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Autism Spectrum Disorders, Empathy, and Communication: Research Draft

Abstract

As technology increases our understanding of Sensory Processing Disorders (SPD) and augments communication across neuro-diverse populations, exciting possibilities for improving the quality of life of people on the Autism Spectrum have begun to emerge. By investigating the neurological differences observed in Autism Spectrum Disorder (ASD) populations, the reader will begin to understand how someone with ASD or SPD experiences reality differently. Using anecdotal evidence, we will examine how sensory processing issues impact a person's ability to communicate, assess the needs of self and others, and exercise self-control to manage anxiety and sensory needs. We will look to occupational therapy practices and social emotional learning resources to explore typical tools for handling sensory processing issues. By understanding existing adaptive strategies and therapies, we provide context for creative engineers to design assistive technologies that enhance communication and empathy to improve quality of life for high-functioning adults on the spectrum.

Keywords

Autism Spectrum Disorder
Sensory Processing Disorder
Sensory Integration Therapy
Neuro-typical/neuro-diverse
Strength-Based Approach

Rigid vs. Fluid Approaches to the Body and Self

Taught to think rigidly about ourselves, injury and healing, need rigid strength and perserverence, but we also need help, have internal and external needs for structure

Have you ever had a long term injury that prevented you from doing something as rigorously as you're used to? I have. Doctors tell you to rest. Physical Therapists tell you to do your exercises unless they are painful. Then, they tell you to rest. Other people tell you to stop eating gluten. Everyone has something to say about what you should do, and they all say something different based on their perception of your body and needs, based on their experiences and beliefs. When you really do need help, you try everything. Maybe you try to keep going. The injury flares up. You rest. You get restless. You try to move again. It feels good, so you try something you could do before the injury. It flares up. So you rest. A lot. For a long time. The pain subsides, but you are miserable. And weak. You finally feel brave enough to try moving, and your injury flares up immediately on something that used to be safe. So what should you do now? Should you rest? Should you push through the pain? It's tricky.

We all need the drive that motivates us to keep going through adversity, even through pain... the one that we see in Nike and Rebok commercials. We also need the drive that motivates us to set boundaries and stop trying so hard when it is hurting us. Sometimes, we need the rigid approach to life: I will make this body do what I want it to do. This drives progress. Other times, we need a softer approach to life: this body can't do that thing right now, and it is ok. In managing injuries or other major obstacles, we must learn to modulate these two ways of thinking. I believe we can learn to reconcile the conflict between the two by adopting a more fluid view of ourselves. We can rethink our understanding of ideal bodies and the rigidity of our standards to allow more flexible goals and methods for reaching them.

In September 2014, Autism advocate Paul Kotler titled a blog post "Teamwork and Independence: We all need supports." I couldn't have said it any better: We all need assistance at one time or another. None of us needs assistance all the time with everything. We are all the best judge of when we need help. Other people may perceive that we need assistance, but get in our way when we are not in a place to accept it. So what does help look like? What does support look like?

What is assistive tech? Cures/therapies vs. adaptive/assistive

In a talk at Eyeo Festival, Sara Hendren distinguishes between a logic of cure/therapy (engineering/science) and a logic of accommodation of difference (art). Hendren illustrates these approaches with the example of prosthetic limbs. When we think about prosthetic technologies, we envision a powerful woman running on prosthetic feet or robot arms that visually and functionally replicate human arms down to the wedding ring on the finger. Hendren provides a contrasting image of a man named Chris who was born with one arm. Chris can accomplish nearly all "normal" daily tasks without

a second arm, so he is not interested in prostheses. It may be tempting for us to create the arm that he never had so that he will fit better into our understanding of happy, healthy human beings, but he finds that prostheses are restrictive more than assistive. That said, Chris would like to be able to rock-climb, so he worked with a team of designers on a removeable prosthetic attachment that he can snap on and snap off that much better suits his needs.

I suggest that these two logics reflect respectively rigid and fluid understandings of the body as it influences and defines identity. Moreover, I suggest that our understanding of help reflects our approach to the body. A body that needs help is considered to be weak, too maleable, in need of support. In this view, help takes a rigid form of extra attention, structure that can be leaned on, pushes and hand-holding. There are absolutely times when this sort of help is appropriate and constructive, but there are also times when this form of assistance is overbearing.

Cultural Shifts Towards Progress: Technology

The past 15 years have seen great cultural shifts, many of which can be traced back to rapid development in technology. With fast, global communication, diagnoses of developmental disorders and their implications are increasingly accurate. In 2009, "the Centers for Disease Control and Prevention (CDC) revised the ASD prevalence estimates from 1 in 150 children to 1 in 110 children… a 600% increase over the past 2 decades and a 57% increase over the past 4 years" (Koenig 1). We have seen a recent eruption in diagnoses of Autism that may be due to a surge in instances or may be the result of an upturn in awareness and communication.

Simultaneously, a move toward holistic approaches to improving lives has seen an explosion of yoga studios, gluten and casein-free diets, and meditation practices. Advances in our scientific understanding of the brain support the view of mind-body connectivity in achieving maximum health and wellness. It is only natural that holistic approaches to treating people with Autism have begun to gain traction and support from occupational therapists and neurologists alike.

With continuing detailed examination of neurological differences observed in people on the spectrum through the use of brain scans, scientists guide the direction of intervention and education practices for Autism. Concurrently, globalization of scientific communities supports collaboration in the study of efficacy of typical and sensory-based interventions. Efforts across fields will steer medical and educational policy, affecting the lives of autistic individuals and their families. Through enhanced communication and awareness, we are already witnessing improved quality of life of individuals with ASD, but the struggle to be respected and understood in neuro-typical settings continues to cause great emotional pain.

