. To engage in the interaction—the game—participants tend to follow social practices or rules of the game, including establishing goals for interacting, game pathways, and ways to take a turn or pass on a turn. See Table 4.
- **Social Mechanics:** To construct moves, participants engage in communicative acts—game mechanics. During interactions, communicative acts include speech, signaling, and illocutionary acts (e.g., assertives, directives, commissives). See Table 5.

We mailed design kits to participants containing design materials and the following handouts: (1) a welcome letter; (2) instructions, (3) a design kit inventory list, and (4) a design journal. The materials were presented as an uncategorized set of items and included 3D objects (tubes, Styrofoam balls, wooden dowels, pipe cleaners), flat surfaces (multi-colored construction paper), drawing supplies (markers, colored pencils, pencils), and tools (scissors, glue, tape, post-it notes). By sending all participants a common set of materials, we were able to provide specific suggestions for entering into design activities and could provide remote support to those needing help in the fabrication of their ideas. In the instructions, participants were oriented to the asynchronous plan for completing tasks that drew from asynchronous remote community (ARC) research methods [44]. We provided participants with optional communication avenues as they completed the design activities: email, Zoom synchronous design meetups, and a Slack channel. Our remote participatory design approach was beneficial to our participants' communication and cognitive styles, allowing them to (1) communicate in their preferred modality (writing, speaking, video calls), (2) engage in in-situ design (making the design process more relevant), and (3) engage at times and speeds that work for them.

*4.3.2 Instructions for Design Activity.* The instructions introduced the idea that conversations are like playing a game. The researcher asked participants to think of a game they like to play, and

Table 3. Operationalization of **Initiation** Common Ground and Gameplay Framework into Design Activity

Design Prompt	Data and Artifacts	Analytic Focus
<b>Consider social interactions as a game between you and your conversation partner. What are objects that would represent yourself and your partner?</b> Create game pieces for you and your partner. How can they connect, engage, or maintain space?	Gameplayer pieces representing neurodiverse interaction partners	Perception of self and others; sensory connections and boundaries
<b>What could you create for the space and pathways between you and your partner?</b> Design a game board to hold your interactions.	Game board form, materials; Locations and pathways between players	How interactions are contained by space, actions, and time
<b>We come into social interactions with how we are feeling, what is on our mind, and what we perceive about the other person.</b> Design ways to establish grounding knowledge (ways for you to have or track information about the “place and space” you and your partner are coming from). Show emotional and sensory states and needs.	Gameplayer pieces; allowable choices and rules; Game elements and rules for showing and modifying emotions and sensory experiences	Desired grounding information (people’s similarities, differences; backdrop of an interaction); Externalization of emotions, sensations, and thoughts

Table 4. Operationalization of **Social Practices** Common Ground and Gameplay Framework into Design Activity

Design Prompt for Conversation Game Design	Data and Artifacts	Analytic Focus
<b>During conversations, we may act in familiar, predictable ways. With your game components, show and scaffold common patterns.</b> Show communication patterns and moves (e.g., Move tokens, levers to take turns or clarify ideas). Show consequences and outcomes of moves.	Board game elements, game mechanics, game rules	Social interaction mechanics and rules; Ways that communication moves can be more explicit
<b>If you think of interactions as a game, what are the rules that the players follow? What rules do you like and dislike?</b> Specify rules of the game: How do you move through the interaction? What are things your communication partner can do or have to make the interaction clearer?	Definition of game mechanics and rules	Social interaction mechanics and rules; Common patterns of movement and use of game elements
<b>What are the wins and losses that occur? Are there goals to your game?</b> Define the game’s goals; What are you hoping to achieve or experience during the interaction?	Definition of “the end game”	Mental models of “the end game,” purpose, and goals

then think about some ways that playing that game and having a conversation are similar. The instructions then presented four activities: (1) create two game pieces to represent yourself and your conversation partner, (2) create a game board to move around in during a conversation, (3) create a list of rules and choices players have along with related game elements, (4) create a way for

Table 5. Operationalization of **Social Mechanics** Common Ground and Gameplay Framework into Design Activity

Design Prompt for Conversation Game Design	Data and Artifacts	Analytic Focus
<b>Interactions can bring up emotions (high, low, neutral). You can start to feel different things in your body. What emotions are you aware of and how could you and your partner share those?</b> Create game mechanics and materials to share emotions and sensations: Use levers, images, etc. to supplement verbal discussion with emotion and sensory cues.	Definition of game mechanics and rules; physical representations of emotions and sensations	Explore emotion represented in physical forms ways that they want to manipulate, show, and hide

gameplayers to indicate emotions and communicate about physical sensations, and (5) share your game design with a trusted conversation partner. Each activity had a design prompt, questions to respond to in their design journal, instructions and parameters for creating artifacts, and example artifacts. The example artifacts were generated during the pilot studies; we included a note that these are just examples; their responses will be different. In the instructions, participants were encouraged to gather materials from around their homes to supplement the materials provided in the design kits. Importantly, we emphasized that we were not evaluating their work based on their design or drawing skills, but were more interested in the ways that they wanted to represent their conversations. We included simple examples such as a game board made out of stones laid out on the grass and a player piece that was a piece of paper folded in the shape of an animal. The design instructions are summarized in Appendix A.

#### 4.4 Data Analysis

We analyzed data from the two design activities separately and then integrated the findings. Data from the paired interviews consisted of research memos written soon after the interviews; transcriptions of the interviews; the common ground swimlane diagrams, and Zoom video recordings. During the swimlane activity, the dyads reconstructed an episode rather than engaged in an interaction for immediate capture by the activity. Thus, our analysis was of the episode as it was reconstructed (and co-constructed) by the dyad, not of the dyad's real-time interaction during the interview. Two members of the research team used MaxQDA qualitative coding software to analyze the data following an iterative deductive approach [54] based on Clark's common ground theory (Table 6). We added codes for participants describing the icon catalog and reflecting upon the Common Ground activity.

