An Emotion Translator: Speculative Design By Neurodiverse Dyads

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ABSTRACT

For autistic individuals, navigating social and emotional interactions can be complex, often involving disproportionately high cognitive labor in contrast to neurotypical conversation partners. Through a novel approach to speculative co-design, autistic adults explored affective imaginaries — imagined futuristic technology interventions — to probe a provocative question: What if technology could translate emotions like it can translate spoken language? The resulting speculative prototype for an image-enabled emotion translator chat application included: (1) a visual system for representing personalized emotion taxonomies, and (2) a Wizard of Oz implementation of these taxonomies in a low-fidelity chat application. Although wary of technology that purports to understand emotions, autistic participants saw value in being able to deploy visual emotion taxonomies during chats with neurotypical conversation partners. This work shows that affective technology should enable users to: (1) curate encodings of emotions used in system artifacts, (2) enhance interactive emotional understanding, and (3) have agency over how and when to use emotion features.

CCS CONCEPTS

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

KEYWORDS

speculative design, affective computing, autism, accessibility

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1 INTRODUCTION

We invited autistic young adults to envision *affective computing imaginaries*—imagined futures that include new ways for technology to play a role in deepening mutual understanding of emotional experiences between neurodiverse conversation partners. *Affective computing*, refers to responsive technology that supports emotional awareness. Systems can model emotional awareness in many ways, from automated detection and labeling of emotions to interactive conversation agents that use machine learning to generate emotionally aware responses to human language queries. *Socio-technical imaginaries* are products of imagination about what technology *is, could be,* and *could provide.*[61].

In her book about the role of disability in imagined futures, feminist, queer, and disability theorist Alison Kafer explores the uses and representations of disability and able-bodiedness/able-mindedness [38]. In discussing the ways that designing for an inclusive future can involve engaging with different aspects of material experiences, Kafer describes how "spaces get imagined differently in different futures; creating accessible futures requires attention to space, both metaphorical and material" [38, p. 20]. We engaged in speculative co-design with autistic young adults to explore ways that a shared conversation space could provide a setting for exploring affective computing imaginaries.

Autistic people describe experiencing emotional disconnects (especially with neurotypical conversants) due in part to interpreting and expressing emotions in non-normative ways [90]. Autistic children and youth tend to experience social exclusion, bullying, and stigma [18], contributing to lower educational opportunities and higher rates of underemployment and unemployment compared to non-disabled populations and some cognitive disability populations [58, 67, 83]. Autistic people have expressed wanting more insight into the emotional experiences of both themselves and others to help them better navigate interpersonal relationships. Examples include superpower-like tools that could allow them to swap emotions with their conversation partner, read the minds of others to know their emotions and control—even block—certain of their own emotions. They have also collectively articulated hopes for affective imaginaries [52] that would enable neurodiverse dyads to feel equally safe and understood [90].

For this study, we asked autistic adults to "speculate-through-design" [28] about emotionally aware technology within the context of interpersonal conversations. According to Dunne and Raby, the speculative design approach explores potential design interventions by conjuring "possibilities that can be discussed, debated, and used collectively to define a preferable future for a given group of people" [28, p. 6]. This approach led to a provocative question, *What if, during interpersonal interactions, technology could translate emotions between people as it can translate between languages?* The concept of an "emotion translator" evolved as a means of initially expressing one's emotions in ways that feel most natural to both neurodivergent and neurotypical conversants. Technology, then, was proposed to translate those personalized expressions of emotions in a way that was accessible and understandable to each

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conversation partner. Participants engaged directly with a speculative design prototype composing (1) a customizable matrix of emotion pictograms and (2) an emotion translator chat interface. Our study explored two guiding research questions: RQ1: What do neurodiverse dyads choose to preserve, change, repurpose, and convert in a speculative emotion translator application? RQ2: What do neurodiverse dyads perceive as potential impacts of the emotion translator design concept?

In addition to contributing to the growing use of design fictions in HCI [13], our work demonstrates that engaging autistic adults in speculative [28] and adaptive design [50] is a viable and generative method for creating more inclusive and accessible technology. This approach engages imagination, creativity, and open dialog—characteristics of autistic adults that are not commonly drawn upon for research and that counter limiting stereotypes of autism as characterized by deficits in areas of emotions, communication, social skills, and imaginative skills [4, 23]. Speculative design activities were crafted to allow participants to freely express ideas and engage in sensemaking on their own terms. This approach aligns with recent work in the design justice space [21], which calls for participatory, critical, and intersectional research methods. In addition to this work, we also draw from empowered, emancipatory disability studies research applied in HCI, which we discuss in more depth in the next section [12, 44, 56].

2 BACKGROUND

We situate our work in scholarship focused on neurodiverse interpersonal communication and HCI design approaches.

2.1 Computer-mediated Communication and Neurodiverse Social Interactions

Many in the autism community view the internet as a valuable meeting space, and it is even touted by some as the "ideal country for autistics" where they "can interact without getting on each other's nerves—gently, carefully" [23, p. 798]. In essence, "the Internet has begun to challenge stereotypes surrounding the competence of people with autism to communicate effectively" [23, p. 797]. As with in-person conversations, when using computer-mediated communication (CMC), autistic individuals describe using coping strategies for masking or camouflaging certain autistic traits in an effort to adhere to social norms and reduce stigma [88]. However, researchers have found that, in general, using CMC for daily communication can often be more comfortable for autistic people than face-to-face interactions [17, 25, 88, 89]. Common perceived benefits of CMC include reduced sensory processing, more control over the pacing of communication, and increased comprehension of communication. Autistic people may prefer using text-based communication (e.g., texting, writing letters) to clarify their thoughts, diffuse conflicts, and playfully tease each other, even when having the option to speak face-to-face with their conversation partner [90].

That said, autistic adults tend to have difficulty translating social rules they have learned in one context to another [17]; autistic adults report having difficulty discerning social rules across a wide range of CMC sites and platforms, including Facebook, Twitter, and World of Warcraft. Autistic adults use online chat apps on various platforms such as internet forums, social media messaging (e.g., Facebook Messages), and mobile text messaging [17, 88]. Therefore, our emotion translator chat app was designed to leverage familiar chat applications while introducing novel visual emotion cues to extend the perceiv4d benefits of CMC for neurodiverse users.

Chat has evolved to include a set of standard non-verbal visual cues and practices. Emoticons and emojis originated as representations of emotions as expressed through facial expressions [5] and as of 2017, 92% of the online population [40] uses them. The Unicode standard defines emojis and has expanded beyond facial expressions to include bodies, nature, travel, food, activities, etc. Users have a wide range of emojis to choose from and interpret; in the latest Unicode 14.0, there are 3,633 emoji [78]. Emojis can add valuable non-verbal cues to CMC; however, they are also open to interpretation and can result in misconstrual—a difference between what the speaker intended and the addressee's interpretation [20, 49, 75] due to factors such as cultural differences [39], personality [49], and communication platform [31].

This is particularly relevant for neurodivergent users who might already be expressing and interpreting emotions in non-normative ways. Specifically, alexithymia is a personality trait common in autism populations [43] characterized by difficulties in identifying and naming emotions experienced by one's self or others [68]. People at the high end of the alexithymic continuum tend to use emojis less frequently than other groups [82]. Speculative technology has been proposed to better support detection and interpretation of emotions for neurodiverse users. For example, smart glasses [80] or other types of wearable assistive technology [9] could receive and display real-time emotion identification. Video calling tools and emotion AI could use video and audio streams to detect and classify facial cues and emotions [88] and present them in various visual ways, such as emojis, emotion meters [7], or bubble visualizations [47]. Sobel et al. [73] researched communication practices of people with disabilities who are nonverbal, which includes a subset of autistic individuals. As users of augmentative and alternative communication (AAC) devices, their expressive communication is constrained by the capabilities of the AAC device, which typically converts symbols or text phrases to spoken language. Sobel et al. identified the need to communicate emotion and mediate communication flow. For communicating emotion as output from an awareness display, Sobel et al. chose to convey emotions using emoticons (text-based emojis) and graphical emojis since they are known to users and viewed as socially acceptable. However, they heed that emoticons and emojis are normative displays of emotional states and perhaps not as expressive as other design concepts, such as abstract color animations.

Given the value of online communication for autistic individuals and considering the potential for communication breakdowns due to affective misinterpretations, our work explored how neurodiverse dyads engaged in the speculative design of a chat-based emotion translator that offered rich and customizable visual representations of emotions.

2.2 Participatory HCI Design Practices in Accessibility Research

"Nothing about us without us" is a mantra in disability communities [19]. Including disability communities in technology research and design enriches HCI approaches to accessibility and pedagogy [48]. Several HCI design practices leverage theoretical frameworks and approaches to support inclusion. User-sensitive design formalizes disability as a key aspect of user-centered design [51]. Design for user empowerment [44] specifies that users with disabilities should be involved throughout the design process, from developing the project to refining the design, resulting in increased self-determination and technical expertise. This approach is aligned with calls in disability studies for emancipatory research methods and design outcomes that liberate disabled people from socio-technical constraints and systemic barriers [12, 55, 56].