The Body as a Medium rather than a Signifier

Supporting a movement toward more holistic approaches to understanding people and their bodies, cognitive and neural science research provides substantial evidence of a link between non-verbal sensations and emotional state. In a study published in 2010, Casasanto and Dijkstra examined the relationship between simple, meaningless motor tasks and emotions. Subjects were asked to recall emotional memories while moving

marbles between upper and lower color-coated bins. When subjects were moving marbles from the upper bin to the lower bin, they were able to recall memories with negative emotions faster than those with positive memories, and, when given emotionally neutral prompts for memories, they were significantly more likely to recall emotionally negative memories. Conversely, when subjects were moving marbles from the lower bin to the upper bin, they were able to recall positive memories more quickly and more likely to recall positive memories in response to neutral prompts (Casasanto). The study suggests a link between arbitrary motor action and human emotion, supporting conjecture that the physical state of a body affects an individual's mental and emotional states. In mainstream media, Amy Cuddy's research on power-posing indicates that spending two minutes in a powerful position raises testosterone levels and lowers cortisol in the brain, enhancing confident functioning in social situations. She has found that the converse is also true (Cuddy).

The view of the physical representation of the human as a multidirectional medium for communication and influence empowers bodies. In rigid understandings of Western tradition, the body is seen as a vehicle for carrying out and representing the intentions of the mind. A happy person communicates emotional state to the outside world through a smile according to the control of the happy mind, which dictates the contraction of facial muscles to produce the appropriate expression. An able body consists of a torso, head, four limbs, ten fingers, and ten toes, which execute actions to serve all desires of the mind. A body that does not meet these criteria, is missing parts or cannot execute any desired tasks, is viewed as disabled. I will finish this argument later, but I think there is something here.

History of Autism: Shift from Rigid Thinking to More Dynamic Approaches

Because autism was initially lumped into the broad category of mental illness, we have little knowledge of the disorder prior to the 20th century. This does not, however, indicate that autism is a new phenomenon. Researchers have been able to piece together biographical accounts that resemble the profile of a person on the Autism spectrum from hundreds of years ago. For example, in a particularly revealing account, Protestant Reformation leader Martin Luther reportedly said an ill boy was "possessed by the devil and had no soul" (Wing 2). In retrospect, the boy appears to have been severely autistic. There is some question regarding the validity of the report, but the suggestion of it is revealing of attitudes and treatment towards individuals with Autism Spectrum Disorders prior to the 20th century: they were considered mentally and emotionally deficient and often sent to live in asylums.

It was in 1908 that Eugene Bleuler, a Swiss psychiatrist studying schizophrenia, first coined the term "autism." Bleuler used the word to refer to a sort of self-obsession, describing "autistic withdrawal of the patient to his fantasies, against which any influence from outside becomes an intolerable disturbance" (Kuhn 1). Only in 1938 was the name autism used in its current context by Austrian pediatrician Hans Asperger in a series of lectures on socially removed adolescents. Soon after, in 1943, American child psychiatrist Leo Kanner again used the term in a modern sense to describe a group of 11 children characterized by "autistic aloneness" and "insistence on sameness." Kanner categorized these children with the label early infantile autism (Lyons 1) and noted their

"attractive, alert, intelligent appearance" in contrast with their difficulty with speech (Wing 4). The following year, Asperger published a paper describing a similar syndrome involving social "inappropriateness," "poor intonation and body language," "poor motor coordination," and "[absorption] in circumscribed interested" (Wing 4). The distinction between Asperger's subjects and Kanner's included older age and stronger speech skills.

The 1940's mark the beginning of the study of Autism as we understand it today, but researchers were not out of the shadows until much later. Following Kanner's original theories, scientists believed that autism had an emotional cause: rigid, perfectionist, cold parents, who became known as "refrigerator mothers" (Wing 5). More rigorous methodology was developed in the social sciences during the 1960's and was imposed on the study of Autism, shattering assumptions about the socioeconomic backgrounds of those affected and proving that parents were not to blame for the condition (Fombonne 1). Careful categorization of autistic characteristics in combination with and independent of other known conditions such as mental retardation shed light on a few facts about Autism: it is a lifelong disorder of brain development, separate from childhood schizophrenia and language disorders, independent of parenting (Fombonne 1).

In the early 1970s, experimental studies demonstrated that children with autism could make progress in social interactions, learning, and managing behaviors with structured learning educational environments designed to "capitalize on their strengths and compensate their deficits…" (Fombonne 2). Therapies and educational practices that followed have been influenced by educational psychologist and occupational therapist A. Jean Ayers' Sensory Integration Theory. According to Ayers, the sensory processing of a person's environment can be used to "explain why individuals behave in particular ways, plan intervention to ameliorate particular difficulties, and predict how behavior will change as a result of intervention" (Ayers 5). Typical SI therapies "use planned, controlled sensory input in accordance with the needs of the child and are characterized by an emphasis on sensory stimulation and active participation of the client and involve client-directed activities… The goals of treatment are to improve sensory modulation related to behavior and attention and to increase abilities for social interactions, academic skills, and independence through better SI" (Pfeiffer 1).

In 1980, "infantile autism" was included in the Diagnostic and Statistical Manual of Mental Disorders (DSM) for the first time, officially separating autism from childhood schizophrenia. In the decades that followed, scientific advances in biology and neurology have completed the portrait of Autism that we hold today: a hereditary spectrum of neurological disorders that include Asperger's syndrome, Kanner autism, and many other specific diagnoses.

Paul Kotler: A Modern Adult Living with Autism

> "For 15 years the only way I had to express my anger or humiliation was through behaviors. I did not have the ability to express the words that were in my head, so I acted out my anger and humiliation. This was not necessarily the best option, but it was the only one I had. When I began to use rapid prompting and then typing, I was able to much more easily express my emotions, but I still to this day have a hard time during confrontational and emotionally charged situations. I revert back to using behaviors and that is not a good thing to do. In order to achieve

> independence, I need to control this and I need to trust in my ability to communicate." (Kotler)

Paul Kotler is an adult living with Autism. His sensory processing issues, particularly his difficulties with motor planning and execution, prevent him from speaking. This is not for any lack of intelligent thought, but the result of inhibited communication. It is a struggle for Paul to make the right mouth shapes and control his breath in a coordinated way to produce spoken words. Likewise, it is a struggle for Paul to smoothly transfer his weight from one foot to the other to produce a walking motion, or to filter out unnecessary sounds so that he may focus on a teacher's voice in school, or to ignore physical discomfort due to temperature or itchy clothing in order to sit still for prolonged periods of time.