Data from the game design activity comprised design artifacts (video and photos), design journals (narratives about their design artifacts and process). From the Zoom design session (with Sarah, Kendall, and Michelle), we have additional data (Zoom recording and researcher notes). To analyze the data, we documented the type of materials used and our descriptions of the created artifacts. We collated the journal entries so we could compare them across participants. We coded the data for the following categories: aspects of self that they choose to emphasize or diminish, available actions, impacts of moves, and points of mediation (See Table 7). Participants may or may not be using technology as a means to support their actions. Two members of the research team used affinity diagramming to analyze data for emergent themes [42]. Through the process of iterative clustering of key data points and defining categories, relationships between codes emerged; for example, the

Table 6. Codebook for Swimlane Activity

Code	Description	Examples from Data
Roles	Dynamic roles people take on	Passive, advocate, try to be positive
Setting	Context of interaction (location, time); physical and conceptual boundaries	Family dinner, son at computer with mom across hall
Goals	Stated or implied goals of each person	Loosen up schedule, introduce people
Conversational Moves	Engagement and coordination (moves one makes to establish tasks, negotiate, accept, reject, clarify, reflect). Choices and rules. Assemblage of communicative acts. Patterns, boundaries, and barriers during the interaction.	Initiate conversation, propose topics, ignore; find free time in schedule; make dinner together
Communicative acts	Discrete verbal communication, non-verbal communication actions (incl. tech use). Internal and external states.	Ask for repeated instructions, confused, hide anger
Icon	Choose icons, discuss if icon makes sense	Choose puzzle icon to represent building resume
Reflection	Comments about doing the activity	Found it confusing, learned something new

Table 7. Codebook for Game Design Activity

Code	Description	Examples from Data
Aspects of self emphasized or diminished	Ways to observe and engage with others, maintain space and boundaries, externalize emotion.	Attributes of gameplayer pieces (colors, sizes, movement, pieces in comparison)
Available actions	Social interaction mechanics and rules; ways communication moves are materialized or characterized	Game choices and rules (concrete, fluid); game board boundaries and spaces (multiple paths, static, dynamic).
Impact of moves	Available choices and consequences; ways drew on or incorporated social-emotional-sensory experiences (emotion spinners, dice).	Purpose of game choices and rules; mental models of “the end game” (clear winner; both can win)
Points of mediation	Description of things, actions, feelings participants would want changed; ways to manipulate, show, and hide emotions	Opportunities to change gameplay (spinners, decisions); game elements to enhance social-emotional-sensory experiences (rolling, stirring).
Reflection	Comments about engaging in design and sharing with others.	Not sure how to begin; fun; solved problems together

types of interactions afforded by objects, ways that objects supported joint decision-making, and game elements to set boundaries for physical comfort.



## 5 RESULTS

First, we present results from the swimlane activity that described current tendencies and conversation patterns of neurodiverse dyads. Then, we present results from the remote game design activity during which autistic adults designed their preferred and imagined ways of interacting and locating common ground.

### 5.1 Current Interactions as Reconstructed by Neurodiverse Dyads

Overall, the nature of most of these episodes centered on negotiating the boundaries of relationships and expectations, experiencing intense emotions, and navigating differences of opinions and perspectives. Common themes were planning, negotiating, disagreeing on, and heightened feelings about attending required work or school activities, introducing significant others to family, negotiating home responsibilities, and responding to being socially excluded by others. The dyads discussed these interactions in the context of deeper concerns about nurturing their relationship, personal and shared accountability, and balancing needs for social inclusion and exclusion.

According to Clark's framing, a role corresponds to a person's position in relation to others and is closely connected to their goals for a given interaction. People's roles are dynamic and not constrained to their identity within a family or workplace. Our primary participants took on various roles, including advocating, provoking, seeking clarity, expressing a desire for autonomy, and being frustrated or confused. We found that the roles of the dyads did not always serve complementary purposes—one person being confused did not mean the other person provided clarity. We found that many roles mirror family roles, with the young adult trying to gain more autonomy from the family or seeking advice from parents. We observed this dynamic role behavior within a single interaction. For example, there were occasions when participants shifted from defensiveness to taking responsibility for conflict or misunderstandings, or shifted from being open about a social interaction to feelings of uncertainty. The roles of the individuals became evident as they co-created the swimlane diagrams with each other and the researcher. This does not imply that during the interaction, they explicitly stated these roles or even their goals, but rather, by co-creating and reflecting on this activity, a layer of meaning emerged through this reflective process.

In describing their interactions, dyads tended to be most explicit about articulating their interaction roles and goals when there was strain between what they were each trying to accomplish. Many dyads expressed tensions regarding expectations for time spent together and what constitutes quality time. Families cited obligations such as jobs, health challenges, and childcare as sources of time constraints. Two romantic couples shared that a source of tension in their relationship was negotiating time together and time with a broader social group. As Alana shared, *"I'm very stubborn, and I don't think I need help with social interaction—but I do. I would like to be comfortable in social groups. It's not that I don't want to be social because I do. It's hard, so I just retreat from it."* However, another couple expressed that they bonded over preferring time together rather than being with an extended social group. Sarah and her boyfriend, quarantining together during the COVID-19 pandemic, sometimes playfully texted each other from different rooms. Although they missed going outside as much as usual, Sarah's boyfriend said, *"most of the stuff we like to do is already inside. We are both introverts."* To which Sarah responded, *"I'm kinda like, 'Welcome to my life.' Social isolation."* This sentiment that the COVID-19 pandemic has presented opportunities for non-disabled people to encounter circumstances of social isolation resonates with the autism and broader disability community, who call for more empathy for the experiences of disabled people [27]. Equally important is recognizing that many of the pandemic-era accommodations put in place for remote work and school have been advocated for by disability activists for decades.

Technology played a part in forming and maintaining dyad relationships, even before the COVID-19 pandemic. Dyads used cell phone texting, messenger apps, phone calls, and to a lesser extent, video calls (e.g., Google Duo, Facetime) to keep in touch on a daily basis. Sarah met her boyfriend through a Facebook dating app; Emily and her boyfriend use Facebook Messenger to communicate at night and have weekly phone calls. Participants described choosing a communication medium by factoring in their individual needs for self-soothing and control over performing normative social expectations. For example, Sarah shared that she prefers texting to a video call because she can *“do my own thing at the same time”* and does not have to do as much *“masking”*, referring to the practice of subduing autistic characteristics and intentionally performing neurotypical social norms, such as making eye contact [67]. In contrast, some dyads emphasized the importance of nightly family dinners (David) and more face-to-face time together (Emily).