Specific to autism technology research, HCI researchers have called for including neurodivergent users in design (e.g., [32]). One adopted approach is participatory design [65], which mitigates the inordinate control technologists often have in deciding how, where, and when technology is deployed [15]. Participatory design positions users as experts and encourages design moves situated in lived experiences and practices [66]. Finally, participatory design scaffolds 'imaginative freedom' (Schulz, as cited in [15]) and "enlarges the design space and maintains it open to the possibility of change" [15, p. 442]. Related, the diversity for design framework uses evidence-based practices from education, such as demonstrating tasks to supplement verbal instructions [10]. Futures workshops and cooperative inquiry have been deployed to tap into autistic children's creativity [33]. During one set of workshops, researchers took on roles of play partner and observer in an open-ended design process during which autistic children conceptualized personalized Internet of Things objects [33]. One participant devised a physical "concentration cap" that could help him focus and a "remembering machine" to remember forgotten events.

Deploying participatory design studies is not without challenges. Planning and executing a participatory study needs to consider power, conflict, politics, and decision-making. Participants are often brought in when the research team has already established their agenda and overall approach, identified basic user requirements, and delineated the design space enough to prepare activities for a design session. At this point, how flexible is the design team? What assumptions have been embedded into the preliminary design materials and the structure of the design session? Engaging with people with autism earlier in the design process may lead to focus on different lived experiences and design directions [14]. In addition, design sessions require a degree of skill, such as the ability to work with abstract concepts and hypotheticals. Design explorations are, by nature, relatively ambiguous and not always clearly delineated [87]. Therefore, care must be taken to make design activities accessible to autistic individuals who tend to focus more on concrete than abstract representations [3, 14].

We deployed a speculative co-design methodology to build upon these traditions of participatory and inclusive research. We also aligned this work with calls from disability advocates and researchers to address power imbalances and systemic barriers. The combination of these approaches resonates with Levick-Parkin's argument that "If we commit to design speculations, beyond normative and pre-configured futures/ realities, it can be a methodology which clarifies the importance of our positionality and our engagement with ethics and how to materialise this as a central part of our material practices" [45, p. 211]. Specifically, speculative design is a framework for imagining future instantiations of technology that explore possibilities unfettered by a need to maintain a status quo. As Dunne and Raby point out, a preferable future lies somewhere between the *probable* and the *plausible*: a stretch, but not a breaking, of imaginaries [28, p.5]. Importantly, speculative design provides space for also extending towards the marginally *possible* as an exercise in imagining what it could be like if specific intractable problems (like racism or ableism) were solved. Speculative design shows that "situating a new technology within a narrative forces us to grapple with questions of ethics, values, social perspectives, causality, politics, psychology, and emotions." [74, p. 22]. In the next section, we provide further details regarding how we adapted this arc of likely to possible in the speculative co-design work we did in collaboration with autistic young adults.

3 METHODS

This research brought emerging technology into the hands of the participants for critique, manipulation, and "the establishing of new social practices in light of new technologies" [86, p. 139]. This speculative prototyping study was conducted as the final phase of a grounded visualization design (GVD) project focused on exploring the ways that emotions and affective experiences could be more appropriately represented in technology designed for autistic users. GVD is an emerging approach to the design of visualizations being developed by the second author to forefront lived experiences and participant engagement in the process of designing visual encoding systems for personal data. The design of the prototype described in this section was grounded in participant experiences and explored during initial ideation work with members of the autism community [90, 91]. Iterations to initial designs emerged during our study, as described in the Results section.

3.1 Participants

Seven autistic young adults (names listed in Fig. 9) were recruited who (1) self-identified as autistic (using the terminology of their choice), (2) were 18-32 years old, (3) could communicate verbally in English without the use of a communication aid, (3) were conversational, meaning, able to participate in conversations about their experiences and decision-making processes, (4) had experience using consumer technology, such as a computer, tablet, or gaming console, and (5) had fine motor skills at a level able to participate in design activities using design materials (pen and paper). These primary participants each invited one secondary participant—a trusted conversation partner—to join the study (n=14; 7 pairs).

All 14 participants were paid $50 for their involvement. Our institutional review board approved the study, and we collected data in February and March 2021. All participants lived in mid-sized cities (2) or large metropolitan cities or suburbs (5) in the United States. The primary participants were 19-33 years old, with an average of 25. There were 3 women, 3 men and 1 non-binary individual. Their educational experiences included a transition program for life and job skills at a community college (2), a Master of Music (1), a Ph.D. in statistics (1), a medical residency program (1), Bachelor degree (1), and high school graduate (1). They were employed in technology and music fields or had internships with local retail shops (bakery, feed store, pizza restaurant, computer repair). The secondary participants were 17-65 years old; 5 were female and 4 were male. Their relationships with the primary participants were family (2), instructors at college (2), boyfriends (2), and a friend (1).

3.2 Emotion Translator Design Artifact

An initial speculative emotion translator prototype was created based on previous work related to using CMC to better support neurodoverse dyads (e.g., [17, 34, 90, 91]). This design concept was offered as a seed for co-design activities and was intended to be adapted, altered, and improved by participants. The emotion translator design concept was motivated by situations described by autistic individuals when they experienced difficulty conveying their emotions to other people or wanted to conceal certain emotions or intense emotional states [88, 90]. Autistic individuals described being challenged at times during conversations because they either did not understand a person's emotional reaction, could not accurately interpret someone's emotions, or questioned the intention behind another person's actions or words. In a study of neurodiverse conversation dyads, both autistic and non-autistic individuals expressed frustration at not being able to adequately express their emotions in ways that their conversation partners could understand [91].

We envisioned an affective computing tool similar to spoken-language translation services such as Google Translate. The emotion translator concept allowed the research team and participants to co-design ways to augment a text-based conversation with information about their embodied emotional states. We build upon scholarship on neurodiverse communication and self-expression ([7, 84, 88, 91]) to explore ways that a digital tool could enable each individual to freely express their emotions in a manner that could be comprehensive, understandable, and recognizable by each conversation participant.

A primary design principle for the emotion translator concept was that people should be able to express themselves according to their unique emotion language, similar to how people have a native spoken (or signed) language. The novel tool was developed to enable each person to fully express themselves according to their comfort level and desired way of communicating emotion. A design requirement was that each person could feel fully heard and acknowledged, thus building mutual empathy.

We implemented the emotion translator as a low-fidelity prototype in Google Slides, which enabled participants and researchers to enter text and manipulate images and the interface in real time. We created a low-fidelity prototype because this level of fidelity helped participants understand that the artifact was a work-in-progress, as opposed to a more concrete medium- or high-fidelity model prototype. Implementing emotion taxonomies into a generic chat application had three benefits. First, as a form of language technology, the translator would focus on the task of translation, rather than changing or "correcting" expressions of affect. Second, by not bounding the chat software to a specific app or platform, we hoped it would be easier for participants to imagine using similar and familiar tools within their daily communication. Third, it was possible to integrate the software design into online, remote interactions when the study occurred when many were still under COVID-19 social distancing restrictions.

Figure 1: Human forms set of 16 images (from artist Poddar) in the "emotion picker".

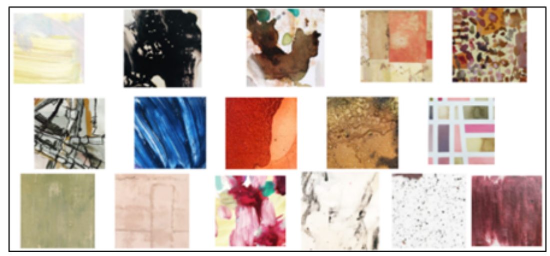

Figure 2: Abstract set of 16 images (from artist Calladine) in the "emotion picker"

We next detail the prototype's two modules: (1) personal and configurable taxonomies of emotion pictographs displayed via a matrix, and (2) an online chat application with Wizard of Oz implementation of those taxonomies for use during chats between neurodiverse dyads.

3.2.1 Emotion Taxonomy Matrix. A personalized emotion taxonomy matrix captured each person's desired "emotion language" through a series of unique pictograms. The matrix interface was a template of a two-dimensional grid for participants to fill out using visual icons licensed by visual artists. Once selected and added to the matrix, pictographs were available to use within the chat interface in a manner similar to using emojis. Each participant selected images from 32 images, shown in Figure 1 and Figure 2.

