PSYCHOPHYSICAL TRAINING MAY AMELORIATE SYMPTOMS OF ASD

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Abstract

We report preliminary results from children displaying Autism Spectrum Disorder (ASD) from mild to severe. The children participated in a psychophysically based neurosensory training technology (PlayWisely). The program was designed to 1) systematically train stimulus tracking, identification, discrimination, and integration and 2) multimodal integration and 3) gross motor and fine motor development and coordination. This study, funded by the Timberlawn Psychiatric Research Foundation provided the cognitive training portion of the program to 18 children between 2 to 10 years of age diagnosed with Autism Spectrum Disorder (ASD) from mild to severe. The presentation will illustrate the application and evaluation of psychophysics research to training programs for cognitive and physical development in special needs and also healthy children.

Human infants are altricial, born helpless and requiring years of care before being able to fend for themselves. Core motor, sensory, perception, cognitive, emotional, and social systems, however, are in place and develop relatively rapidly after birth. Blink-startle responses (Birnholtz, 1981) and eye-movements (Birnholtz & Benacerraf, 1983), for example, have been documented in humans developing in utero. Even at birth, human infants have been found to show multimodal coordination in the form of orienting to sound "clicks" (Wertheimer, 1961). Additionally, although the human visual system is sensitive to visual contrast at birth (Frantz, 1966), typically developing children have been found to discriminate between blue, green, yellow, and red wavelengths as early as 1-5 days after birth (Adams, Maurer, & Davis, 1985). Furthermore, higher level scanning and pattern recognition processes appear early and also develop fairly rapidly. For example, infants progress from scanning external contours to scanning internal elements by 2 months (Maurer & Sakaoatek, 1976); and infants, less than five days old, even show preferences for faces (Frantz, 1966), soon after (5-7 weeks) show increased face fixations on the eyes (Haith, Bergman & Moore, 1977), and between 4 and 6 months, show recognition of familiar faces (Fagan, 1976).

Experience also shapes developing processing systems. Although infants even respond to looming patterns, widening eyes and moving their heads and hands, as early as 6 days after birth (Bower, Broughton, & Moore, 1971), it seems that the perception of depth requires more experience. A startle response to the visual cliff, for example, appears to emerge after infants have some experience crawling (Bertenthal & Campos, 1990). Furthermore, studies of congenital or induced restrictions on the visual system (and other systems) have led to discoveries of critical periods during which failure to use the system can lead to permanent deficits (e.g., Hirsch & Spinelli, 1970; see Gregory, 1977). Thus, the exercising of core motor, sensory, perception, cognitive, emotional, and social systems is generally essential for proper maturation.

Research on the relationship between socioeconomic status (SES) and academic achievement has provided further evidence that failure to provide adequate cognitive stimulation early in life can have long-lasting effects on higher-order processing and academic achievement. Path analysis of the large-scale dataset (n=1735 ages 14 to 21) using structural equation modeling examined mediation of the relationship between poverty and intellectual development using the latent mediator variables of cognitive stimulation at home, positive parent-child interactions, home condition/safety, child care quality, health at birth, and childhood quality (Guo & Harris, 2000). Longer periods of childhood poverty were associated with less cognitive stimulation, fewer positive parent-child interactions, and poor health at birth, and these variables mediated the relationship between poverty duration and intellectual development. Cognitive stimulation, however, was found to be the strongest mediator of the association between SES and intellectual development (also see Hart & Risley, 1995, 1999, for similar fingings on SES, exposure to language, and cognitive outcomes). These findings are consistent with studies showing that rats raised in enriched environments, with toys and other rats, produced more synapses within certain brain regions and ran complicated mazes more quickly than rats raised in isolation (Renner & Rosenzweig, 1987). Of course, further research is necessary to rule out possible influences of third variables, and such data do not necessarily indicate that critical periods might have been missed and that the child is then incapable of properly building the necessary cognitive systems. The data do, however, support the notion that early cognitive exercise helps to establish the cognitive systems that support higher-order processes.

The research and references above refer to the development of sensory, lower-level perceptual, and cognitive systems, the data suggest that failing to adequately exercise cognitive processing systems at a young age impacts broader cognitive function later in life. Of course, formal education follows this general paradigm. Children are taught facts, concepts, and skills that are deemed appropriate for their current knowledge base and cognitive capacities. As their knowledge base and capacities grow, the curriculum is advanced to be appropriate for the gains. Thus, learning fundamental facts, concepts, and skills is necessary to mature as a learner.

