A Single-Case Experimental Analysis of the Effects of Ambient Prism Lenses for an Adolescent With Developmental Disabilities

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ABSTRACT

We evaluated ambient prism lenses as an intervention to improve the cognitive and motor skills of an adolescent diagnosed with autism and mild mental retardation. Cognitive tasks were presented in both ambient prism lenses and no lenses conditions across four assessments in a multielement design. We then evaluated the effects of ambient prism lenses, placebo lenses, and no lenses on motor skills assessed in previous studies (i.e., balance beam walk and ball-catch) as well as leisure and vocational tasks relevant to the student's academic programming (i.e., money sorting and basketball shooting). Results across assessments indicated relative increases in scores across all experimental conditions, indicating practice effects. No differences across the use of ambient prism, placebo, or no lenses conditions were observed. We conclude with a discussion on how to objectively evaluate controversial and/or alternative therapies for children with developmental disabilities.

Keywords: alternative therapies, ambient prism lenses, autism, single-case experimental design, vision therapy

The advent of novel treatments for children with disabilities presents scientist-practitioners with a dilemma. Many treatments are marketed to the public prior to establishing a substantial body of evidence, which can lead to clinicians facing the difficult decision of whether or not to adopt the intervention. The current investigation began when one of our agency's students, John, came to school wearing a pair of prescription lenses that we had never seen before. John's parents indicated that the lenses were prescribed by an ophthalmologist and were designed to improve John's visual scanning ability. Upon reviewing the ophthalmologist's report, we learned that these "ambient lenses" were designed to have an "immediate impact" on our student's visual processing, much like prescription lenses immediately improve blurry vision. We believed the intervention might have some merit because a vision specialist prescribed the lenses. Therefore, we began looking further into what ambient lenses are and how they might help our student.

Ambient prism lenses are worn in standard eyeglass frames, but they feature wedge prism lenses in lieu of typical refractive ones (Carmody, Kaplan, & Gaydos, 2001). The rationale behind such lenses is related to neuroscientific findings that the brain houses two functionally and anatomically distinct visual systems: An acuity system that focuses on objects (referred to as the "what" system) and another that is responsible for tracking objects in space and allocating attentional resources to spatial information (referred to as the "where" system; Goodale & Milner, 1992; Mishkin, Ungerleider, & Macko, 1983). Ambient lenses are hypothesized to immediately improve the functioning of the "where" system by shifting the field of vision by transforming light through angular displacement (Dunn, 2008). This purported improvement has been said to "reduce behavior problems in autistic individuals" (Kaplan, Edelson, & Seip, 1998, p. 67) based upon the notion that "some problems commonly observed in autistic children may be due to a

dysfunctional ambient visual system" (p. 66). Moreover, remediation of the dysfunctional ambient system in clients with autism spectrum disorders has been purported to lead to partial recovery from the syndrome given the "powerful role that distortion in sensory processing plays..." (Kaplan et al., 1998, p. 65). Yet another appealing claim is that the "improvement in performance will usually be immediate" due to "visual dominance over other sensory modalities" (Kaplan et al., 1998, p. 67).

We looked to the research literature to determine the extent to which the effects of ambient lenses have been evaluated. Our search yielded only a handful of studies with somewhat mixed findings. Kay and Vyse (2005) described an 8-year-old child with autism who was prescribed ambient lenses to improve visual processing and gait and to decrease toe walking. Using an alternating treatments design, however, they found that the child's appropriate walking decreased while wearing ambient lenses compared to when he was wearing empty frames.

In addition, he was more resistant to physical prompts and engaged in more disruptive behavior in the ambient lenses condition. The Kay and Vyse study was reported in a book chapter rather than a peer-reviewed publication, however. Two other studies published in the same peer-reviewed journal (Carmody et al., 2001; Kaplan, Carmody, & Gaydos, 1996), reported immediate improvements in performance on visual-motor tasks while participants wore the lenses. An additional study published in the same journal (Kaplan et al., 1998), reported no improvements on these tasks but did report improvements on the Aberrant Behavior Checklist (Aman, Singh, Stewart, & Field, 1985), which relies on reports of caregivers and yields a global score regarding problem behavior. Nevertheless, only the study reported by Kay and Vyse featured ongoing progress monitoring of performance (i.e., session-by-session assessments graphed via a time-series figures to detect behavioral improvements while wearing ambient prism lenses). To date, there have been no published studies evaluating the effects of ambient lenses using standardized norm-referenced measures of visual-spatial ability.¹

Why Assess an Alternative Treatment?