Common representations of emotion schemas tend to be based on people experiencing emotions as discernable, distinct, and unique emotional states with no overlap or mixing. However, in their descriptive work, Zolyomi et al., found that common representations of emotions, such as Ekman's six basic emotions [30], did not adequately represent the emotional states of autistic adults [90]. This is aligned with autism research on misinterpretation of facial expressions of emotions in autistic adults [29]. Autistic individuals have described ways that they express and interpret emotions beyond facial expressions in more embodied, sensorial ways [24, 26]. Emotions are expressed through the body, metaphorical or connotative language, and prosody. Therefore, rather than use common representations of emotions limited to facial expressions, our pictograph library was populated with images curated from the work of two visual artists familiar with neurodiversity and whose work focuses

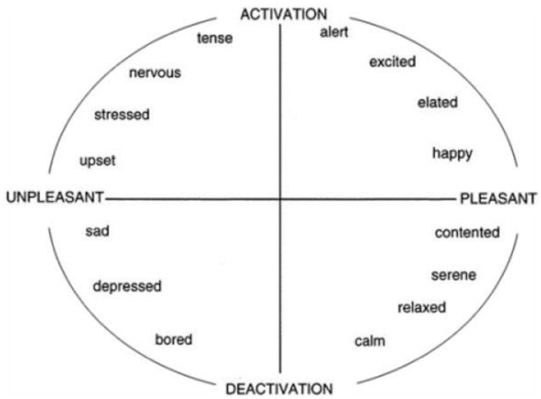

Figure 3: Russell's circumplex model of affect with the x-axis representing valence and the y-axis representing arousal [59]

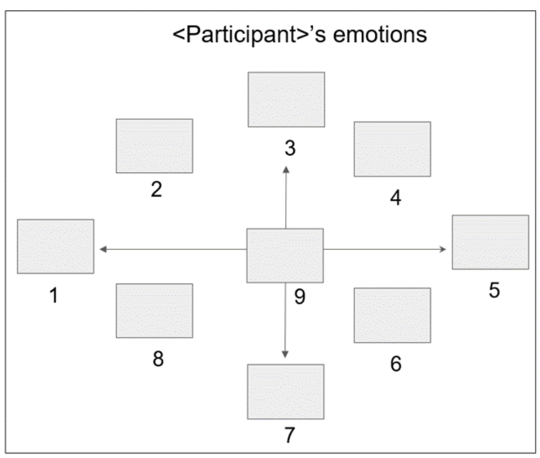

Figure 4: Emotion matrix template with axes unlabeled to elicit labels from participants. Instructions given to place emotion pictographs according to how participants considered the images to represent unpleasant-to-pleasant states (x-axis) and lower-to-higher energy states (y-axis).

on expressions of affect and emotion. One set of images is of human forms, which we chose because of their potential to capture the embodied sensemaking of autistic individuals. The other set were colorful abstract images, chosen because (1) visual abstract art often conveys emotions [22], (2) may appeal to autistic individuals, whose eye gaze movements during dyadic interaction differ from those of non-autistic individuals [11, 53], and (3) disability research called out the potential for abstract images to convey emotions in conversations [73]. (See Appendix A: Custom Pictographs for our image curation process.)

Along with the images, other important design elements of the emotion matrix were the layout and labels for the grid (Figure 4). The matrix template was based on the shape of Russell's circumplex model of affect, a two-dimensional framework representing the valence and arousal levels of neurophysiological systems [60]. Russell's model labels the dimension end-points as unpleasant and pleasant along the x-axis and deactivation to activation along the y-axis. However, recognizing that these dualities can be limiting, we left the matrix unlabeled and asked participants to create labels meaningful to them.

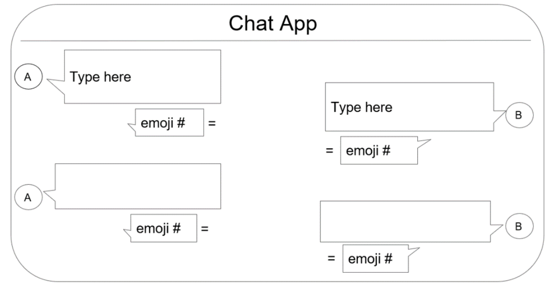

Figure 5: Chat template slide customized for the session with Alec and his conversation partner, Bob (names are pseudonyms)

3.2.2 Emotion Translator Chat Application. We implemented a low-fidelity interface of a basic chat app using Google Slides. Each slide represented a different screen that the participants could access that contained their personal emotion matrix and the chat interface. The basic chat app prototype was designed to enable two people to: (1) type, see, and respond to each other's typed messages and (2) select pictographs to insert into the message window. The interface is shown in Figure 5, similar to texting windows on many mobile devices. The initial text bubble for each participant showed "type here" to indicate where they needed to place their cursor to type.

As the participants typed in the chat app, they would choose a pictograph from their emotion matrix that corresponded to what they had typed (Figure 6). The speculative functionality of an emotion translator was conveyed using a Wizard of Oz technique in which a researcher acts as a "wizard" to simulate the envisioned interactions [27]. When a participant said or typed a pictograph number, a researcher (1) pasted the pictograph into a pictograph speech bubble, then (2) pasted their partner's corresponding image based on the pictograph number. For example, based on Alec's and Bob's emotion matrices shown in Figure 6, when Alec chose image 5, the wizard copy-and-pasted Alec's image 5 (two figures) and Bob's (an abstract black-and-white image) side-by-side (Figure 7). As they interacted with the prototype., participants were inviting to adapt the interface elements to better suit their needs.

3.3 Using Emotion Translator Chat Prototype

To prepare for their research session over Zoom, all 14 participants completed a 15-minute activity *before* to configure their emotion matrix. We emailed participants a link to a Google Slide with an emotion matrix template and instructions to (1) select 9 images from pictograph collections representing their feelings during conversations, and (2) place chosen images on their emotion matrix. The research team copied the completed emotion matrices into a chat prototype to be easily accessed during the Zoom session.

A user session with each pair of primary and secondary participants was conducted over Zoom, during which the pair interacted with emotion chat prototype that had been personalized for their

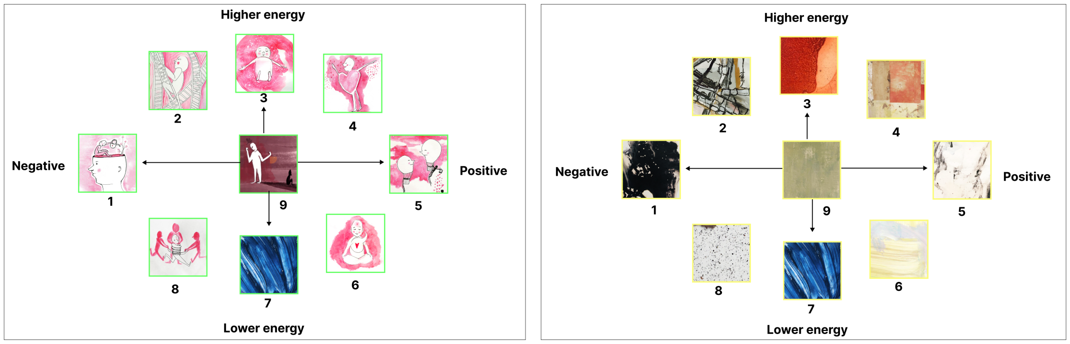

Figure 6: Example of emotion matrices customized by a dyad, Alec and Bob.

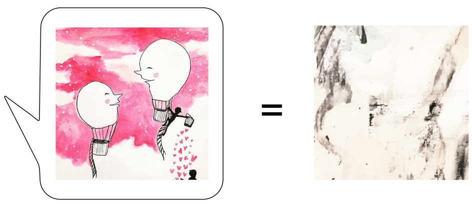

Figure 7: Example of mapping the primary participant's image for the pleasant and middle-energy spot on the emotion matrix.

dyad. The user session was conducted by an interviewer and a second researcher who acted as the behind-the-scenes wizard simulating the emotion translation. At the beginning of each session, the interviewer introduced the other researcher as a note-taker. After introductions, the interviewer provided a brief recap of research activities thus far since participants had been part of prior phases. Each participant and the interviewer opened the Google slides for the chat prototype, and the interviewer shared her screen in Zoom.

The interviewer walked the participants through each activity, moving the slides and asking them to move, on their computer, to the slide where they would type into the chat interface. Chat tasks included (1) greeting each other, (2) discussing the two emotional matrices, (3) chatting about current events or a "hot topic" like COVID-19 and including picking a pictograph from respective emotion matrices, (4a) exploring ways that the pictograph could be positioned and shared (e.g., size, location, etc.), (4b) explore the "hot topic" conversation with no word, just looking at images.

Participants were empowered to edit, interact with, and guide changes to the behavior of the chat prototype. In real-time, during Zoom sessions, the researchers incorporated participants' actions and verbal feedback into the prototype. As the speculative design sessions progressed, we prioritized feedback and carefully adjusted the prototype. The research team recorded ideas from participants (Table 2, presented in Results). After each interview, we grouped potential changes into one of the following categories: (1) crucial issues—points of confusion in the purpose or fundamental functionality of the prototype, (2) concern or idea to probe in future sessions, or (3) idea to track for broader analysis. In preparation for the next user session, we addressed the critical issues by making continual, relevant changes to emotion matrix slides and chat prototype slides. We detail this experimentation and evolution in the Results section.

3.4 Data Analysis

Data comprised participant personalized emotion matrices, chat activity (text and pictographs), video recording of Zoom interviews, and researcher notes taken during the Zoom sessions. After each interview, the interviewer and the wizard researcher debriefed about their impressions of the participants' engagement with the prototype and discussed emerging themes.