Along with roles and goals, we also draw from Clark’s common ground theory to examine what conversational moves—coordinating—and acts—discrete verbal and non-verbal communication—were described by neurodiverse dyads. Autistic participants described planning, executing, and interpreting conversational moves and acts such as planning how to transition topics and needing to repeatedly ask for instructions. Sarah articulated this work and related stress about social interactions as needing to engage in *“social dancing”*. Through conversations between Sarah and her boyfriend, he gained an understanding that Sarah felt she is *“not good at social dancing... trying to go through several steps to get to the point you’re trying to make; trying to make sure people feel good; distraction outside of what you are actually saying.”* Next, we describe two swimlane episodes as exemplars of insights gained about social dancing and co-locating common ground.

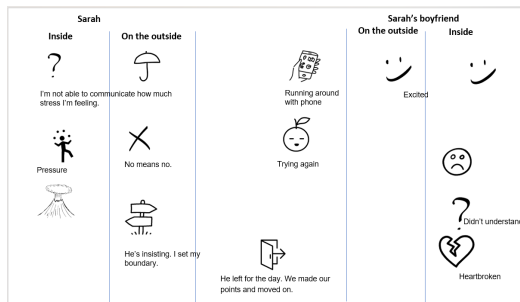


Fig. 4. Sarah and boyfriend diagrammed conversation

An episode described by Sarah and her boyfriend (Figure 4) illuminates the hidden work of questioning, juggling, setting boundaries, and managing emotions. The interaction was initiated by Sarah’s boyfriend announcing an unplanned phone call during which Sarah would be introduced to her boyfriend’s mother. He was very excited, as depicted by the smiley face for internal and external states. However, Sarah was caught by surprise by the call and was unprepared. She selected a question mark for the mix of thoughts and emotions she experienced internally. She selected an umbrella for her uncertain and guarded external state, saying *I am not able to communicate how much stress I am feeling...I was smiling, but my hands were like no and shaking.* This demonstrates a key insight: both autistic and non-autistic individuals experienced what may appear to be incongruent internal and external states. However, while an internal state of being confused and an external state of being reserved are distinct experiences, they not necessarily irreconcilable. It can be natural to want to approach a situation hesitantly if one feels confused. This complexity demonstrates that emotional experiences are nuanced and can involve a mix of emotions connected to social goals. People can feel a mix of emotions and this may come across externally as a different or only

one aspect of their emotional landscape. In other cases, people may want to put forward a certain persona due to the circumstances and hide their full range of emotions or intentions. Because of the strong ties between goals and roles in establishing and maintaining common ground, these socio-emotional experiences can greatly impact how conversation partners align with each other.

A key activity during Sarah and her boyfriend’s episode (represented by the hand holding a smartphone in the center lane) was Sarah’s boyfriend’s enthusiastically running around with his phone on speaker and encouraging Sarah to speak. However, Sarah’s pressure (represented with a juggling figure) built up until she recalls, *“I was a volcano mushroom cloud on the inside. On the outside, I said ‘That’s not cool.’ I was really mad.”* Sarah did not speak to her boyfriend’s mother. He felt heartbroken at the missed connection and Sarah’s anger. Sarah was upset that he was not understanding and not respecting her boundary. The interaction ended when he left the apartment to go to work (illustrated by a door).

Sarah and her boyfriend said they had moved on since this interaction; however, they have revisited this event to try to build more understanding between them. During the pair interview, Sarah shared that it is hard to express her thoughts and feelings to *“someone who doesn’t have that inner turmoil– this is how my brain works.”* Sarah expressed a perspective shared by other primary participants: that she has to *prepare, do a lot of mental work to communicate.* In similar unresolved episodes retold by other dyads, a variety of images were used to represent escalating, cyclical shared states, including the hook, gears, and spiral.

Importantly, the swimlane visual activity revealed conversational moves that are often opaque or misinterpreted during neurodiverse interactions yet are crucial components of locating common ground. The choice of imagery helps us see the moves in physical form, such as a person balancing on one foot while keeping moving balls in the air. An image of two signs going in different directions was an adequate—but not perfect, according to Sarah—representation of her attempts to have her boundaries respected. Through verbal and non-verbal communication acts, Sarah repeatedly tried to convey her boundaries and frustrations. This example episode is representative of patterns we observed in the swimlane diagrams, namely, nuanced differences between internal and external states, the escalating nature of emotions that mix with intense internal dialog, difficulty expressing intense emotions, and unsatisfactory endpoints to conflicts.

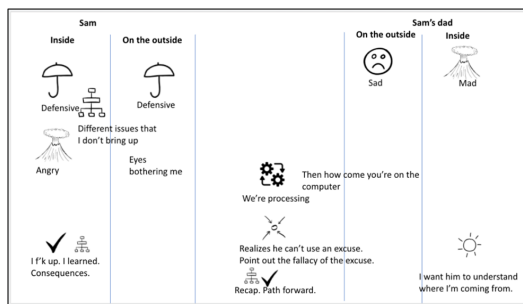


Fig. 5. Sam and his father’s diagrammed conversation

The second example swimlane episode (Figure 5), as reconstructed by Sam and his father, provides more details about hidden work and turmoil, yet also provides an example of a more mutually-satisfying closing to an interaction. Sam and his father recalled an interaction sparked when Sam’s father was informed that Sam had been skipping school for much of the past month. Sam’s father initially expressed sadness to Sam (frowning face) but was also privately extremely upset (volcano). Sam recalled that he took a defensive stance, both internally and externally (umbrella). In his mind,

Sam was listing off various reasons he had missed school (hierarchical boxes), only some of which he voiced. Anger arose in Sam, along with a sensation of irritation coming from his eyes, which was not an uncommon sensation for him due to complications with his corneas in both eyes. Sam's father characterized this point of their interaction as processing (gears in the center lane). Their conversation went back-and-forth, with Sam applying logical rationale and his dad "*pointing out fallacies of his excuses*." Sam's father chose a sun image to correspond to his internal sentiment that "*I want him to understand where I'm coming from*." The pair used a series of images (check mark, hierarchical boxes) to represent multiple internal and shared states as the interaction came to a close. Sam acknowledged that "*I fucked up. I learned from it. I know there are consequences*," and then they were able to proceed.

