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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

Introduction: Our Evolving Understanding of Autism and Sensory Perception

> "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.

History of Autism

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.

Autism Today

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.

Hindered Communication and ASD

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.

Social Differences and Their Neurological Roots

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.

Imagine you are a high-functioning autistic adult on a dinner date with each of the sensory processing issues mentioned above. Suppose the restaurant is loud: you cannot distinguish between the sounds of your date's voice and the conversation going on at the table next to you, nor can you augment your listening with lip-reading. Suppose it is December and you are seated near the entrance/exit of a restaurant: you cannot ignore your discomfort at the wave of cold air that hits you every time the door opens and closes. Suppose your date makes a sarcastic joke about preferring an activity over his/her job: you cannot distinguish the sarcasm by the person's gaze or expression, and you detail all of the reason's the person's job is irrelevant and unpleasant. Suppose your date asks you about your job: you begin a 45-minute monologue detailing the specific challenges of each task in a given day. Your date shifts focus around the room and makes a bored or annoyed face, but you do not notice or piece this information together, and when your date tries to change the subject, you become visibly agitated by the change. Suppose your date asks you to pass the salt: you oblige to the simple, direct social cue, but your hand goes just an inch past where you intended to place it, knocking your date's glass of wine onto his/her plate of food. Frustrated by the situation, your tone of voice becomes perturbed and your movements become frantic until your date becomes so uncomfortable that he/she excuses him/herself and leaves. You express anger at the date for leaving. You are not surprised, but you don't know exactly why this has happened.

Your experience of reality has prevented you from recognize your emotions and their effect on behavior, managing thoughts and impulses, and engaging with this new person in a way that demonstrates caring and concern for others, establishes a positive relationship, and enables you to make responsible decisions to maintain the relationship. So what do you do? What are the tools that will help you grow toward a more positive dating experience in the future? Therapists have developed a range of methods to help people on the autism spectrum lead more fulfilling, independent lives. Current interventions are designed to train the brain to integrate sensory inputs, prepare the brain and body for challenging activities to help with behavioral management, and build learnable social skills by decoding complex messages from the self and others consciously.

Holistic and Sensory Integration 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.

I suggest that we look to other disciplines that require mind-body connectivity to accomplish goals as comparable interventions. 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.

Behavioral Management Approaches

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 and the Future of ASD

Extending Autism's intrinsic barriers to communication and empathy, devices designed to assist people on the spectrum enhance the visual contrast between autistic and neuro-typical individuals. 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 be 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. 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 typing, especially used with a voicebox, have given a voice to a previously non-verbal individual. As technology for artificial speech improves, Paul's voice will become increasingly relatable and increasingly human. The internet has given Paul voice 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.

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. Kinect games have used movement and facial expression imitation goals to promote improved functioning of outward communication mechanisms. Robots that imitate gestures and facial expressions have been used to encourage social engagement and learning. Vibrating attention watches and phone applications have been used to remind students to stay on task and present themselves amicably to peers. 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.

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?

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