To assess participant engagement with the emotion translator, we conducted inductive analysis of notes to examine the appropriation and adaptation tendencies of participants, including how particular features provided mechanisms by which participants could incorporate the technology into their daily practices [36, 42, 62, 63, 79]. Inductive analysis is an appropriate approach since the "existing literature on appropriation does not contain definitions for appropriability metrics, but suitable measures are linked to a system's usefulness in various settings, and its configurability with other systems in the use contexts" [63, p. 12]. For example, we collected participants' pictographs in position #9—the neutral position in the emotion matrix—and displayed them together (Figure 9) to examine diversity of interpretations of neutral emotion.

We analyzed the messages and pictographs as they were generated by the participants, meaning the order of message and pictograph mattered as it does in conversation analysis techniques ([37, 54]. We leveraged Goodwin's principles of interaction analysis, a method used in the systematic investigation of talk-in-interaction during daily activities [35]. This approach involved using an "embodied participation framework" composed of body positioning, artifacts, gestures, gazes, and linguistic markers. In our work, interaction analysis is primarily based on text and pictographs captured in the chat interface, supplemented with (1) the participants' body positioning, gestures, and gazes visible within the Zoom camera and (2) the movements of the mouse and keyboard cursor in Google slides. By accounting for various verbal and nonverbal cues during the chat exchange, we analyze not only the written messages and selected pictographs but also, for example, a pause in typing during which the dyad had a verbal exchange before typing resumed.

Rather than generating a notated transcript as in traditional conversational analysis, we used the written and visual record of the completed chat to strategically select chat exchanges for deeper analysis, referring to video recordings and researcher memos for related data.

As the participant sessions continued, common themes emerged regarding interpretations of images, tensions between structure and elusive emotion taxonomies, accessing pictographs during chat, reconfiguring the emotion matrix, intuitiveness of emotion translation, and perceptions of values and harms.

4 RESULTS

Our analysis focused on how, through engagement with the speculative concept of an emotion translator, neurodiverse pairs changed, repurposed and/or converted the design to suit their needs better. We observed that the autistic participants (refer to Fig.9 for their names) and their partners could interact and use all the components of the prototype: the emotion matrix, the emotion translator chat interface, and the emotion translation functionality. This section describes how participants interacted with the prototype, including taking unexpected actions during both asynchronous and synchronous activities. The main change participants suggested involved the behavior of the emotion translator. Their actions and verbal feedback raise important issues about embedding assumptions into emotion-related features in communication technology. In addition, many participants resisted the proposed structure of the emotion matrix by changing the axes' number, direction, and labels. Some participants placed pictographs on the matrix bunched up together, not in evenly spaced out placeholders created by the researchers. These findings reveal factors for designing affective computing interfaces, including careful consideration of: the initial configuration of the user experience, the visual systems used to encode emotions, shared meaning ascribed to affective images, and the balance of tensions between structure and flexibility.

4.1 Diverse Rationale for Pictograph Selection

No two participant pictograph sets were alike. Variation was succinctly rationalized by Kyle, who, when asked what he thought about the differences between his emotion language and his partner's emotion language said, *"everyone is different."* Human-form images were more frequently selected than abstract forms. Representational images resonated with the autistic participants because they depicted *"literally figures in situations that are expressing emotions"* (Sarah). The human forms had faces, which were *"better to show emotion and energy"* (Alec). The forms were more relevant to emotions, whereas the abstract "color swatch" images were considered "more ambiguous" (Sarah). Sarah also appreciated that she "could pick multiple emotions for one image." Emily said that she started with *"the non-human images,"* then realized *"they did not represent energy."* She considered energy to be a human attribute not reflected in the abstract images.

The most diverse selection of images within a pair came from Alec and his partner. His partner was the only participant to select all abstract images (Figure 6). Coincidentally, they both selected the same abstract blue image for position 7, lower energy, midway between negative and positive.

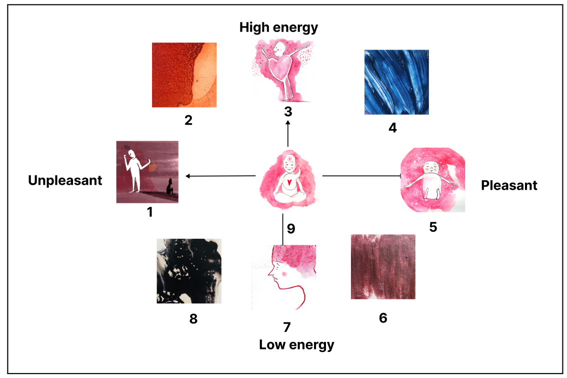

Figure 8: Mitchell's emotion matrix with human forms and abstract images. His selection of images reflect life experiences.

Participants expressed strong opinions about the interpretive nature of images, which could lead to misunderstandings about emotional states when shared during chats. Participants shared personal connections with the images. The majority of participants said that it was easy to select images. They said that the images *"represent how I feel,"* and to Mitchell, *"how my life has been."* Mitchell placed himself in the situations of the human forms in the images. For instance, the first image he selected was *"the guy looking back at his shadow (1). I came from a dark childhood and I'm not going to look back. I move forward"* (Figure 8).

After discussing their mutual images for neutral emotions, Sarah shared that *"I like being able to figure out what the discrepancy is, and that helps me. Helps me figure out where people are coming from. If he says neutral, I should just get it. But I'm not used to it."* The pictographs served as an avenue for learning about other people's perspectives and emotional expressions. We propose that these are unique conversation moves afforded by the emotion matrix. Unprompted by researchers, many participants spontaneously examined each other's center image (#9) in their emotion matrices, noting similarities and differences. Figure 9 shows image #9 for each primary participant in the top row and for their respective conversation pair in the bottom row. Some participants referred to this image as the neutral emotion. However, this was not always the case; some participants viewed the emotion matrix as a conversation cycle (Laurel's mom) or representative of emotions they felt throughout life (Mitchell).

The variation in the participants' meaning ascribed to the central position on the matrix and the variety of pictographs chosen for that position demonstrates that autistic people have different interpretations of visual layouts and varying embodied experiences with neutral emotions. Other marginalized populations can also have emotional experiences for which a normative, straight-line, middle-state of a baseline emotion is not representative. For example, Snyder found that when people with bipolar disorder created visual representations of mood changes over time, they tended to identify a zone or spectrum of acceptable states, rather than a single target line associated with feeling "normal" [71]. These findings point to the importance of affective computing technologies being designed to enable individuals to encode their emotional experiences in ways that make sense to them and align with their lived experiences. At the same time, these applications also need to provide a way for communication partners to map or transpose these bespoke visual systems to their own emotion matrices.

4.2 Interpretation and Reconfiguration of Emotion Matrix Structure

Most of the participants reconfigured or expressed resistance to the matrix structure (Sarah, Mitchell, Kyle, Charlie, Laurel). During sessions, they changed the layout, axis labels, and the number and positions of images, producing unexpected and novel configurations that surfaced ways that the standardized representation of emotions failed to meet their needs.

We left the labels for the emotion matrix dimensions empty and asked the pair to label the axis. The interviewer gave examples from which participants could choose (high-low energy, small-big, angry-happy, and negative-positive). Participants often debated how to use the axis. Sarah chose negative-positive and high-low energy because *"They seem like basic foundations for different emotions. But I feel like there should be more dimensions."* Taking a different approach, her partner labeled the x-axis as "interaction starts-interaction ends" (from left to right) and the y-axis as "emotions at the end-emotions at the beginning" (from top to bottom). Without suggested labels, the dyad had vastly different interpretations of the matrix. Since the Wizard functionality relied on mapping each pair's images—matching images in position #1 to indicate a positive emotion, for instance—we anticipated that the Wizard functionality would result in inherently mismatched pictographs. Therefore, during the Zoom call, Sarah's partner was invited to align his matrix labels to hers after sharing how they approached customizing their emotion matrix. To achieve improved alignment for subsequent dyads, the matrix axes were labeled as "low to high energy" (on the x-axis) and "unpleasant to pleasant" (on the y-axis), in keeping with Russell's circumplex model of affect (Figure 3).

Some participants, both those who were autistic and non-autistic, added a temporal aspect to the matrix and interpreted it as a cycle (Mitchell and Teri). As shown in Figure 8 above, Mitchell viewed emotions as starting positive then cycling downward to negative, saying that *"I can grate a conversation then it can go down the drain."* Mitchell expands on the connections between the images and his emotional life experience as follows:

"The colors represent my rage and my mood; ones with the bodies represent how I'd look like when I'm in a good mood or bad mood. Image 9, I'm at peace. Image 2 represents me going from a sad day into a better day. Image 5 is me trying to stay as calm as possible but it slowly translates into me wanting to close up from the world. Image 6 is me closing up from the world; not wanting to talk to people. Image 8 is a link from 1 to 7. And image 7 is doubting the choices I did in the past."

Upon listening to Mitchell's explanation, his conversation partner said that it was insightful for him to learn about how Mitchell *"internalize[d] the shapes and colors to mean something to him. I had a hard time making meaning of those [abstract images] in context of the chart. They still don't mean much to me."*

Several participants found it difficult to distinguish clearly between all positions on the matrix, especially in-between positions (2, 4, 6, and 8) that did not anchor endpoints. For example, Kyle selected the same image for multiple positions (Figure 10).