This episode illustrates conversational moves related to being defensive, moving from excuses to accountability, and seeking a path forward through mutual understanding. The images, while static themselves, imply actions, such as using an umbrella to defend oneself and a volcano (rather than an angry emoji face) to convey a sense of rising anger. The images help portray the mental model of identifying and organizing issues (hierarchical boxes), both as an internal process and a joint verbal recap of the conversation. The checkmark indicated, at one point, acknowledgment of a mistake and, at another point, mutually sensing a path forward. The nuanced interpretation of images in this example is similar to Sarah's swimlane diagram; for example, her comment that the bi-directional sign image was adequate but not perfect. The visual icon catalog expanded as we conducted the interviews. Figure ?? shows the images that participants chose to add when they sought representations that more closely illustrated their intended internal or external state. All the images in the original set were used at least once during the paired interviews. Therefore, the complete visual icon catalog used in our paired interviews is a combination of icons in 3.

## 5.2 Desired Ways of Interacting and Establishing Common Ground, as Designed by Autistic Adults

The goal of the design activities was to generate game design ideas on one level, and on another, to use game paradigms to probe the participants' underlying conceptions of what constitutes a conversation and what desirable interaction patterns might look like. Participants created games that, in general, involved navigating a physical game board using gameplayer pieces. The gameplayer pieces emphasized individual traits, such as personality, hobbies, and items of interest. In all of the games, players took turns using game mechanics like dice or spinners. The most common rules encouraged players to "*stay on topic*" and actively listen, stated as *listen patiently* (Daniel), "*do not interrupt when others are talking*" (Rahul), and "*try to express that I've understood the person before saying my next piece of information*" (Charlie). The participants had rules about politeness, such as "*keep voices at a normal level*" (Rahul) and "*avoid sensitive words and subjects* (Daniel).

Eight of the designs were highly *structured*, moving in a logical way through conversation topics and providing equitable time for each "player" to speak (Figure 6). However, five game designs were more *fluid* and allowed for the gameplayers to co-construct a game experience in real time (Figure 7). In the fluid game category, player pieces moved in unpredictable ways, and the players explored topics connections. In these dynamic game designs, many interactions between player pieces involved some form of kinesthetic action, such as rolling a tube on the floor or moving pieces around a Styrofoam ball. Next, we describe two game designs as exemplars of the *structured* and *fluid* game types.

As an exemplar of a *structured* game design (Figure 6a), Emily designed a "*cooperative*" game for spending time with her boyfriend. Her rectangular game board had 12 squares, each labeled with a conversation topic or activity. The cells were color-coded to indicate (1) general topics they are both comfortable talking about, (2) topics one player may not feel comfortable about sometimes,

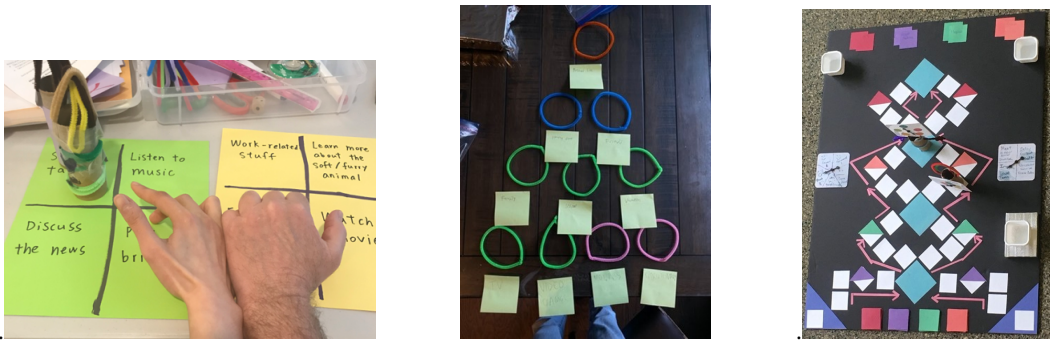


Fig. 6. Left to right: (a) Emily’s structured game design with topics laid out in a grid (b) Rahul’s hierarchical game board with topics on post-it notes (c) Alec’s game design of multiple structured paths.

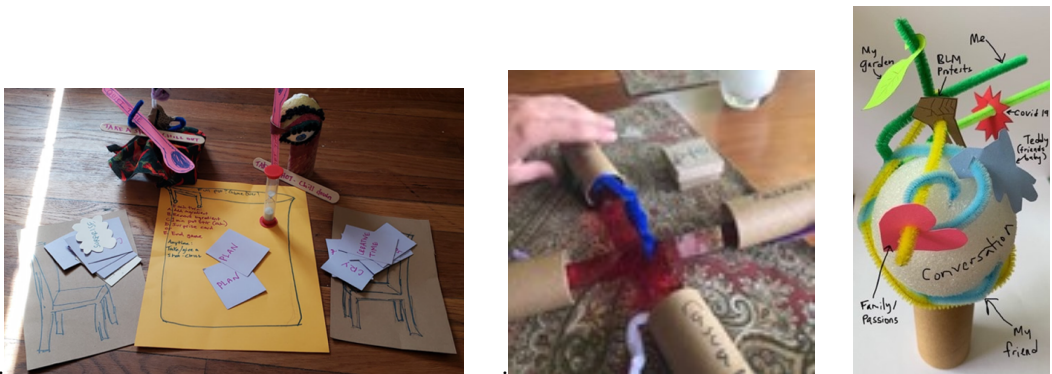


Fig. 7. Left to right: (a) Charlie’s game to co-create a metaphorical soup. (b) Steve’s game design balanced tubes on crossing rulers. Players spin tubes to select topic attributes. (c) Sarah’s conversation is represented by a Styrofoam ball, around which are entwined the player pieces (pipe cleaner) and topics (paper cut-outs labelled by the participant as My Garden, BLM Protests, COVID19, Teddy (friend’s baby), Family/Passions).

and (3) intimate topics. Her game pieces were representations of her and her boyfriend in physical form. She used cylinders for their bodies, pipe cleaners for hair and "body fur", and post-it notes for clothing. Her game pieces interacted with each other when they were in the same cell, at which point players also talked about the topic of the cell or did the assigned activity.