Paul's battles are similar to those of many who have been diagnosed with Autism Spectrum Disorders, and like those many others, Paul's future once looked bleak. Without the ability to engage with verbal language, an individual's personal, professional, and educational prospects are slim. Just a few years ago, however, Paul began a training methodology called rapid prompting, which helps non-verbal people learn to communicate through pointing to letters and words in response to questions, and eventually learned to type. Since then, Paul has been able to communicate and connect with other people in newly fulfilling ways. Through a blog, public speaking, and participation as a judge for AT&T's Connect Ability Challenge, Paul has become an advocate for people on the spectrum, attempting to raise awareness and build empathy for those living with disabilities like his own.

In spite of the difficulty his sensory processing issues add to an already challenging exploit, Paul is a student at Delaware County Community College. Traditional colleges have not been available to many people on the spectrum, but Paul is combining his perseverance and typing abilities to be able to attend. In a blog post from September 10, 2014, Paul describes his efforts to manage his needs and behaviors to fit into a neuro-typical learning setting. Paul covers the expected environmental obstacles, such as "very little noise absorption and fluorescent lighting that buzzes and flashes," along with the effort to control his responses to these sensory inputs, needing to "make some noises… [or] odd actions" or take breaks. But most heartbreakingly, Paul describes the humiliation and embarrassment of "[being] observed by administrators from the office of disability to determine whether or not [he] could 'behave' appropriately in a class... and [having] individuals question [his] communication assistants as to whether or not [he] was really doing [his] own work…" (Kotler). Of the many challenges he describes in this and other posts on his blog, Paul articulates most profoundly the frustration of being misunderstood, mislabeled, and dismissed.

Hindered Communication and Autism

When we deal with hindered communication across barriers, we often consider cultural differences, which result from learned meanings associated with particular gestures or words. For example, a thumbs-up is used to indicate a job well done or an agreement in the United States, but in Russia and other countries, it is equivalent to the aggressive middle finger. Differences in meanings associated with particular symbols is

certainly a setback in communication, but cultural differences in values that shape the way an individual interprets the world around them can play a more significant role. For example, an African-American in the United States, who speaks the same language as a Caucasian person and grew up in the same city, may have a completely different understanding of the police force, caused by a lifetime of contrasting experiences, racial stereotypes, and socioeconomic class dynamics. In this instance, it can be argued that reality as the two individuals in question have been conditioned to experience it is different, and communicating across different hidden assumptions about reality can be nearly impossible. Despite massive efforts between these two people to communicate, a white person cannot understand the emotional impact of watching an uncle get violently arrested for a trivial offense of the law at a young age.

When we think about communication difficulties for non-verbal people, we tend to assume a lack of comprehension of words or an inability to say them, comparable to a simple breakdown of symbolic language. While both of these, more likely the latter, can contribute to difficulties in communication for people on the spectrum, there is a deeper root from which miscommunication stems. In our current paradigm, the differences between a neuro-typical person and a person with an Autism Spectrum Disorder are caused by structural differences in the brain, many of which appear to be related to sensory processing and integration. As Ayers explains, "Sensory Integration is the organization of sensations for use. Our senses give us information about the physical conditions of our body and the environment around us...The brain must organize all of our sensations if a person is to move and learn and behave in a productive manner" (Ayers 5).

A person who organizes and interprets sensory information differently experiences reality differently. Beginning from infancy, a person's perception of reality is determined by the changing state of his/her body. Interactions between an infant and mother help build cause and effect relationships that serve as rules for perceiving the outside world (Bloch 76). Not only is it the case that a person who experiences sensory stimuli differently develops a different understanding of reality, but a person who has experiences sensory input differently from infancy has developed a different framework for understanding sensory information.

While neural scientists are in the early stages of learning about differences in sensory processing, the effects of these differences on communication and social interaction appear to be significant and pervasive. Evidence suggests that, "Over 96% of children with ASD report hyper and hypo-sensitivities in multiple domains… and while sensory hyper- and hypo-responsiveness are not unique to ASD, they appear to be more prevalent in this population than in other developmental disabilities" (Marco 1).

So how might these sensory processing issues present themselves? A rather poignant example is presented by Nadel in her book on imitation and social development of children with Autism. A group of children, some with ASD diagnoses and some without, are seated one at a time at a table with their hands beneath the table's surface. In front of them, an image of moving hands is projected onto a screen. The projected hands imitate the movements of the child's hands, and researchers observe the child's behavioral responses. Many children, on and off the spectrum, stop moving their hands, which researchers interpret as an indication of recognition that "those are not my hands." Subsequently, many children recognize that their hands are being imitated and test the

imitator with complex hand movements. A handful of children with Autism, however, are unable to recognize that they are being imitated and develop a strategy of leaning down to look at their own hands to compare them visually to the hands being projected.

Nadel cites this experiment as evidence that "the intermodal relationship between visual and proprioceptive feedback has not been attained, and because of this, the recognition of imitation cannot be demonstrated" (Nadel 155). This experiment presents a situation in which a child would need to rely on information from more than one sensory channel to observe and comprehend the cause and effect relationships in his/her immediate environment, but the inability to integrate this sensory information prevents the child from understanding how his/her "actions have an effect on the environment and on other people" (Nadel 154-155). In this instance, a child's ineffective sensory integration prevents a dialogue between imitator and imitatee, which is essential to the process of learning to communicate. Furthermore, the inability to recognize cause and effect relationships in this instance undermines the recognition of a need for building communication. If a person's actions have no predictable effect on his or her environment, what would be the advantage of communicating?

This study provides an example of hindered communication at the multisensory integration level, but different sensory processing issues present challenges for an autistic person interacting with his or her environment at every step of the process.