In another example, Charlie described how they found the matrix conflicting, explaining that *"Structure is helpful until it is not. I think abstractly, but I need structure. I need context. I need examples. Then, I could assign an emotion to it. Or the emotions are overlapping and always move and changing."* Charlie converted their matrix from fitting into the proposed structure to overlapping groupings of images (Figure 11). This was a more representative depiction of the fluid and ambiguous nature of how they experienced and attempted to define emotional states.

During the Zoom session, three dyads converted their matrices from two dimensions to one dimension (e.g., horizontal matrices of Kyle and his partner in Figures 12 and **??**). The linear layout aligned with their conceptual models of emotions, as Mitchell explained, *"it makes more sense. It shows how I could have bad attitudes and slowly progress into a better one."* The dyads found selecting a pictograph during chats from a linear matrix more straightforward than from a two-dimensional matrix. Linear layouts helped to disambiguate the two axes that these participants viewed as incongruent or competing with each other. This difficulty with the two-dimensional matrix was exacerbated during the chat because, as described by Mitchell's partner, textit"there are four criteria you are picking from in real-time".

When converting the emotion matrix, the participants demonstrated agency over the matrices and pictographs. For instance, Kyle took the opportunity to make a linear matrix and remove the redundant pictographs he had used in his original matrix. Laurel and her mother used the time to share their interpretation of matrix labels and the possible number of images per dimension (Figure 13). Three participants noted that their choice of images changed from their original selection a few days ago, which Mitchell explained by saying his emotions *"depend on the day"* he is having. Through their appropriation actions, participants demonstrated the dynamic nature of how people feel and express emotions.

As they engaged in the chat and used these pictographs, Mitchell's conversation partner said that hearing Mitchell's explanation of his emotion matrix gave him more insights into Mitchell's use of the images, saying, *"if I hadn't just sat and listened to him, I wouldn't have understood."* The examples in this section demonstrate that new conversational moves were afforded by using and jointly reflecting on the emotion matrices. New conversational moves were also afforded by using the pictographs while in conversation.

4.3 Appropriation of Emotion Translator Chat Application

The participants spontaneously took unexpected actions throughout the study while using the emotion translator chat app. Table 1 lists the key changes to the chat app based on participant actions and feedback. With a low-fidelity prototype and wizard researcher, we could adjust the prototype's look-and-feel in real-time. For instance, Alec immediately asked if he could choose two images, saying, *"Just like someone asks for vanilla bean and French vanilla*

Figure 9: Images in position 9 for all participants. The pairs are in the same column. Note that Mitchell and Kyle had the same conversation partner (their instructor); thus, his yellow abstract image appears twice in the bottom row.

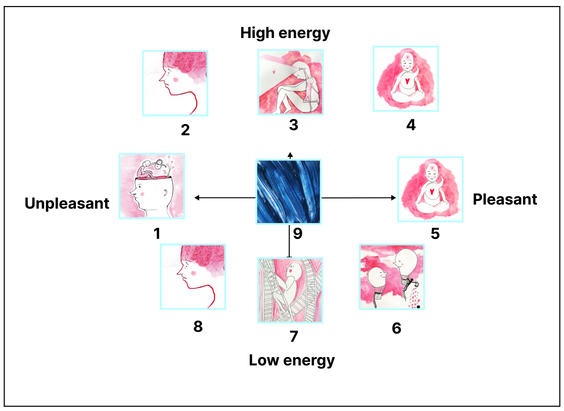

Figure 10: Kyle used identical images in positions 4 and 5 and again in positions 2 and 8.

[ice cream], I can feel 2 emotions." In response, the wizard elongated the pictograph bubble and stacked Alec's pictographs and the mapped pictographs in his partner's emotion language (Figure 14). While chatting, participants desired more space for pictographs in the emotion translator chat to allow them to reply to each other's pictographs (Figure 15). This was particularly important for participants who often *"communicate with pictographs"* and when they use a pictograph, *"they get an emoji back"* (Mitchell's partner).

Next, we describe our experimentation with the emotion translator functionality and participant responses. The original design was for the wizard to map the pictograph from one user's emotion language to their partners (Figure 16). When participants first encountered the emotion translation in the chat, several participants understood the meaning of the emotion mapping within the first page of chat messages, as evidenced by their comments on what they were observing. They typically commented in cases in which the dyad's emotion matrices had obvious differences (e.g., Figures 17 and 18).

Upon reflection, Bob said, *"I was a little confused by the pictographs [human forms]. I had a hard time assigning emotions to them. When I see Alec's translated to mine, I get it more. I don't have to look at matrix. When I see the two together, in black and white, it is easier to translate into my mapping."* To which Alec responded, *"Our system is totally different, but it accomplishes the same end thing. It's almost like depending on the situation, which system will work for the situation."*

On the other hand, many participants did not pick up on the meaning of the mapping in real time. Some noted that they were focused on what they were typing, had too much to think about, were thinking about their emotions, or were otherwise unable to decipher the meaning of the layout of the pictographs. For the latter case, participants voiced several issues about how and why it was hard to discern the translation. In at least two instances, participants made fresh interpretations of the images within the context of the chat topic. For instance, Emily's chat was about whether it was safe to begin eating in restaurants again since COVID-19 pandemic restrictions were being eased. Upon seeing her partner's pictograph (Figure 16), she interpreted it as people having a feast and pointing at someone. Her partner's intention, however, was that he felt worried about the situation.

All participants understood the intent of the emotion translator once the functionality was explained and examples in their chat were discussed. Overall, all participants responded positively to the concept, saying that it was a *"cool idea"* (Sarah) that provided visual reinforcement of emotions that would be helpful for them to avoid misunderstandings. A common theme was the desire to learn more about each other and viewing these pictographs as *"an invitation for further exploration"* (Charlie). Sarah anticipated that emotion translation would help ease the effort she puts into understanding conversations, saying:

"Neurotype has a lot involved in how people interact. Autistic people communicate directly and say what's on their mind. Neurotypical people - it's a social game, let's lie about how we feel. It can be a fun game. The emotions I feel, is what I say. People will assume I am playing the game. They think I mean the opposite and not being straight forward. I think this is why autistic people are misunderstood. . . .It takes effort to understand if you communicate differently."

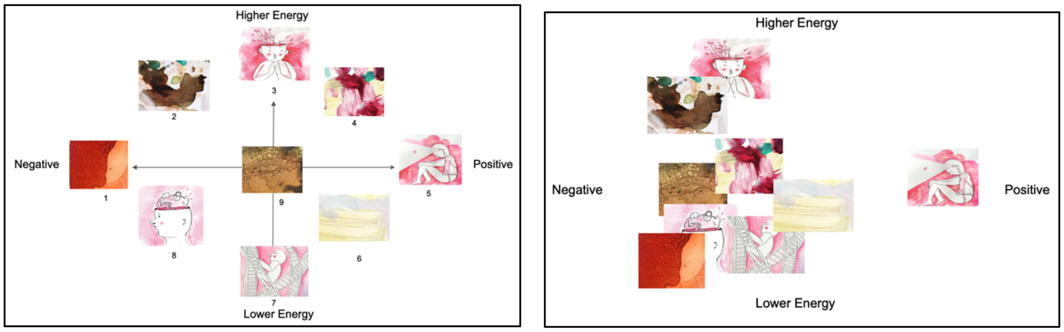

Figure 11: Charlie's converted matrix from two-dimensional (left) into groupings (right).

Table 1: Design modifications incorporated into Emotion Translator Chat app in response to participant appropriation

Category	Design Change	Rationale
Visual treatment	Color-code names, speech bubbles, and pictographs	Visually connect speech bubbles and pictographs to user
Visual treatment	Place images into speech bubbles to mimic visual behavior of familiar chat apps	Consistent with technology user experiences
Selecting pictographs	User can select pictographs with voice or typing pictograph number	Typing number allows users to continue typing without having to switch to speaking to researcher
Selecting pictographs	User can respond to partner's pictograph with a pictograph (rather than going straight to written response) Selecting pictographs	Allow for response that acknowledges and validates partner's emotion. Consistent with behavior of common chat apps.
Selecting pictographs	User can choose 1 or 2 pictographs	Feeling more than 1 emotion
Selecting pictographs	User can select pictograph from partner's set	Not finding pictograph in their own set
Emotion translation	Added equal sign between pictographs to indicate equivalency	Clarify that images mapped to each other
Emotion translation	Experiment with transparency of pictograph mapping: (1) show pictographs mapped together; (2) put user's pictograph under their initial and translated pictograph in shared area; (3) show only translated pictograph	Probe participant preferences for seeing only translated pictograph or it mapped to original pictograph

Figure 12: Kyle's (top) and partner's (bottom) reconfigured linear matrices

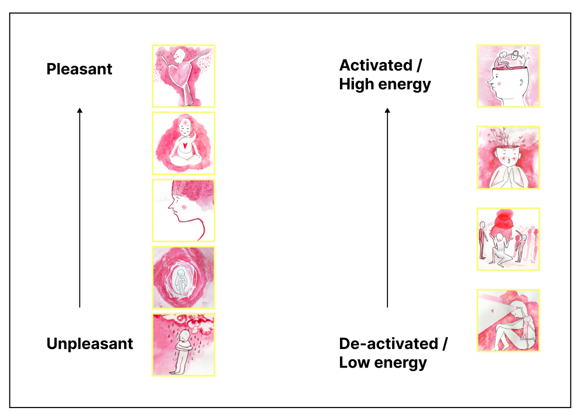

Figure 13: Laurel's reconfigured matrix as two spectrums.