Her rules included the right to refuse a conversation topic or to quit the game at any time and for any reason. Her game design revealed a combination of everyday conversations (e.g., small talk, discuss work), plus ongoing plans and topics of interest (e.g., travel plans, human biology). Activities included listening to music, playing bridge, and watching a movie. She included topics and activities related to the couple’s romantic and physical relationship, which they referred to as "furry time". In her design journal, Emily emphasized that the most important choice players have during this conversation game was to quit, refuse to follow, and/or negotiate. Her rules note that "negotiation is encouraged, but bribing is forbidden." Her game design mechanisms included ways to negotiate topics and activities (find a cell that both players are willing to stay in or mark an off-limits topic with a red "x" drawn on a post-it note and placed over the square.) The game ends when one or more player decides to end the game and, in keeping with the cooperative nature of her game, "if both players are happy, they both win. If at least one player is not happy, they both lose."

In summary, Emily’s game emphasized key actions that were important to her gameplay, and by extension, conversational moves. These key actions included choosing and changing topics of discussion, having clear rules for how the pair should interact, and having the right to refuse a topic or quit the game. Participants who designed structured games prioritized predictability over spontaneity. Game designs included rules for how long to engage in a topic, ranging from, for example, “*you have to say three different things about a topic*” to “*converse about the topic for 15 minutes or more.*” Several participants shared that they can find conversational dynamics difficult, such as pauses in conversation, uncertainty about what to bring up next, and how to politely end the interaction. These concerns tended to arise during one-on-one interactions and even more frequently in group interactions for some participants. Participants had design ideas for using visual objects as conversation cues. For example, Laurel suggested that people could pick from a stack of index cards with topic ideas. They could use timers to indicate to each other how much longer they wanted to remain on the topic or in the conversation. Michelle proposed that people in a group could take a physical cube or stick when they want to talk or hand it over to the person they want to hear from next.

One unique aspect of Emily’s game from other structured game designs was that it accounted for intimate topics with a romantic partner. The physical closeness between romantic partners involves navigating sensory experiences and boundaries. Emily and her boyfriend discussed her fear of being close to particular parts of the body, such as mouths, and depictions of human bodies, such as skeletons at Halloween. She expressed that she “*sometimes feel[s] bad that he has to be careful because I get triggered for a lot of different things, sometimes I didn’t even know about.*” Her boyfriend, in turn, expressed his concerns about her being triggered and that he, too, was emotionally impacted by these situations. These examples highlight the interdependency between the couple’s social, emotional, and sensory experiences.

In contrast to structured game designs, fluid game designs focused on the interactions of the player pieces and the joint formation of a conversation that “*creates itself as we play*” (Charlie). As an exemplar of *fluid* game designs, Charlie based their game design on the metaphor of creating soup, suggesting, “*the point of the conversation is to remain connected so keep making ‘soup’.*” Charlie’s game board comprised sketches of chairs on either side of a big pot for cooking soup (Figure 7a). Players take turns adding ingredients (a.k.a., topics) to this “soup” conversation, or alternatively, choosing a soup spoon to allocate quiet time for themselves. Being fully seen by their conversation partner, in her unmasked, playful self, is important to Charlie as evident by their player pieces and game design. Charlie designed some of the most elaborate player pieces of all the research participant’s pieces (Figure 8).



Fig. 8. Charlie’s gameplayer pieces

Charlie described their player piece as *“me as a drag queen because it shows my loud creative side and shows me as human...I’m performing as a drag queen, but I don’t have to perform (or mask) around him. So the drag is actually me having permission to play and be myself.”* Charlie’s conversation partner is depicted as a *“big eyeball with eye makeup because he sees me loud and clear.”* Charlie valued building up a conversation with their conversation partner. The exact topics and sequence of topics are dependent on what they want to catch up on, what matters most is to have *“open space for thoughts (game pieces) to move around”*, and for the *“game to take its own sort of path, rather than a clear beginning and end with a winner and loser.”* These values are evident in their game mechanics that gave each player *control of putting in or taking out ingredients and that means we each can be casual about the game*. Charlie, and other designers of fluid game designs, described how their trusted relationship with their conversation partner and choice of topics were interrelated. As Charlie described:

*“It helps me to have a topic to start with, but often we are catching up in our lives and that interests me, so it’s easy to fall into a rhythm where I feel in sync. My favorite is to remember things we have done or learned and feel connected well when we are both excited about planning something together or figuring out something.”*

Charlie’s description of their gameplayer pieces and gameplay dynamics were similar to other kinesthetic-focused game types. However, note that although these two categories of games provided a way to compare and contrast the game designs, these categories are not concrete and a few of the games straddled both categories. Across both structured and fluid game designs, a crucial, pervasive theme was for the conversation pair to establish and follow rules of consent regarding verbal conversation and physical interactions. In our exemplar game designs, Emily’s game was explicit about negotiating topics, consent about comfort, especially when the topic of conversation could lead to physical closeness between the two of them. Charlie articulated the necessity of mutual agreement about conversation topics, saying, *“Since each ingredient comes one at a time they have time to talk about each ingredient before the next turn. It’s a soup they end up making together, but each person has a say in how they want it to be.”* These perspectives aligned with other participants. At a fundamental level, Daniel articulated his right not to engage in the conversation at all, saying that for him, there *“are three basic choices per conversation: speak; don’t speak; and ignore.”* Tanish expressed that *“you can always hide or withhold certain details. You can choose to focus on your points or the other points or find a nice balance. Alternatively, you can find common ground or choose to deflect from sensitive topics, or meet it head on.”*

Overall, in areas of verbal and non-verbal closeness, trust and explicit agreement to share were paramount. Another crucial component of establishing trusted common ground was the ability to choose how and when to share emotions. Sources of changes in their emotions during interactions were wide-ranging, as articulated by Daniel, *“Lack of communication and misunderstanding can cause frustrations and tempers to rise, as one example. Topic, words said, and personal experience can cause all sorts of emotions as well.”* In Alec’s game (Figure 6c), players could express their own emotions by *“adjusting the face on your piece if you are happy or sad.”* Also, players could respond to the other’s feelings, by, for example, *“giving the other player a goodwill gem if he helps you feel better, notices your emotion.”* Sarah imagined the use of dice with a facial expression on each side to explicitly express emotions, especially as an alternative to masking—a term in the autism community for hiding their autistic characteristics—by performing the body language and facial expressions expected by neurotypical social norms.