Sensory Processing Differences

As I mentioned in the introduction, Paul Kotler, like many other people on the Autism Spectrum, is easily distracted, even pained, by seemingly benign sounds like buzzing fluorescent lights. Paul writes an entire blog post about the difficulty he has with public speaking because he hears and processes every word whispered in the audience while he is talking. Sensory processing issues are assessed by occupational therapists according to outward behaviors. Therapists observe sensory modulation issues, including both hypo-responsiveness and hyper-responsiveness to stimuli, as gauged by outward reactions. Hypo-responsiveness to particular stimuli may result in sensory seeking behaviors, such as non-functional repetitive movements or deep touches. Hyper-responsiveness could present as outward expressions of anxiety and frustration to itchy tags or buzzing lights. Other sensory processing issues that might be recognized are sensory discrimination disorders, marked by difficulty organizing and accurately interpreting sensory information, and sensory-based motor disorders, which can involve difficulty balancing or difficulty planning and executing movements. Though medical professionals may be able to detect sensory processing issues given an individual's behavior, neural scientist are just now beginning to understand the underlying structural and functional brain differences that cause individuals on the autism spectrum to react to stimuli differently. Research is geared toward understanding the nature of brain differences and how they affect "normal" human interactions like conversation. It is natural that scientists would begin to investigate engagement with language in the auditory processing modality.

In a review of current research, Marco and co-authors explain that, "Understanding the nature of [transmission of auditory input to the brainstem] is crucial because the ability to acquire and parse a variety of incoming sounds forms the foundation for language and communication" (Marco 1). Marco goes on to explain the

work of scientists who are making significant headway in the study of auditory processing differences of those with Autism. For the most part, they seem to observe greater than average latencies in processing of basic sounds, which increase with higher complexity, suggesting an over-recruitment of certain parts of the brain at low level processing. In other words, the parts of the brain that initially break down sounds as they are registered in the brain are working too hard, slowing down the transmission of the signal to the brainstem.

Continuing research on auditory processing aims to explain differences in the brains of non-verbal people with autism and those on the spectrum with little difficulty speaking. Beyond determining an individual's ability to engage with language, auditory processing has broad implications in social and learning environments. Marco suggests the likelihood, "that the atypical processing is related to the unusual behavioral responses so commonly observed in children on the autism spectrum such as covering of the ears to seemingly benign sounds such as the vacuum cleaner and the blender. Furthermore, one might conjecture that if the auditory input is perceived as unpleasant or noxious, affected individuals will learn to avoid auditory input, and thus curtail the learning that comes from listening to the people and world around them" (Marco 2).

Differences in visual processing are also believed to affect social and emotional engagement. Perhaps the most obvious application of visual processing to human social interaction is that of facial expressions, the subject of intense investigation in developmental neural sciences. Current evidence suggests differences between ASD control populations in ability to integrate and interpret more than one facial cue. For example, averted gaze in combination with a particular mouth shape and forehead shape can communicate a clearer message than any of the visual cues independently. Autistic individuals have been shown to read a combination of cues less accurately than a control group, and evidence suggests decreased activation in the fusiform gyrus and other parts of the brain responsible for proper interpretation of facial features (Golarai 1). Marco and colleagues further explain that "the type of visual information matters; children with autism may respond more robustly than controls to neutral and detailed, high-spatial frequency information and less robustly to the rapid low-frequency processing that is so critical to our fast-paced social world" (Marco 2). Not only is there a difference in the ability of the autistic brain to integrate different facial cues, but there are differences in the ability to engage with and process different types of visual information.

Visual processing is also required to interpret intentionality of human movement and communicative gestures. Marco explains, "that children with autism show impairments in the processing of dynamic noise, motion coherence, and form-from-motion detection" (Marco 2). In an experiment, Golarai and researchers tested the ability of people with and without ASD to recognize and name motions from point-light displays, finding no difference in ability to recognize everyday objects, but impairment in ability to recognize emotional movements. According to Marco, "this finding suggests a potential disconnection from the limbic or "emotion" neural networks that inform primary sensory processing" (Marco 2). "Taken as a whole, these studies further support a disruption in the processing of basic unimodal sensory information that forms the backbone of higher order cortical abilities such as socialization" (Marco 2).

In addition to processing differences in individual senses, the integration of information from multiple sensory modalities appears to be impaired. For example, an

illusion called the “flash-beep” illusion uses a single flash timed with two beeps to create the illusion of two flashes in neuro-typical populations. When administered in the classic way, the “flash-beep” illusion is perceived the same in ASD populations, but if “the timing between stimulus sets are perturbed during presentation… disparity between the auditory and visual stimulus onset times will impact the effect of the illusion, until they appear uncoupled at a certain threshold…” (Marco 3). The illusion is upheld for ASD populations with longer time intervals between stimuli than for control groups, suggesting “a level of inefficiency in the Multi-Sensory Integration in this population” (Marco 3).

Extending the illusion to the higher-order processing of language, experimenters uncoupled the timing of auditory and visual speech stimuli. When presented with the uncoordinated stimuli, autistic individuals at less capable of demonstrating language comprehension. Morever, where neuro-typical individuals are able to rely on lip-reading to fill in missed information in noisy environments, autistic individuals simply miss the information, demonstrating an “inability to “fall back” on certain sets of sensory stimuli in the presence of challenging environmental stimuli [which] may contribute to the communication deficits that are well-characterized in this disorder” (Marco 3).

Beyond the processing of individual sensory inputs and the connections between different sensory modalities, an individual must quickly and non-consciously determine which sensory information must be attended to. Marco and colleagues “suggest that this multidirectional flow of information is impaired for individuals with ASD and that this disruption in cortical communication underlies the individual's inability to attend to their environment in a flexible, productive, and meaningful way” (Marco 5). Two aspects of selective attention are the focus of current research: switching attention between different types of sensory stimuli and prioritizing particular stimuli in the face of increased sensory inputs (producing sustained attention).