Sarah raised reasons why the communication styles of autistic and non-autistic people lend themselves to misunderstandings. Laurel's conversation partner, her mom, said that this idea could help them avoid some misunderstanding and even though she did not find the particular images resonate with her emotions, *"I would love to see art that better represents emotions. It's not just for autism;*

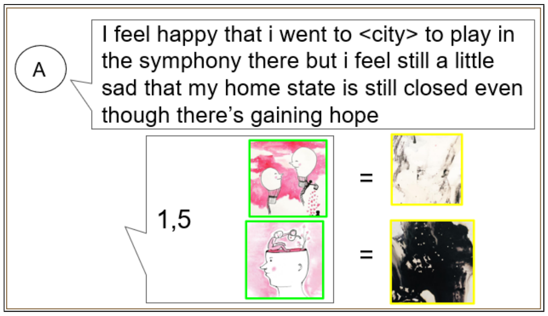

Figure 14: Chat message between Alec and Bob. Alec felt more than one emotion, so he chose two pictographs (left, green border). The "Wizard of Oz" emotion translator mapped Alec's pictographs to Bob's (right, yellow border).

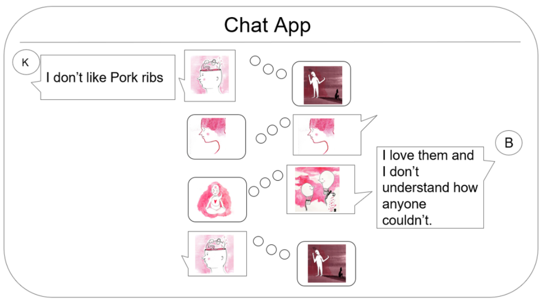

Figure 15: Chat app design change to allow for a pictograph in response to a pictograph. The pictographs in call-out boxes point to the user that sent the pictograph. Emojis in squares (with no call-out arrows) are the translated pictographs.

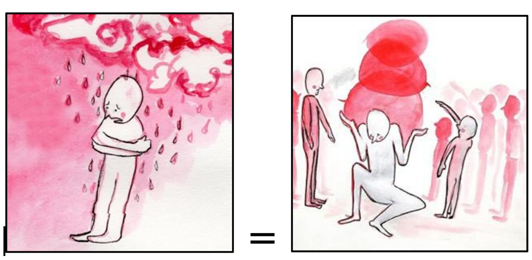

Figure 16: Emily's pictograph (left) translated to her partner's pictograph (right).

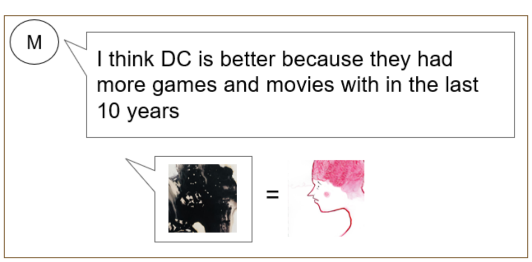

Figure 17: Mitchell's abstract image translated to partner's human form language.

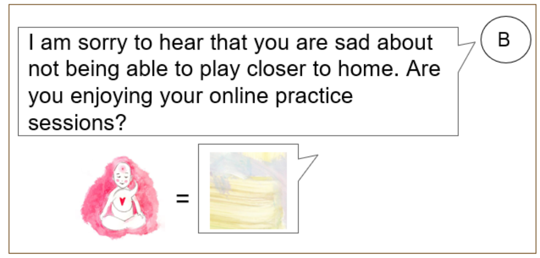

Figure 18: Alec and Bob's translated pictographs. Bob verbally commented on noticing the translation, to which Alec concurred.

everyone could use this." In response, Laurel agreed, adding that she *"just wants [my mom] to interpret them the way I see them."*

Although the design concept was positively received, there were important concerns about potential harms. Several participants noted that different interpretations of novel pictographs opened an opportunity to misunderstand the images and (by extension) their partner's emotions. The challenges of the emotion matrix structure could lead to misunderstandings if, for instance, one person considered a position on the matrix to be for anxiety and the other person saw it as anger. Charlie suggested addressing this lack of definition by having a *"way that all the pictographs are clearly defined for each person."* Both conversants could access a common reference with pictographs and definitions. This reference could be used in conjunction with the playful interaction that some participants enjoy when observing their partner use new pictographs and then eventually learning about them and adopting them to *"mirror them in interaction so we can get along better"* (Sarah). In addition to Charlie's design modification described above, participants had other specific design ideas, such as including a wider range of expressions (e.g., silly, very upset), images with stimming movement, and memes. They also provided feedback that we translated into design changes, such as allowing users to use each other's pictograph set to support perspective-taking. (See Appendix A for the full list of design feedback.)

These reflections and design ideas highlight the challenges of navigating social norms from autistic and non-autistic perspectives. Several dyads shared that they have misunderstandings in daily interactions and strive to achieve mutual understanding. They expressed that trust is required to be vulnerable and that as they disclose more with each other, there is a greater risk of being hurt. Ultimately, any technology mediation for neurodiverse conversations needs to respect desired levels of disclosure and provide ways to bolster the trust the pair has worked hard to establish.

5 DISCUSSION

Our work reinforces three crucial themes about the potential role of technology in neurodiverse conversations regarding cognitive load, visual representations of emotions, and user acceptance of artificial intelligence systems.

First, through the use of an emotion translator prototype, neurodiverse dyads demonstrated the cognitive load they experience during social interactions when they need to initiate conversations, acknowledge what their partner is saying, and understand—and respond to—underlying intentions. Autistic individuals describe having an awareness of and difficulty navigating the social cues of non-autistic individuals. As described by participants in this study and substantiated by related work ([24, 88]), intentions of non-autistic people can be unclear and obscured by discrepancies between language and emotions (e.g., sarcasm). The emotion translator concept invited participants to envision conversations where this burden was mitigated (if not removed entirely). The speculative aspects of the design concept asked neurodiverse conversation partners to imagine communicating without the need to mask or camouflage their feelings for fear of being misunderstood.

Although this study was conducted online, participants noted that an emotion translator could be useful when communicators are co-located, especially given their current socio-technical behaviors, such as texting each other while home together and sharing written letters about topics that were difficult to discuss face-to-face. These uses of technology align with related work investigating the use of technology for co-located scenarios of digital game play [41, 89], co-working, and attending remote school. Thus, these social practices could generally be used to mitigate cognitive load in work and school life for co-located and remote neurodiverse pairs.

Second, our work reveals that autistic individuals engage in existing socio-technical practices of using pictographs and found the pictographs valuable. Using the emotion translator prototype, neurodiverse dyads engaged in a range of adaptive design actions including: (1) resisting and reconfiguring the emotion language; (2) making literal and situated interpretations of pictographs; and (3) selecting multiple pictographs together to represent the confluence of emotions they were feeling. The process of assessing, selecting, and adapting visual representations of emotions provided an opportunity for both self-reflection and collaborative sense-making between partners. As we have reported in the Results section, there were many points of disconnect between the experience of emotions and the visual depiction of affect (both pictograms and how those images were deployed within the chat interface).

Our emotion matrix was based on Russell's circumplex model of affect, and although the model has been heavily validated, there are still scrutinized aspects resulting in alternative views such as the social construction of emotions [6]. Importantly, some work has shown that the model is not uniformly valid for autistic individuals [77]. Use for autism populations is less studied and tends to rely on the facial expressions of emotions, which autistic individuals tend to misinterpret and not visually attend to compared to non-autistic individuals [29, 64]. Our work shows that providing autistic individuals with the opportunity to reconfigure an emotion matrix can be a way to engage them in affective identification and discussion, thus creating *co-constructed* circumplex models that extend Russell's original fixed model. Therefore, our work contributes to what researchers in various fields, including psychology and neuro-physiology, are still learning about polarities and associations between emotions for autistic individuals (e.g., [76].

Participants demonstrated challenging sensemaking of socio-technical emotion experiences, as also observed in autism (e.g., [7] and non-autism research (e.g., [46, 75]. However, in our work, because participants were free to question, adapt, and reconfigure prototype elements, these discrepancies fed and enriched speculative inquiry. Visualizing ineffable, intangible, and internal experiences can be a means of prompting participants to reflect on their values, priorities, and expectations, especially in the context of interpersonal communication [69, 70, 72]. Throughout the co-design process, we saw ways that embedding that process of externalizing emotional states in an easily shared format enables participants to work together to imagine new ways of interacting. Users of affective computing may want to mix and match new pictographs—or richer representations of emotions—with emojis they are familiar with from their current communication tools. Thus, communication and affective technology designers should explore the use of richer pictographs and annotations to build upon the autism community's knowledge of emojis and probe the limitations of emojis for autistic [82]and non-autistic users [75].