Considering the increase in the interest in and the use of the term “evidence-based practice” in recent years (DiGennaro Reed & Reed, 2008), it has become increasingly important for clinical researchers to document not only “what works,” but also what “doesn’t work.” Without such information, consumers and practitioners would not know how one intervention fares against another with regards to relative efficacy. As Detrich (2008) describes, standards of evidence for “evidence-based practices” come from either the *threshold* (i.e., how much research exists validating the treatment) or the *hierarchy of evidence* (relative comparisons of efficacy along a continuum for treatments targeting a particular concern). The absence of peer-reviewed documentation of a treatment’s degree of efficacy—due to a paucity of objective scientific research on the subject—may prohibit that particular treatment from scrutiny afforded by such standards of evidence-based methods. In the present case, the lack of well-controlled studies on the utility of ambient lenses makes them an alternative, and nonevidence based, treatment.

Clients should be guaranteed their right for the most effective and least intrusive treatment (see Van Houten et al., 1988) and the ethical guidelines of the American Psychological Association (APA), Behavior Analyst Certification Board® (BACB), and National Association of School Psychology (NASP) mandate that selection of interventions be a data-driven process. The BACB directly addresses the dilemma of a recommendation for an alternative treatment by stating that “behavior analysts are responsible for review and appraisal of likely effects of all alternative treatments, including those provided by other disciplines and no intervention” (BACB, 2004, 2.09c). Thus, in this scenario, the behavior analyst is encouraged to collect data on nonvalidated treatments—or perhaps directing the client to research literature on the nonvalidated

treatment—while supplementing this treatment with previously validated ones to maintain the individuals’ right to effective intervention.

Normand (2008) champions the idea of rigorously evaluating alternative treatments using technologies afforded to clinicians via behavior analysis and has termed such evaluations “skeptical research.” As one example of skeptical research, Lerman et al. (2008) evaluated the efficacy of hyperbaric oxygen therapy—a treatment purported to rectify neurological abnormalities—after parents had requested this form of treatment. At the time of this study, no experimental evaluations on the efficacy of this treatment were available in the peer-reviewed scientific literature. Using a multiple-baseline across participants design, the researchers demonstrated that hyperbaric oxygen treatment was no more effective than behavioral treatment alone for increasing task engagement or spontaneous communication. The goal of the present study was to assess ambient prism lenses using the kind of skeptical research proposed by Normand and employed by Lerman et al.

A Proposed Model for Assessing Alternative Treatments

Upon the request to evaluate a controversial or alternative treatment approach, the practitioner must ensure that proper procedures are in place to ethically and objectively evaluate the efficacy of the intervention. First, the practitioner must be able to detect with precision the specific effects of an intervention on socially important performances (i.e., be able to demonstrate experimental control of the intervention). In these kinds of treatment evaluations, Barlow, Nock, and Hersen (2009) advocate the use of single-case experimental designs, as they “are particularly well suited to initial pilot testing because one can establish important functional relationships between an intervention and the problem or disorder under consideration utilizing far fewer subjects” (p. 29). Moreover, one must apply the best practices of empirically supported treatment implementation to the alternative treatment at hand (e.g., Lerman et al., 2008). Specifically, the practitioner must ensure that the treatment is being implemented in the manner in which it was designed, for the population it is recommended for, using well-selected methods of progress-monitoring, and implemented by staff or therapists who have been adequately trained on the treatment method (Detrich, 2008). As ethical service providers operating within the scientist–practitioner model, the consultant must then be prepared to adopt the alternative treatment if the data suggest that this treatment is the most efficacious, least restrictive option for the individual (or refer the client elsewhere if they are not able to implement the treatment). As a prime example of how and why controversial treatments should be objectively assessed, the reader is encouraged to consult the literature describing strong evidence against the use of facilitated communication (e.g., Cook Myers, Miltenberger, & Suda, 1998; Green, 1994; Mostert, 2001).