Marco’s research group cites studies that observe brain activity during attention shifting that “correlate with a behavioral measure of intolerance to change,” supporting theories that in ASD populations, “local processing networks are over-connected at the expense of long-range connections with integration and attention networks” (Marco 6). They also reference studies of selective attention. Evidence suggests that all people have a threshold of information to which they can attend. With a wealth of information coming from the environment at any given time, we must focus on only certain information, suppressing or ignoring the other information in order to functionally engage with our surroundings. Autistic people have been shown to “rely more heavily on already overloaded attention and working-memory based networks, such that when the stimuli reach and exceed capacity, the processing system fails” (Marco 6).

With the cultural shift toward holistic approaches to health and wellness, practitioners and scholars of education are investigating social and emotional learning as they prepare students for career and personal success as adults. Collaborative for Academic, Social, and Emotional Learning (CASEL) has outlined 5 social and emotional competencies: the ability to recognize emotions and their effect on behaviors, manage emotions and impulses, develop caring and concern for others, establish positive relationships, and make responsible decisions (CASEL). It is straightforward to deduce how these competencies are inhibited by sensory processing issues. If one experiences difficulty discriminating between sensory inputs, heightened anxiety in response to

unpleasant stimuli, trouble prioritizing important sensory information over irrelevant signals, and increased distress over shifting attention, maintaining a conversation with another person is difficult.

Let's analyze the situation of a person with Autism melting down in response to sensory overload. A neuro-typical response might be to ask what is wrong? It might be to lightly touch the person's shoulder to express compassion. It might be to ask the person how we can help. None of these approaches are likely to be effective in calming the person down. Perhaps they reflect the wrong reasons for wanting to calm the person done. Is this to help the person or to help us feel more comfortable? Other approaches that might be more helpful are both more fluid and more rigid, but reflect a more flexible interpretation of behaviors and needs. A person on the Autistic spectrum is likely to experience discomfort with light touches and unlikely to be able to identify or communicate needs in moments of heightened arousal. Instead, we might darken, quiet, and minimize our presence in the room, removing distracting sensory stimuli and giving the person space to calm down on their own terms. In this approach, we provide assistance by empowering the individual to care for themselves. Alternatively, we might provide a strong, grounding sensory input, maybe a firm pressure to help the person's brain organize and prioritize sensory processing. In this instance, we provide assistance in the form of structure to press against and orient oneself in the murky space of the social world.

These approaches of intervention for Autism Spectrum Disorders reflect the two most fluid schools of thought in education and occupational therapy. The first provides tools to solidify the changing, elusive landscape of social interactions and space for individuals to manage their own needs. The second uses the body to access the mind, and has gained support in cognitive psychology and neuroscience research like Amy Cuddy's work on power posing. Sensory integration therapy and yoga practices are holistic approaches to understanding mind/body/person, and recent research suggests that they are effective in reducing maladaptive behaviors for people on the Autism Spectrum.

Forms of interventions: improve functioning vs. improve function within context of social landscape that is fluid (changing elusive boundaries)

Cures and Therapies: Improving Functioning

Fluid View of the Body in ASD Therapies

Since Ayers initially postulated her Sensory Integration Theory in the 1970's, therapists have attempted to design interventions to promote the integration of sensory inputs in individuals with sensory processing issues and Autism Spectrum Disorders. Intensive treatment programs, for instance, guided by the Lovaas Model of Applied Behavior Analysis dictate 40 hours of therapy weekly for young children on the spectrum. Another rigorous method called the Wilbarger Brushing Protocol requires 10 minutes of sensory stimulation from brushing every 2 hours. Parents spend thousands of dollars and countless hours on regular sessions with therapists and sensory devices every year, but there is disagreement regarding the efficacy of these treatments.

Pfeiffer and colleagues addressed the discord among occupational therapists regarding SI therapies in a recent double blind-study. Autistic children ages 6-12 were

randomly assigned a course of either traditional table-top occupational therapy or Sensory Integration therapy. Participants were tested before and after the course of treatment for "social responsiveness, sensory processing, functional motor skills, and social–emotional factors" according to various models of assessment. Significant progress in these areas was observed in both groups, but "more significant changes occurred in the SI group, and a significant decrease in autistic mannerisms occurred in the SI group" (Pfeiffer 2). Though evidence does not yet support increased neurological functioning, the research group highlights a noticeable reduction in maladaptive behaviors such as "stereotypic motor movements, aimless running, aggression, and self-injurious behaviors" (Pfeiffer 4). Furthermore, teachers who had no awareness of the students' group assignments were able to correctly guess which students were in the SI group based on their progress. Though it is a pilot study, the work of Pfeiffer and her team support the effectiveness of Sensory Integration therapeutic techniques for people with ASD, and future studies in the field will continue to identify the most successful practices and guide the design of assistive and therapeutic devices.

Noting cultural shifts toward alternative medicine and meditation in mainstream culture and a concurrent trend in occupational therapy, Koenig and her team composed a 16-week study of daily yoga practice designed specifically for children with ASD. Regarded as a mind-body intervention, yoga requires a student to respond to visual and auditory cues, imitate movements and positions of another person's body, use proprioceptive and equilibrioceptive sensory information to find accurate body placement, and maintain breath and focus by managing anxiety, effort, and even pain. Few other activities require quite the same level of sensory integration and mind-body awareness, so it is natural that many education programs for people with ASD have adopted yoga. In Koenig's study, students were randomly assigned to either a group that began each day with an unchanging yoga routine or a group that began each day with typical morning classroom rituals. Koenig found that, "the intervention group showed a reduction in behaviors that were identified as maladaptive by teachers, including irritability, lethargy, social withdrawal, hyperactivity, and noncompliance" (Koenig 6). Though the findings are not adequate to assert that yoga improves sensory integration at a neurological level, it is clear that the regular practice of yoga can have an overall positive effect on the functioning of people with ASD.