Third, individual and societal attitudes towards the role of artificial intelligence should also be accounted for in the design of affective computing. In this study, some participants were wary of artificial intelligence making errors in translation and dictating too many constraints on their emotion language. Their apprehension is aligned with related work on perceived harms of artificial intelligence and emotion [1]. The dyads demonstrated their apprehension by reconfiguring, resisting, and questioning elements of the prototype. For example, they changed the axes on their emotion matrices and questioned the Wizard of Oz translation of pictographs. During the session, participants used in-person and digital resources available to them, such as speaking with each other aloud over the Zoom audio channel while typing in the chat prototype, typing on each other's computer, and selecting from each other's set of pictographs. Their use of various communication channels demonstrates resourcefulness and effort taken to "code switch" [70] between communication modes, adapt to technology affordances, and allocate cognitive resources to translate the information they want to convey. These actions allowed users to have more agency over the system rather than being passive users, thus demonstrating ways for AI systems to be more acceptable to users.

5.1 Designing Assistive Technology to Scaffold Conversations

Although wary of technology that purports to understand emotions, participants saw value in using technology to help them map their experiences of emotions to those expressed by a neurotypical conversation partner. To support neurodivergent communication strategies, communication and affective technology can: (1) provide ways for users to curate emotion-related system artifacts, (2) treat personal emotion-related artifacts as resources for users to enhance their emotional understanding, and (3) allow users to reconfigure and resist emotion-related features.

Current assistive technology designed for autistic individuals to use during conversations tends to focus on (1) converting text input to speech output and (2) detecting and labeling emotions based primarily on facial expressions. Our work suggests that conversation assistive technology can scaffold the dyad in sensemaking about the holistic interaction. The interaction includes the underlying intention behind verbal communication and building mutual understanding about each other. This need for emotional sensemaking is aligned with the needs of other cross-cultural communication, such as occurs in cross-lingual social media [46]. The emotion translation prototype allowed each person to pre-configure their emotional language to capture a myriad of embodied expressions of how emotions feel and what they may look like in terms of shapes, actions, colors, etc. The Wizard of Oz translation functionality provided ways for the dyad to express themselves in their language and have different levels of visibility of their partner's emotional responses. This customization of opaqueness and transparency respects participant desires to have powers that range from full embodiment of someone's emotional state to blocking emotions entirely.

As we consider the potential depth and range of translation, we consider that there is no objective ground truth of emotions that the translator is attempting to convey. The sociolinguistic basis of our analysis is built on this notion that communication is socially constructed—meaning, results from interaction. The goal of the translator is to present one person's expression of emotion in a way that resonates with another person's frame of reference. In the case of emotion communication, the desired outcome is a scaffolded *process*—not a string of text or labeled pictograph—between the dyad that helps build mutual understanding. Dyads in our study engaged in embodied sensemaking that allowed them to not only hear or see their own emotions and their partner's but integrate that information into their understanding and social awareness, which could, in turn, also inform future interactions. Perhaps a more appropriate framing of this process is as a *transposition* of emotions rather than a translation. Similar to how a piece of written music is transposed from one instrument to another, our prototype intended to relay one person's emotional intention and affective response to another person while maintaining the structure of both conversant's emotional expressions and language intact.

Our work suggests where and how technology can intervene on a conversation, rather than technology always intervening, and thus enforcing change, on the actions of the disabled person. For example, the emotion translator prototype intervened on distinct conversational moves of either conversant. The choice is up to the individual on whether to initiate an interaction using a pictograph, and the other person could choose to respond with text or another pictograph. Choice is important for traditional interfaces and emerging artificial intelligent interfaces. When the Wizard of Oz translation changed the mapping of their pictographs, participants experimented with what behind-the-curtain functionality they would be exposed to. Sometimes they wanted to see their original pictograph mapped to their partners and sometimes they only wanted to resulting translated pictograph. These types of technology customizations, transparency, and opt-in models are important aspects of equitable technology that enable people to choose when, how, and with whom to use the technology.

Assistive technology can also explore more layered and nuanced communication mediums, such as a scaffolded communication process that provides multiple communication channels for conveying the intention and emotional tenor of communication. The value of the emotion translator was not only in how the participants used and perceived the rich pictographs in-the-moment, but also how they inspired discussions about emotions. Both autistic and non-autistic participants appreciated opportunities to inquire about discrepancies in pictograph selections. These calibrations helped them understand each other's perspectives and mutual understanding. The emotion translator became a technological resource for action—system features and properties that provide users with mechanisms for action within a social interaction [62]. According to Salovarra, resources for action are not only independent end-user features, such as email and instant messaging, but also the user's act of using a combination of email and IM to coordinate a social activity. Emotionally aware and communication technologies could be intentionally designed as a resource for action, for instance, by using pictographs as an avenue for joint discovery motivated by people's desire to learn about each other.

The pictographs also intervened on the *temporal* dimension of the dyads' interactions. Participants asynchronously prepared for conversations and then engaged in real-time chat while on Zoom, which allowed the participants to see each other and talk verbally while typing in the chat prototype and, less often, the Zoom chat. The prototype provided a visual history of their interactions and the outcomes of their appropriation actions. The reflection and dialog about the pictographs *after* the interaction proved valuable to the dyad. Before, during, and after the chat conversation, conversation dyads and researchers engaged in joint reflection using a variety of modalities, including speech, gestures, typing, and pointing the mouse cursor to elements on the slides. Likewise, communication and affective technology designers could lay the groundwork for establishing common ground even before the dyad engages in conversation and facilitate joint reflection at different stages of the conversation, even beforehand and afterward. The technology could provide a way for people to reflect on rich information after the fact, which could potentially be used as a training or teaching resource.

Another aspect to consider in designing technology for autistic individuals is the various roles the individual takes or may want to take during a social practice. Rather than designing technology assuming the individual needs help, assistance, or a set of normative goals, the technology should allow the individual to take on various roles in the interaction, including initiators of conversations, negotiators, listeners, clarifiers, etc. Some participants enjoyed learning about how their friends use emojis so they could understand their point of view and adopt similar communication styles. These insights about how autistic individuals engage in information-seeking and social-emotional learning reframe the goals and behaviors of autistic individuals. These insights also alter how HCI researchers should view the role of technology and media in the autism community. Current HCI work tends to position technology as an assistive tool to augment the abilities of autistic individuals. However, by considering technology as an information source for social-emotional learning, autistic individuals can be viewed as empowered learners and distributors of knowledge for others in the community.

5.2 Implications for Inclusive Emotionally Aware Artificial Intelligence

As reflected in our participants' responses to the emotion translator, some people will be hesitant to use AI-driven technologies, and others will be open, or perhaps oblivious, to it. This is an area of potential harm that designers and other technologists need to account for, such as giving options to turn off AI-driven capabilities while keeping the core communication capabilities intact. This is in keeping with other accessibility guidelines for supporting technology to operate seamlessly even if advanced functionality (such as JavaScript-enabled web content) is turned off [81]. However, this division in technology capabilities is not a best practice because it often presents a divergent user experience for disabled and non-disabled users, with disabled users often receiving a deprecated user experience. Therefore, future work should investigate ways to make AI-based options available to all users with customizations that allow users to adjust, restrict, or eliminate AI-driven functionality. Crucially, the default configuration mode would provide equitable user experiences for all users and not degrade the user experience for users who choose not to enable AI-based functionality.

To create AI systems that respect neurodiverse user needs, emotion AI systems can operate with notions of consent and transparency. Systems should respect a person's desire for levels of consent, meaning that systems should allow the user to adjust how the system works based on the individual's level of comfort in the interaction. For example, an emotion-aware system could allow users to hide, reveal, and receive information about emotional states according to their comfort levels. To help users understand the intentions and limitations of emotion-aware functionality, the system should be somewhat transparent about its emotional literacy and constraints. For example, the system could convey that it can detect basic but not nuanced emotions. The system could state its limitations, such as being unable to detect non-verbal cues outside the camera view. Ultimately, due to the potential for misreading and misinterpreting emotions—which causes the user cognitive and emotional dissonance—the user should be given control and enabled to use the system without emotion AI capabilities activated. Further research can explore designing trauma-informed affective computing, meaning it respects difficult and painful emotional experiences and helps individuals establish emotional boundaries and consent between humans and technology and within the social group.

When designing the user interface for emotionally aware AI systems, insights from our research can inform the visual encoding, textual descriptions, taxonomy, and automatic detection and categorization of emotion states used in emotionally aware and communication technologies. For example, the range of visual representations and taxonomies of emotions can be expanded to offer nuanced expressions of neutrality. Emotion AI systems can account for personalized baseline emotions, such as anxiety, and gauge emotion intensities or detect other emotional states from those personalized baselines. Interfaces for emotion AI systems can be non-judgmental in how they convey or contextualize emotional states typically considered as "negative" states since the AI system may be misinterpreting the emotional state of the individual and since the person, even if feeling that type of emotion, may not desire to have their emotional states questioned or altered.