## 6 DISCUSSION

Through this work, we increased our understanding of how neurodiverse dyads conceptualize and experience common ground, identified crucial elements of face-to-face conversations that contribute to common ground, and showed ways that coordination scaffolds can become more visible within these exchanges. The importance of rich models of conversation dynamics has been well-established through technology explorations into a myriad of ICT, such as conversation agent interactions (e.g., [22]). The influence of autism on communication practices has been examined for over 80 years, originating as a medical model of autism defined by categories of observable deficits [32, 58]. Autism self-advocates, disability scholars, and accessibility HCI researchers have called for reframing autism as neurodiversity oriented towards strengths [9, 20, 31, 60]. Aligned with the paradigm of neurodiversity and by using the lens of Clark's common ground theory, our study showed that neurodiverse dyads engage in conversational interactions as mutual, give-and-take maneuvers, with each person having both shared and individual goals, expectations, and sense-making practices. We argue that through co-design with autistic individuals, rich design directions for ICT can be discovered that support more equitable efforts between neurodiverse conversation partners. The concepts developed by participants envisioned ways that technology-mediated communication can better support their unmet needs, not by increasing the burden on themselves to adapt or translate, but by introducing interventions that more evenly distribute the burden of communication between conversation partners.

### 6.1 Reframing of Autism Communication Deficits to Co-locating Common Ground

Neurodiverse dyads demonstrated locating common ground, aligning with Clark's theoretical description of dyads acting upon both public and private goals. Each neurodiverse dyad reflected upon their particular way of entering into an interaction, broaching topics, coordinating their interaction, encountering friction in the interaction, addressing friction, and finally, closing the interaction. Although the interactional sociolinguistic theory on which we built our analytic framing for this study, by definition, focuses on interactions *between* conversation partners (i.e., turn-taking, positioning through stance, alignments) [35], we centered the experiences of neurodiverse conversants to understand better the burdens and opportunities for this under-served stakeholder group. We solicited insights from autistic participants within the context of interacting with their trusted, neurotypical conversation partner. We did this intentionally in order to (1) counter a tendency in HCI research to view the habits and preferences of neurodiverse conversants as limiting, less than, or obstructing "normal" conversation (i.e., neurotypical) and (2) position their needs and preferences as *requirements* to be supported rather than *deficits* to be fixed.

One characteristic commonly attributed to autism is the desire for predictability. Aligned with this, we found that participants desired a balance of structure and flexibility in the interaction. Prior work, e.g., [67], has identified that autistic individuals desire predictable turn-taking and the ability to track conversation topics during remote communication. Our work highlights that this is desired in co-located communication as well, and specifies that autistic individuals want agency in selecting conversation topics along with consistent and fair rules of interaction. Social comfort was established by having clear expectations of the purpose and details of the interaction—including timing, length, and tone of the conversation. However, it was unclear what that would ideally look like in practice, especially in terms of supporting repair work to correct errors and confusion resulting from ambiguous signals from a conversation partner [21] The game design activity enabled us to see and better understand the ways that neurodiverse partners attempted to reestablish common ground during these more unstructured or unpredictable parts of a conversation. So while prior work has emphasized the value of structure and predictability in interactions for autistic



people, we found that some of our participants placed a higher value on flexibility, as evidenced by their use of kinesthetic game elements that could change within the context of the conversation in order to capture these moments of disconnect or ambiguity.

Another type of conversational skill often debated in the autism field is the ability to develop a theory of mind—the ability to take another person’s perspective [13]. We found that as autistic participants engaged in the swimlane diagram activity, they were able to see and clarify their own position in a conversation and gain new insight into their partner’s perspective. It is interesting to note that this process was not in-the-moment of the original interaction, but rather, a recounting and visual documentation of the interaction. We posit that the swimlane diagramming activity allowed for a somewhat neutral space in which to revisit the interaction, to map turns taken, and to reflect on how and why choices were made, responses were crafted, and sense-making unfolded. The structured visual system of the diagram provided a scaffold for conversation partners to examine a range of both normative and idiosyncratic aspects of their exchanges.

We know that as a result of different communication and cognitive styles, autistic people can often experience social unease when trying to adapt to neurotypical patterns of communication and language [26]. Our study provided insights into what this looked and felt like to each partner. We found that (1) both autistic and non-autistic individuals experienced what may appear to be incongruent internal and external states, (2) autistic individuals facing intense emotions often had difficulty expressing their internal turmoil and tended to focus on trying to understand the logic of emotions. For some dyads in our study, voicing differences of opinion resulted in heated arguments and long-standing misunderstandings. In other dyads, a reactionary pattern emerged in which one individual typically shut down or deflected the conversation. In cases in which the non-autistic partner had a strong emotional stance, the autistic individual tended to be focused on trying to understand the logic of (or, in some cases, keep distant from) affective responses. When conflict arose, some pairs tended to get “hooked” on the conflict, cycling through behaviors and statements and then, often, ending the exchange without a mutually-agreeable resolution. These insights serve as counter-evidence for artificial intelligence systems, such as emotion AI, that tend to position external behaviors as the ground truth for internal states.

The neurodiverse dyads experienced these interactions as complex and ambiguous, often without clear outcomes. Interactional sociolinguistic theory, including Clark’s common ground, is often focused on identifying the mechanisms that enable people to communicate despite the imperfect, real-world execution of communication acts [35, 65]. In this project, we sought to better understand complexities and ambiguities rather than to smooth them over, differentiating our work from some prior research on common ground in domains that require clarity and action (e.g., [23] or where the communication burden on a group was low due to the nature of the exchanges being information-driven and unambiguous (e.g., [11]). Although a text chat was found adequate for grounding groups in [11], our work surfaces the need for more nuanced and higher resolution means for representing conversation that would benefit from considering the holistic and mutually affecting emotional tenor of an exchange.

## 6.2 Towards Technology-Mediated "Shared Space" that Empowers Self-Expression, Trust, and Choice

Our participatory research generated insights based on: (1) the ability of common ground visual elicitation activities to provide value to autistic individuals to describe current communication patterns and imagine more desirable alternatives and (2) the importance of recognizing and supporting multi-dimensional aspects of communication practices (i.e., social, emotional, sensory) in establishing and maintaining shared points of reference for neurodiverse conversation dyads.