Adaptive/Assistive: Improving Functioning in Context

Methods that solidify confusing landscapes: 5 point scales, IEPs, rapid prompting, IT firm, simulation videos, build bridge/interface for communication and interaction

In addition to therapies aimed at improving sensory integration and social functioning, teachers and therapists create tools to aid people with autism in managing their behavior. Dunn Buron provides an example of this approach with her 5-point scale, a tool for monitoring mental and emotional states in response to sensory stimuli. The 5-point scale quantifies levels of stress and provides strategies for both caretakers and individuals themselves to avoid meltdowns. Dunn Buron explains, "Emotional regulation can be defined as the ability to separate your emotional responses to a problem from the thinking you must perform to resolve the problem." (Dunn Buron 1). The 5-point scale helps "to organize a person's thinking when working through difficult moments… [It]

can be considered a strength-based approach since most individuals with autism tend to learn most effectively through concrete, predictable systems" (Dunn Buron 2).

To create a useable 5-point scale, a person should identify a challenge area, like getting along with classmates in school. Then, he or she should create a scale that "breaks down stress into the following 5 parts: 5 = This could make me lose control. 4 = This can really upset me. 3 = This can make me nervous. 2 = This sometimes bothers me. 1 = This never bothers me" (Dunn Buron 2). For each level on the scale, the person should identify a set of factors that could drive him/her to this level, along with a list of indicators (physical sensations, behaviors, urges) and strategies for calming down. For example, level 3 on a scale for getting along with classmates might detail boys talking loudly or chairs scraping across floors as driving factors, saying shut up quietly to oneself as an indicator, and talking to the teacher as a strategy to avoid an escalation of anxiety.

Quantifying complex emotional systems can help a person with Autism to maintain perspective and control reactions to stimuli. Techniques that digest multifaceted situations serve as valuable tools for learning and practicing social and emotional skills that do not come naturally to people on the spectrum. The quantification approach is also the basis for Individualized Education Plans for people with Autism, in which goals are set and progress is tracked by counting instances of successful social interactions as well as reductions in maladaptive behaviors (Social Emotional Learning). Though useful in a special needs education environment or at home, worksheets may not be the best tool for managing one's behavior in a neuro-typical setting. Perhaps more discrete assistive technologies can capitalize on the methodology of these traditional tools. Efforts should be made to bring them into the 21st century by integrating the approach into a contemporary mind-body work flow.

Technology-Based Interventions

Prior to the 21st century, devices designed to assist people on the spectrum enhance the visual contrast between autistic and neuro-typical individuals, extending Autism's intrinsic barriers to communication and empathy. Sensory gyms, the setting of most Sensory Integration therapy, are filled with bright, primary colors and large geometric shapes. While the visual stimulation and organization may are appealing and engaging to young children, teenagers who wish to engage in sensory experiences of this sort are left without age-appropriate alternatives. When special needs education facilities cater to this aesthetic, teenage students on the spectrum who are associated with these facilities are viewed as mentally incapable by their neuro-typical peers. Stereotypes involving mental retardation are reinforced. Empathy and communication are undermined. Current personal devices carry a social stigma as well. Weighted vests, sensory stress balls, and other calming sensory stimuli are obvious. They tend to reflect either a child-like aesthetic– bright colors, smiley faces, porcupine tendrils– or a dry medical appearance – sterile lines of black and white with red accents. A recently developed adjustable weighted vest (Vayu Vest) marks progress in the direction of discrete, user-centered solutions, but adjustments require the attachment of a pump, which is difficult in the middle of class or a birthday party. There is a hole in the landscape of available projects where fresh, attractive, grown-up behavioral management adaptive devices should be.

We are living in the midst of a global shift in technology and lifestyles. With the explosion of social media and mobile devices, global communication and connectivity have never been more accessible. Frustration with screen-based interfaces is driving the development of computer vision, gesture recognition, and wearable devices. Improvements in neural mapping techniques are pushing progress in our understanding of the brain-body system as our interface with the rest of the world. Disillusionment with the so-called "American Dream" is driving an overhaul of assumptions about happiness, career, government and finances, propelling technology-based disruptions of traditional systems in American society. The results of these cultural shifts are gradually making their way into the development of new, progressive assistive technologies.

As we observed in the case of Paul Kotler, the mobility and accessibility of new typing systems, especially used with a TalkBack feature, have given a voice to a previously non-verbal individual. Picture-based interfaces for communicating feelings and needs make communication for nonverbal individuals, especially children, far simpler. Torii and researchers developed a system called Lets Talk! to "help users to communicate by selecting images and sounds from the program. They tested the system's efficacy with the help of an Autistic 9-year-old boy, whose "bad behavior improved as he learned to express his thoughts and interests appropriately with the application" (Aresti-Bartolome 2). This report is consistent with reflections of Kotler in his blog, where he shares that typing has made it possible for him to express feelings of frustration or displeasure that he could previously only express by "acting out" (Kotler). Not only has typing technology given Kotler a medium for clear, productive expression in daily situations, the internet has given Paul a platform for reaching neuro-typical populations with his perspective. For the first time, Paul is able to communicate his experiences of reality to people who cannot otherwise understand.

In the vein of therapeutic interventions that view the body holistically, social robots are an exciting innovation in the care of people with ASD. Various models of robots that are capable of gestures, facial expressions, and even verbal communication have been used to encourage social engagement and learning in adolescents with Autism Spectrum Disorders. Advanced models of the robots use cameras and computer vision algorithms to read and respond dynamically to the physical expressions, particularly head movements, of users. In a study by Goodrich and collaborators, "researchers analyzed children's behavior with the robot, including language, gestures, eye contact, imitation and demonstrations of affection... [to find] that the children were very motivated to interact with the robot" and more likely to interact with clinicians after than before the treatment (Aresti-Bartolome 5). In a movement and imitation focused study, Srinivasan and researchers worked with 15 neuro-typical children and children with ASD/ADHD for 8 practice and 8 test sessions, in which they evaluated the children's ability to imitate a robot doing karate and dance movements. They determined that the "participants made fewer errors during the test than during the practice session, thus improving imitation-specific tasks" (Aresti-Bartolome 5). This research suggests that the use of social robots is a promising therapeutic avenue for children with Autism Spectrum Disorders to practice social skills and imitating peers, which can improve motor functioning and communication.