5.3 Conducting Speculative Design with Autistic Adults

Autism HCI researchers have discussed the potential value of engaging autistic participants in speculative requirements [33], noting that participatory design engages the research population as designers, thus incorporating their perspectives and values throughout the design process. However, minimal HCI research has engaged autistic people, especially adults, in speculative design. Our work provides an example of conducting speculative design research with autistic adults and offers lessons in crafting inclusive speculative design activities. We found speculative design to be especially useful in research involving autistic adults because (1) it brought their perspective into the design process, which helps counter assumptions and implicit bias about the community, and (2) it gave more power to the research population, thus shifting the power dynamics between the researcher, research population, and other stakeholders.

When crafting the design activity, there is a tension between the futuristic nature of speculative design and the need to provide participants with concrete instructions and ways to engage with the speculative design concept. Researchers exploring speculative design concepts have used methods including brainstorming sessions [16] and engaging with design fictions [85]. There is a strong storytelling element through textual and visual narratives [74]. Drawing from guidance on design with autistic participants, including [10, 14], we anticipated the need to provide structure and clear guidance in our speculative design research. Thus, the guiding principle of our speculative design research was to *make the design research concrete but not rigid.* This principle applied to (1) the design research instructions, (2) design materials, and (3) expectations on participation levels. Although the overall concept of an emotion translator was quite abstract, we concretized it as a system of pictographs, matrices, and Wizard of Oz translation. One approach for making the activity concrete is through discrete design artifacts with strong sensory components, such as visuals or tactile, physical objects. We recognized that speculative design methods may not work for all participants due to cognitive styles and sensory needs. We provided flexibility in how they approached the design study. For example, although we designed the study to have an independent component of customizing the emotion matrices, we allocated time during the joint, synchronous session to review, adjust, and discuss the matrices. This opened up dialog about the matrices, and the researchers could observe the dyad's joint actions as some further refined their matrices together. It is also important to provide multi-modal ways to engage in the activity. Materials and visuals can be interpreted in particular ways; some may irritate sensory sensitivities to color, texture, objects, etc. Consider the location of the design sessions. Despite the challenges of adjusting research methods at the onset of the COVID-19 pandemic, conducting remote interviews and design enabled more modes of engagement. By participating in their home environment, participants had access to their usual resources for physical, emotional, and cognitive comfort. They could engage in the design activities according to their communication styles, such as live Zoom sessions or independent, asynchronous engagement. An unexpected benefit was that the research team received more information about participant spaces and social groups. These benefits align with those found by Bennet and Rosner, who, in their research, position disabled people as designers, noting their strengths in drawing upon abilities, perspectives, and resources [8].

5.4 Limitations and Future Work

Participants found the concept of an emotion translator compelling; however, our work is just one step in exploring the full range of emotional, affective, and communicative lived experiences of neurodivergent communities. We recognize the limitations and desire for future HCI work to more fully connect with neurodivergent communities and their diverse lived experiences [48]. The material manifestation of the concept as an online chat with pictograph mapping was a particular incarnation of the concept; however, many other manifestations could be explored, such as using physical computing to provide a multi-modal, embodied emotional experience. Our design focused on a dyad, and participants conveyed that an emotional translator could potentially be valuable in larger social groups and among people who do not know each other and the trusted conversation partners chosen for this study. By envisioning future uses and making design suggestions, participants engaged in design moves for technologies not yet in existence. This is not an easy feat for research participants to confidently provide feedback during research and design of emerging technologies (e.g., related to human-robotic interactions, [87].

Our speculative design concept of an emotion translator could be an avenue of exploration for other research exploring nonverbal communication in conversations. Research could investigate using common emojis in conjunction with rich pictographs and annotations. This work could inform research on individuals who are non-verbal and use communication devices (e.g., [73] to explore what an emotion translator would look and act like in conjunction with speech devices. By designing for communication preferences and styles of the particular human in human-AI agent communication—even perhaps style matching [2]—the individual is more likely to feel emotionally and socially connected.

More broadly, if we had chosen to focus on a different theme or made different design choices when envisioning a speculative design concept, the artifact and appropriate findings would yield different insights. This is an opportunity for future research to explore an alternative design theme or speculative design concept for emotions. Further research could investigate the connections between the three design themes, such as identifying and amplifying factors that impact independence and agency for neurodivergent individuals—factors that encompass clear communication and freedom of emotional experiences [57].

6 CONCLUSION

Our work uses the HCI design practice of speculative design for research participants within the autism community to generate and critique design concepts. The speculative design concept of an emotion translator demonstrated ways that novel affective computing could act in support of the social group by facilitating the respectful and nuanced co-construction of social, emotional, and sensory experiences. This design concept inspired alternative ways to augment a conversation with imagery and material sensations to convey emotional states. This concept also explored ways emotional experiences are co-constructed. This work introduces an emotion translator prototype composed of an emotion matrix interface and an emotion translator chat application. Our speculative design study enabled neurodiverse dyads to explore their desires for expressing and interpreting emotions during everyday conversations in a material, observable fashion. Participants were empowered to edit, interact with, and guide changes to the behavior of the prototype. Our study revealed that neurodiverse dyads interpret emotion languages fluidly based on conversation context. Although wary of technology that purports understanding emotions, the participants perceived value in using technology as tools for inquiring about other's emotions. Computer-mediated communication and emotion-aware computing should account for non-normative and co-constructed emotional experiences by, for example, enabling dyads to jointly reflect upon, resist, and refine emotion-related features. By exploring affective computing imaginaries, we learn more about the preferred direction of emotion-aware and communication technologies for neurodiverse conversation pairs, including the perceived values and harms of affective computing. Our work deepens our knowledge about neurodivergent young adults experiences with social interactions, thus, opening design horizons for more inclusive emotionally aware communication technology and design methods.

7 APPENDIX A: CUSTOM PICTOGRAPHS

For the emotion chat app, we licensed images from two artists. We selected the artists based on the following criteria: (1) their work evoked different embodied qualities of emotions through visual features (e.g., depictions of environment or space, social relations, colors, etc) and (2) their work was visually distinct from each other to provide a range of options to participants. The first artist, Rukmini Poddar, creates art that inspires emotional well-being and introspection. Poddar draws human figures to depict what she has coined "Obscure Emotions"—emotions "we feel deeply but cannot yet articulate or understand." The second artist, Jacqueline Calladine, is a textile artist who created a series of images based on her experiments using ink dyes from natural materials. Calladine uses various colors and visual variety (e.g., patterns and color swatches) in her abstract textile artwork, contrasting with Poddar's human figures.

The artists were invited to submit digital photos of their artwork, with each image representing their interpretation of a particular emotional state. The artists were paid for their time, and their artwork was directly licensed through them. In collaboration with the artists, 15 images were selected from each of their portfolios to use as embodied representations of emotional states and experiences. Poddar submitted the images shown in Figure 1. Calladine submitted 45 images, of which we selected a subset to obtain variety in color, patterns, and textures (Figure 2). Note that we used a total of 16 images per artist because an image (Poddar's image in the bottom row, far right) was added later based on participant feedback, as described in the Results section.

8 APPENDIX B: PARTICIPANT DESIGN IDEAS FOR CHAT APPLICATION

Participants had specific design ideas and provided feedback that we translated into design ideas (See Table 2).

Table 2: Emergent Design Ideas from Participatory Design Study

Prototype element	Design Request from Participants	Rationale
Matrix	Emotions could occupy overlapping positions in matrix	Emotions are "ever-changing", not discrete
Matrix	Provide matrix filled out with sample situation in mind	More context needed for matrix
Matrix	Provide definitions for what pictographs may mean	Users may choose different emotions for identical matrix position. Users may choose identical image for different matrix positions.
Pictographs	Provide different pictograph sets	Sets did not resonate with all participants; More representations of people
Pictographs	Include wider range of expressions (e.g., silly, very upset)	Support different styles of conversation
Pictographs	Include images or notation for sarcasm and forms of language (e.g., rhetorical question, jokes)	Enable discernment between words and intent
Pictographs	Include images with “stimming” movement (e.g., hamster dancing)	Convey embodied feelings
Pictographs	Include memes	“A meme can be a whole emotion” (Sarah). Memes are common and meaningful forms of digital interactions
Pictographs	Be compatible with emojis on current platforms	Built knowledge about meaning of existing emojis
Chat	Let dyad swap pictograph sets	Support perspective taking and sharing
Chat	Provide prompts for what to say	Unsure how to initiate and maintain conversation
Chat	Allow chat to begin with exchange of pictographs.	Pictographs serve as conversation ice breaker
Chat	In-person version of emotion translator	Real time, face-to-face conversations require more processing than asynchronous, remote interactions. People often misinterpret flat affect as being uninterested or stressed.
Chat	Support for in-person group settings	Harder to process what to say when one-on-one. Social discomfort may increase in groups.
Chat	Support for new social environments	Support adjusting to new social situations
Chat	Chat environment is inclusive and accepting of user behavior (e.g., stimming, eye movements, distracted by things in environment, affect)	Do not want behavior to be misinterpreted or stigmatized

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