We propose these strategies to be valuable not only for conducting research on the communication of neurodiverse dyads but also for the capabilities of communication technology to support neurodiverse dyads.

A key component of the common ground model of communication is the creation of a metaphorical "shared space" within which conversation partners socially construct meaning. Co-design activities offered participants visual, physical, and material methods for examining and iterating on their current and ideal communication spaces. Through these acts of externalizing mental and social processes, participants engaged in collaborative design as described by [5]. The co-design activities required the participants, especially the primary participants, to demonstrate perseverance and problem-solving—two attributes also noted by Bossavit and Parsons in their study involving teenagers designing video games [12]. In building our study on this interactional, externalized model of communication, we sought to inspire new approaches for designing assistive information and communication technology (ICT) to support and scaffold communication for neurodiverse users. Specifically, the common ground model assumes a mutual and shared responsibility for establishing, maintaining, and repairing shared frames of reference. This stands in contrast to other approaches to the design of assistive ICT where a mediating or interpretive intervention is placed in closer proximity to the neurodiverse individual compared to a neurotypical conversation partner, implying that the onus of adaptation or translation to fit a norm is on the neurodiverse person. For example, research focused on designing games [64] for neurodivergent individuals tend to position technology as compensating for perceived deficits.

Our findings forefront the need for autistic adults to feel comfortable during interpersonal interactions. By comfort, we refer to the social, emotional, and sensory factors that can contribute to or detract from the well-being of a person during a technology-mediated interaction. While using communication tools, comfort involves being free from sensory overload and having structure and predictability in conversations. However, it also means having opportunities to introduce or remove sensory inputs in real-time, based on needs at the moment. Tensions between external and internal ways of establishing common ground are important to understand and respect in the design of assistive ICT for neurodivergent individuals so that boundaries are respected, and personal goals, emotions, and thought processes can be kept personal as desired. When asked to model ideal conversation patterns through game designs, the autistic participants described emotional comfort as composed of validating emotions, respecting when someone wanted to withhold emotions, and forgiving social blunders. Trust has been established as a crucial component of human-human and human-agent interactions [22]. Our work builds on the need for trust and adds the need for consent. Threats to common ground can stem from, or at least be exacerbated by, lack of consent, distrust, unpredictability, and not being empowered. To counter and mitigate these factors, participants sought physical comfort, which enabled them to cultivate emotional comfort. Examples of physical comfort included the freedom to seek or avoid sensory inputs, respect sensory boundaries, and establish rules of consent for physical contact.

### 6.3 Boundaries and Opportunities for Socio-Technical Neurodiverse Communication

The gaps participants identified between the lived and ideal experiences of autistic individuals highlight potential points of intervention for assistive ICT. Specifically, we draw attention to the importance of integrating social, emotional, and sensory supports, as these clearly function together when conversations are most fulfilling for both conversation partners. This work shows the importance of designing supports *across* these functional areas, rather than treating them as independent requirements. Further, providing opportunities for users to represent, reflect on, and encode their social, emotional, and sensory experiences during face-to-face conversations played a role in providing this support. In other words, the goal of assistive ICT for neurodiverse

communication groups should not just be to show emotion labels, but to provide a framework or scaffold for externalizing and sharing the current state of a conversation—this type of representation can then be used as a tool for establishing, maintaining, and repairing common ground. Tools with intuitive user experiences (UX), with access to preferred communication modalities, will enhance users' comfort and sense of empowerment. Our work highlights four important aspects of communication technology UX: (1) scaffold the conversation as a whole, (2) support multi-modality with sensitivity to sensory needs, (3) support the users pre-, during, and post-conversations, and, (4) make the state of the conversation visible.

First, we argue that technology should scaffold the conversation as a whole, not just the conversational moves of the autistic individual. Too often, assistive technology interventions target an individual already overly burdened by normative communication practices. Our approach supports interdependence [8]—the concept that people's lives are entangled with each other and with technology infrastructures. By understanding these mutual dependencies, we can achieve new socio-technical ways to meet both individual and group goals. Establishing group norms, such as explicitly managing conversation flow, confirming interpretations of emotions, freely stemming, and exhibiting (and embracing) non-normative behaviors, can be a way to create needed autonomy from the pressures of broader social norms. Technology could support mutual understanding of each other's emotions as each individual intuitively expresses needs and attempts to respond to requests from a conversation partner. Considering the group as a whole, technology could support the dyad in making space and asserting autonomy to establish particular social norms that work for the group.

Second, multi-modality is a fundamental principle of accessible technology [51] across disability types, such as alternative text for images and captions for videos. Our work, like prior work (e.g., [19]), demonstrates the value of visual imagery to supplement verbal conversations, which is an accessibility requirement less studied. Likewise, conversational technology can more directly support multi-modal ways to access communication exchanges, such as providing visual representations of conversations along with written transcripts. Further research can explore design concepts, such as allowing individuals to annotate points of confusion followed by requests for clarification from their partner. The technology could help develop skills for the dyad to navigate through difficult points in the conversation, perhaps by practicing recommended verbal scripts. By diagramming conversations with visual imagery evocative of a variety of psychological and cognitive aspects—particularly emotions, senses, and interactional moves—dyads processed accessed their personal multi-modal ways of knowing.

Third, our insights about embodiment during conversations align with and build upon Alper's notion of inclusive sensory ethnography—built upon empirical evidence of autistic children—which “account(s) for how the internal senses shape participation in and exclusion from daily uses of media and technology, as well as for natural variations in the human ability to organize sensations coming from the body and the mediated environment” [4]. However, by focusing on emotional experiences, this work provides empirical evidence illuminating connections between negotiating social practices of conversations and managing sensorial experiences.

Fourth, our methodology demonstrates how timing can also be an important focus for designers of assistive ICT, by considering when an intervention is presented to users: prior to, during, or after a conversation. Thus, we argue that computing technologies should also provide flexible opportunities for configuring, using, and reflecting upon interactions. This was also noted in the work of social media support for autistic individuals by [19]). Also, revisiting an interpersonal interaction and iterative collaboration has been found to build common ground among collaborators [24]. The technology can present a balanced view of the interaction dynamics while allowing for the dyad to re-construct and re-evaluate their interaction. Our work demonstrates that joint reflection

on difficult conversations is an important way that assistive ICT can create more equitable spaces for neurodiverse communication practices.