Another therapeutic approach that uses the body and physical expression in combination with technology is that of virtual reality and Kinect games, which are used

to provide consequence-free environments for practicing social interactions and movements. Virtual reality technology "makes it possible to create avatars or more real looking characters to enable participants with autism to work on facial expressions and emotions and recognize them while also creating controlled environments to make them feel safe" (Aresti-Bartolome 3). Mitchell and scientists used this technology to create a virtual coffee shop. They showed 6 adolescents with ASD "3 sets of videos of real situations taking place in coffee shops and cafés followed by the virtual environment" (Aresti-Bartolome 3). Participants reported where they chose to sit in the environment and why to 10 evaluators. Participants interacted with the virtual environment for different amounts of time, though they all saw the same videos. Researchers noted "significant improvement, directly related to the time spent in the virtual world when deciding and explaining where they chose to sit" (Aresti-Bartolome 3). In a study of virtual reality in combination with Kinect, Herrera's research group "developed a set of educational games in which children did exercise (using their bodies as the control mechanism) and which also made them more aware of their own bodies" (Arest-Bartolome 3). With increased knowledge of the physical self, people are more able to embody thoughts and feelings to interact with their environments in more effective, meaningful ways. Recall Nadel's study, in which ASD participants were not able to recognize their own hand gestures when they could not see their hands. Improved proprioceptive awareness could lead to more integrated, fluent communications. These virtual reality and Kinect interventions are geared to help adolescents with ASD develop fluency in languages of physical expression. They enable users to practice interpreting and enacting facial and gestural cues in complex social landscapes, preparing users to communicate more successfully in everyday life.

Technological solutions that aim to solidify slippery social concepts and support the use of verbal language in communication are also emerging. In 2008, Grynszpan developed 3 games using "subtitled dialogues that expressed irony, sarcasm and metaphors, in addition to faces showing emotions" to work on communication and interpretation of language in ASD populations. 10 participants with ASD and 10 without were required to correctly interpret and appropriately respond to the visual/verbal prompts over the course of 13 weeks. The researchers found that "the adolescents with ASD performed poorly on rich multimedia interfaces because they lacked initiative when organizing the information given in the multimodal sources" (Aresti-Bartolome 4). Perhaps, future efforts could involve a progression from unimodal media to multimodal media in an effort to train social engagement. Another application that aims to teach social and emotional skills called LOLA App is in the early stages of development. At this point, LOLA uses humorous gifs to reinforce successful completion of daily tasks. A feature article on the App explains, "the user sets a certain number of challenges per week, and receives a push notification at a specified time—if the child completes the task they receive a virtual gold star, and if they don't they see a gif of a crying face with the phrase 'LOLA is sad'" (Bonazzo 3). Efficacy of this type of app has yet to be studied, but developers hope that it will help users by holding them accountable for daily tasks that create the interface through which they interact with the external world.

While each of these applications of technology to working with ASD populations is promising, they still tend to address the individual from a rigid perspective of ideal humans, providing therapies to help ASD populations "improve" functioning and behave

"better" in neurotypical settings. Solutions that take a more adaptive approach also tend to require obvious efforts in order to make adjustments to better suit the moment-to-moment needs of individuals. I suggest we make efforts to reduce the stigma of "Disability" associated with assistive technologies by creating age-appropriate solutions in consultation with affected populations that can be smoothly and easily adjusted according to changing needs. Highly responsive solutions that gauge and provide the assistance that an individual needs in real time would be optimal.

Blurring Boundaries Between Art and Design

As a creator with a background in both art and science, I have found myself torn between a project that falls into the realms of art or engineering, but this rigid adherence to academic structure may be limiting. In the lineage of Lygia Clark, Sara Hendren points out the potential for assistive technology to live somewhere in between between disciplines, affecting change both locally and globally. Her redesign of the universal accessibility symbol serves as an excellent example of this approach. Hendren highlights the rectilinear nature of the current accessibility signifier, which I believe demonstrates the "Disability" stigma discussed above. Hendren's new design contrasts the old way of thinking about ability using curvilinear and diagonal forms, as well as an active gestural arm and action lines indicating movement, to portray the mobility of the wheel-chair supported body rather than a stagnant body that is wheel-chair bound. This is the design: creating an aesthetic that communicates a chosen intention. Extending the scope of the project, Hendren's new symbol is printed on translucent stickers that can be applied over existing signs, confronting outdated, constrictive ideas about able bodies in a public space. This is the art: using media to push boundaries and affect the public to question assumptions and ideals. I am interested in emulating this interdisciplinary approach in my project, and I will look to art practices for continued inspiration.

I suggest that we look to dance as a means of tying together the threads of empowered, holistic bodies and support for social and emotional adaptive functioning. Considering recent evidence for auditory rhythmic cueing as a means for improving motor functioning in ASD populations (Hardy) and the emotional expression inherent in the form, I suggest more rigorous research into dance as a form of therapy for autistic individuals. Depending on the style of dance, it is possible to integrate rhythmic auditory cueing, intentional coordinating between vestibular, visual, and proprioceptive feedback, emotional expression, mental focus and memory, and connection/communication through imitation and spatial negotiation into a single movement exercise. With sensory integration therapy techniques in mind, it may be possible to design a cohesive dance experience with all of these elements in addition to strong touches or smells as reinforcement. Perhaps integrating emotional experiences and management into Sensory Integration therapy would reveal new, unforeseen avenues for progress.

Becoming more specific, contact improvisation can serve as a model of the responsive nature of the technologies I am proposing. It relies on the masterful balance of weight between two bodies to create stability and communication as the balance shifts in different directions to create fluid movement.