Based on psychophysical and neuropsychological research, the PlayWisely program was developed to systematically engage young children with psychosensory activities that exercise basic cognitive and psychomotor systems. PlayWisely uses unique performance algorithms for stimulating and optimizing visual/cognitive development and generating consequential behavioral data. Just as dance can be considered a useful performance algorithm for training the motor system and music as a functional performance algorithm for training the auditory system, PlayWisely has constructed sets of stimuli on large hand-held cards presented rhythmically and sequentially within a controlled space/time frame. We have demonstrated that these experiences optimize observable performance via the visual-cognitive system. Different card sets are presented with defined purpose for stimulating and developing certain psychosensory and cognitive skills. This display method engages perceptual channels tuned for shape, size, number, color, and general sensory detection skills, e.g., location, orientation and directional motion.

One training sequence exercises focused attention and inhibitory processes. The child searches for an image (e.g., a ‘cat’) on a series of cards as the backgrounds become progressively more complex. Children as young as 4 months quickly learn to search the card visually. Children typically progress from searching visually and then pointing to the target pictures. By 12 to 18 months, children in the program coordinate visual pointing, finger pointing and verbal output as anticipation of target demands increase. With advancing ability the child develops executive function skills for organizing the deployment of increasingly challenging performance. For example, children combine alternate pointing with right and left fingers while announcing up to 3 words per image. They maintain speed and rhythm from card to card while simultaneously seeking and finding images on increasingly complex backgrounds. This training exercises the psychosensory navigation skills required to detect, process, and perceive the visual world efficiently. The children learn to react appropriately to inputs by assembling, coordinating and deploying behaviorally within a defined space/time threshold. The method's premise is that learning is essentially psychophysical training. This training represents the 'foundation technique' for the skill we recognize as learning. The 'rules to the game of learning' include developing efficient psychophysical sensory detection and processing skills with complimentary organization, coordination and deployment of appropriate performance outputs within a prescribed space/time environment. The method controls and trains the physical sensory stimulus which generates observable optimization of input/output performance. As the child matures this foundation template of input/output performance can be superimposed with more complex learning skills.

The observations and data so far suggest that the PlayWisely technology may be of value to children displaying Autism Spectrum Disorder (ASD) from mild to severe. We have anecdotal evidence demonstrating the effectiveness of a systematic approach that optimizes cognitive and motor ability (developmental wellness) in neurotypical children as well as enhancing performance in children with specific visual problems (Hypoplasia and Dwayne's Syndrome #1) and delayed language production. Based on this evidence, we undertook a program of research collaborating with the Timberlawn Psychiatric Research Foundation, of Dallas Texas, USA. The program was designed to 1) systematically train stimulus tracking, identification, discrimination, and integration, 2) demonstrate multimodal integration, and 3) indentify transfer to gross motor and fine motor development and coordination. The children who participated where studies within the psychophysically based neurosensory training technology (i.e., PlayWisely). Sample size in the cognitive training portion of the program was 18 children between 2 to 10 years of age diagnosed with Autism Spectrum Disorder (ASD) from mild to severe.

Autism presents unique psychophysical problems and our intent is to determine if symptoms of this disorder can be ameliorated using a psychophysical training approach. A feasibility trial conducted in 2009 provided positive data including one child increasing vocabulary from 1 to 4 words along with enhanced length of attentiveness to a task. This child developed anticipation and made appropriate responses to the task. We plan to define those stimulus properties by selective characteristics that can be psychophysically measured. We will define where in the perceptual system children are not integrating information properly. Just as psychophysics laid the foundation for practical optometry and audiology, so to can psychophysics become the leader in developing solutions for the practical challenge, viz. learning.

Finally, many of the activities in the PlayWisely sequences are similar to common play activities that actively involved parents engage in with their children (e.g., encouraging a child to point to a picture of a 'cat' in a book that the parent is reading to the child). Even involved parents, however, typically engage in such activities unsystematically and without the explicit goal of training core neurosensory and cognitive processes. Thus, one additional benefit of the PlayWisely system is that parents are provided with examples of how to "play wisely" with their children, that is, to play with the goal of encouraging cognitive and physical growth.

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