Despite our design directions and UX guidance, we believe that it is a mistake to expect communication technologies to resolve *all* the social barriers experienced by autistic individuals, but rather advocate for designers of assistive technologies to focus on ways to support neurodiverse users in managing and negotiating interpersonal interactions (such as those involved in creating common ground) and re-balancing leverage points to support more equitable distribution of communication labor. As highlighted by participants, interpersonal social issues related to neurodiverse communication practices will undoubtedly persist regardless of the potential benefits of technology. As described by our participants, it can seem like neurotypical people play a “social game” which can be both frustrating and intriguing at times. This social game can be difficult for neurodivergent individuals to decipher when, for instance, there are discrepancies in what someone says and the person’s underlying emotions (e.g., using sarcasm when the literal words usually do not match the emotion or intention behind the statement). Our goal as designers should not be to erase these points of discrepancies, but to find ways to cultivate trust and mutual points of reference so that both intentional (i.e., sarcasm) and unintentional (i.e., misunderstandings) inconsistencies can be integrated into the process of establishing common ground and other mechanisms of coordination. We argue that based on our findings, designers should (1) provide means for neurodiverse conversation partners to observe and reflect on the flow of interactions rather than simply “fixing” it, (2) enable conversation partners not just to share emotional states but also seek out physio-emotional comfort during social interaction, and (3) support agency and choice over deficit models of normative conversation dynamics.

#### 6.4 Limitations

Our research focused on conversations from the perspective of autistic individuals with a conversation partner they had an established relationship with and viewed as trustworthy. Aligned with ethical research guidelines, these criteria minimized risk to our participants, especially since we asked pairs to reflect on emotionally-laden interactions. Our work does not examine how relationships are established but rather how they are maintained and repaired. Thus, our research does not claim ecological validity for everyday encounters with a range of people, which would include untrusted conversation partners. Also, note that our analysis is based on the conversation pairs’ account of their interactions—not direct observation—and game design activities—based on a metaphor prompt of conversations being somewhat like gameplay. Therefore, our insights related to how the participants remembered, described, and envisioned their interactions as conveyed through interview and design activities. Future research could directly observe participants’ conversations, extend to other types of conversation partners, and reframe design prompts.

Our research sample does not represent the full diversity of the community of autistic young adults. We recruited from autism self-advocacy organizations and a community-college-based program. Thus, our participants were those who participate in such programs and also have resources and motivation to participate in research during the COVID-19 participants. Due to our study’s emphasis on verbal communication, all participants communicated verbally and were comfortable conversing about their life experiences. However, the autism population encompasses a wide range of traits and includes people who are non-verbal and may use an augmentative and alternative communication (AAC) device. Research on users of AAC devices has highlighted unique communication styles and conversational dynamics, including significant challenges in using AAC devices [10]. Further research that examines neurodiverse dyads with autistic individuals who are non-verbal would broaden our understanding of neurodiverse communication dynamics and strategies, adding an important perspective to our understanding of neurodiversity [37].

## 7 CONCLUSION

Technology-mediated education, employment, and social media can establish more inclusive spaces for autistic adults to counter social stigma and reduce access to resources. This work examined interpersonal interactions of neurodiverse days, which were highly motivated by a mutual desire to maintain relationships and support others as they navigate communication landscapes, both personal and professional. Through the lens of common ground and using visualization co-design activities, we identified several emergent requirements for responsive assistive ICT to support neurodiverse conversation dynamics. We found that external representations of emotions and other communication cues need to be dynamic and interactive—acting less like a mirror and more like a multi-dimensional game board. We explored the ways that affective visual encoding systems could be systematic but not standardized. In collaboration with participants, we explored design concepts that recognized translations, correspondences, and comparisons as ongoing processes experienced regardless of neurological profile. We identified a need for assistive technology to be located in the center of “gameplay” in order to preserve and support equitable social interactions. This work offers examples of ways that assistive ICT can support embodied, participatory sense-making across a conversation group—not just focused on autistic individuals in isolation—resulting in more robust and resilient shared spaces for ongoing interactions.

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## 8 APPENDIX A: INSTRUCTIONS FOR REMOTE GAME DESIGN ACTIVITY

Table 8 summarizes the instructions given to participants for the remote game design activity.

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Table 8. Instructions for Remote Game Design Activity

Activity	Design Prompt	Materials and Criteria	Examples Provided
Game Pieces	Create 2 game player pieces to represent yourself and a person that you have a meaningful conversation with	Use materials, shapes and colors to show the person's personality and how they act during conversations. Game pieces need to be a 3D object at least 2" tall.	Images of feather spinner; origami dinosaur
Game Board	Create a physical game board for your game player pieces to move around on during a conversation	Your game board must be a flat surface where your pieces can move around. Use materials, shapes and colors to represent the spaces for your conversation. Your board may have areas for different types of activities.	Image of triangle segmented into different colors labeled: Memes/GIFs; Casual conversation; Jokes/laughing; Deep talks; Intellectual; Love
Conversation Choices and Rules	Create different ways to keep track of the state of the conversation (your game). Create new game elements (like tokens) or use objects from your design kit (like dice or cards).	Show how your game begins. Have at least 4 choices or rules. Show how game players mark process. Show taking turns, making choices, following rules; Show game ending.	Only 1 person talks at a time. They hold a ball while they are talking.; If someone interrupts someone talking, they move their player piece back 1 space.
Emotions and Sensations	Create ways in your game to show emotions	Each game player piece needs to show emotions and respond to emotions of game players. Have a way to indicate when someone is having an intense response to a sensation or a strong need for more sensations. What happens when there is a change of emotions and sensations?	If someone shares how they feel about something, they get an extra bonus card. If someone wants to pause the conversation because they feel upset, all players take 1 minute in the relaxation area of the board.
Game Experimentation	Share your game design with a conversation partner	Explain game pieces and board. Show your list of game choices and rules. Ask for their ideas of how conversations can be like playing a game. Try using the game players, rules, and tracking a conversation together. Write down ideas for changes or make changes as you go along.	Play with the game elements while you talk about something you want to decide together (like what to have for dinner) or something that you want to share (like how you are doing during quarantine).