Emerging Project Threads

Most importantly, assistive technology should be responsive. It needs to reflect an understanding of changing needs. When does a person need structure and when do they need space? I will look to contact improvisation for inspiration as a model of highly effective negotiation of space, needs, and support, achieved through the particalization of the body. What if assistive technology could emulate this modulation and sensitivity? I will also look to projects like Sara Hendren's redesign of the accessibility symbol as both art and engineering. It is possible for a functional project to serve an artistic purpose of prompting thought and reflection. What if my project could address fluid vs. rigid forms of assistance, as well as a social softening of ideals about bodies?

In the process of all of this thinking and reflecting, I was prompted to revisit my initial inspiration cards, and was pleasantly surprised to find that a lot of ideas that had been filtered out of my topic had re-emerged, primarily, particlization, interconnectedness/oneness, mathematical structures/patterns, probabilistic models, dirt/sand/mud, water, contact improvisation, and humility/arrogance/confidence.

These are the threads that keep coming up throughout the process. I keep thinking about particles within fluids and changes in organization that lead to firm structures. I keep thinking about the necessity of relaxing ideals about bodies and identities, the necessity of humility for empathy. I keep noticing the positive changes that come with a holistic view of the body: the body is not just the outward representation of the mind; sensory processing tells us that information travels in two directions. I want to use the body as a multi-directional medium for this project. The actions of one body impact the physical, mental, and emotional states of both the doer and his/her surroundings. So what if I could make one thing that impacts both a user and observers by responsively providing different forms of structure?

Here is what I want to do: I will make a wearable device that transforms the initiation of a repetitive movement, for now handflapping, into and socially clear gestural communication, simulataneously delivering strong, calming sensory stimulation. I have considered that this could seem repressive or manipulative, but anyone wearing the device has opted in because they have expressed frustration with the resulting alienation of repetitive movement behaviors in a neurotypical setting. I think the movements should draw inspiration from power posing, which means they will be rather animated expressions, which may seem like hyperbole in comparison with the typical movements of others. This is a statement against social repression and judgement of physical expression of the body, as well as a potential statement to help rethink Autism and the bodies of those on the spectrum. The idea is that the communication will be improved, and people on the outside will be prompted to examine their own assumptions about Autism, ability, and expressive bodies. These goals are lofty. This vision involves doing a lot of things at the same time. I am fully prepared to reign in the scope of my project or pivot again, but this is where I want to begin my ideation proce

Prototyping

For my first prototype, I am focusing on using the body as a medium for nonverbal communication. I am interested in finding movements and poses that express clearly emotions that might be difficult to express with words. Beyond expressing the

feeling, I am interested in transforming the feeling by transforming body language, a la Amy Cuddy. The use of the body as a means of delivering a message calls into question how we conceptualize the physical representation of ourselves. Is the mind a disembodied control center that the body obeys in order to interact with the outside world? Or can we develop a view that is more holistic?

To approach this, I scoured blogs, videos, and online forums in search of moments when a functioning adult on the spectrum might fall into repetitive movement patterns. I paid special attention to emotions that people were feeling that initiated the repetitive movements and how people felt about this form of expression. One of the most common repetitive movements associated with ASD is hand-flapping, so I chose to focus on this.

I found that adults did still experience repetitive movements in moments of high emotional/sensory stimulation, for both positive and negative reasons. Hand-flapping was cited as an expression of excitement, nervousness, feeling upset, feeling overwhelmed, feeling agitated, or feeling ecstatic. As I expected, I found a range of feelings about this coping mechanism. Many parents of Autistic children felt that hand-flapping should not be stifled. It is an expression of how an individual is feeling when they are unable to verbalize their emotions, and it should not only be allowed, but it should be celebrated. There is scientific evidence of a drop in the stress hormone cortisol as a result of hand-flapping. I understand this perspective, and I tend to agree, but I also found people who felt socially alienated by hand-flapping. The counter-argument is that society should change, not people with Autism. Maybe there is a place where the two perspectives can meet. Maybe we can create a fluid structure to push up against that counteracts repetitive movement, providing a soothing sensory input, and translating the movement into something cohesive with a neurotypical environment. Or hyper-expressive according to neuro-typical ideals, almost as a form of protest. (Liftware and assymmetrical linear resonance actuators are reasons that I think this might be possible.

To prototype this, I explored the six emotions most likely to be expressed by hand-flapping. I tried to find gestures that could express these emotions that would be initiated with the same muscles as hand-flapping. In cases that felt more clear to me, I tried to echo hand-flapping with the gesture in a more specific way. I also considered the power level of poses within movement sequences. For example, when I tried to express nervousness, I found myself making small, closed off, protective gestures, which tend to amplify feelings of nervousness. I thought it might be best to express the nervousness and transform it into a more powerful expression.

Next steps for prototyping this thread are likely to involve getting user feedback on the expressions that I recorded, as well as asking other people to create their own gestures. Then, I'll ask people to try some of the top gestures. If this does go in the direction of sensing and transforming physical expression through wearable tech, I would probably need to focus on one to two emotions.

Other threads will include: structures that can become fluid or rigid depending on organization, wearable devices on the body, transforming movement with technology.

Conclusion

Our understanding of Autism has evolved considerably since it was first postulated in the 1940's. Developments in the neural sciences have just begun to clarify misconceptions and assumptions about a historically misunderstood developmental disorder that inhibits the communicative abilities of those affected by it. As our understanding of sensory perception and interfacing with the mind through the body continue to expand, we can develop therapies and assistive technologies that enhance the quality of life and progress of individuals diagnosed with Autism Spectrum Disorders.

As technology opens up traditionally closed avenues for communication and interdisciplinary study, we can develop new tools for managing anxiety, augmenting adaptive strategies, and improving empathy and communication across neuro-diverse populations to improve the quality of life of those on the spectrum. In this paper, we examine current assistive technologies for ASD to guide our efforts to address communication and empathy. How can we alleviate the frustration of being misunderstood?

Efforts to utilize technology to improve the quality of life of individuals with Autism have taken the forms of both therapeutic technologies and behavioral management technologies. Current research to understand mental impulses could guide technology that assists a user in communicating mental and emotional states or intentions. Developments in haptic wearable devices could provide calming sensory stimulation in more discrete ways with grown-up appeal.

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