In the present article, we propose a method—expanding upon the guidelines put forth by Lerman et al. (2008)—for evaluating controversial or alternative treatments in residential

programs serving individuals with developmental disabilities and other challenging behaviors. Moreover, we propose that, when applicable, standardized norm-referenced tests should be used to detect possible changes in the performances purported to improve as a result of the alternative treatment. Most standardized tests have been thoroughly researched prior to their release and have demonstrated adequate reliability and validity for measuring a particular skill set (as opposed to non-standardized tasks created for specific purposes by clinicians or researchers). Standardized tests also permit the identification of an individual's improvement or decline in performance relative to the larger population, which can provide a complementary measure of the clinical significance of behavior change. For example, if an individual wearing ambient lenses can identify 20 more target items during a visual scanning task than he can without the glasses, is this a meaningful change? Relative to the larger population, would this increase in performance translate to a change in a percentile score?

In addition to standardized tests, we advocate incorporating single-case experimental designs using repeated direct measures over a meaningful timeframe to evaluate socially significant changes in socially-relevant behaviors. Tasks created by practitioners and researchers and monitored in a single-case experimental design have the advantage of serving as direct outcome measures for skills that are individualized for the client. For example, perhaps there is a specific sorting task highly relevant to an individual's vocational program that, if improved, would enhance the probability of attaining employment. Such individualized tasks can be evaluated in the presence and absence of the alternative treatment.

A Case Study on the Evaluation of Ambient Prism Lenses

Using a single-case example, we document the use of this analytic package in the evaluation of the effects of ambient prism lenses on relevant performances by an adolescent male named John. In this case, John's parents were committed to trying this treatment and had paid for the ambient prism lenses using personal finances. Overall, their costs included an ophthalmology exam (\$250), a complementary sensorimotor exam (\$125), the ambient lenses (\$398), and the accompanying frames (\$105), for a total of \$878. The clinical team at our agency agreed to permit John to wear these glasses during school hours with the understanding that a rigorous evaluation of their effects on cognitive and motor functioning would be conducted. The parents agreed that if the data suggested that there were no additional benefits from the ambient prism lenses on John's behavior, the school staff would discontinue the use of these glasses during school hours.

We hypothesized that if ambient lenses were having a beneficial impact on John's cognitive functioning, he would perform significantly better on normative visual-spatial processing tasks compared to when he was not wearing the lenses. Moreover, we hypothesized that if ambient lenses were having an impact on John's spatial processing, we would also see

improved performance across a variety of leisure and vocational tasks that emphasize visual-spatial processing.

Method

Participant and Setting

The participant was a 15-year-old boy diagnosed with autism and mild mental retardation, who attended a private day and residential school for children with developmental disabilities. John's vocal communication skills were limited and he benefited from visual supports to communicate (e.g., visual schedules, photographs, task analyses for programs displayed in sequences of icons and text, etc.). Moreover, John exhibited deficits in safety and community skills (e.g., obeying traffic signs, telling time, reporting an emergency, etc.), as well as the ability to follow multiple-step directions. When denied access to preferred items or activities, or when difficult demands were placed, John occasionally engaged in self-injury, aggression, and tantrums, each of which were targeted with a comprehensive behavioral support plan. Although intense, the frequency of these severe problem behaviors averaged only three instances per year. Thus, the effect of ambient lenses on severe problem behavior was difficult to assess with this student. At the time of the study, John had been receiving educational and residential services from this agency for over eight years.

During a recent neuropsychological evaluation, John's intelligence was assessed using the Wechsler Intelligence Scale for Children Fourth Edition–Integrated (WISC–IV Integrated; Wechsler et al., 2004). Results from that assessment indicated a significant split between the participant's Perceptual Reasoning Index of 69, and the other indices that comprise the Full Scale IQ (Verbal Comprehension Index = 45; Working Memory Index = 50; Processing Speed Index = 50). These results indicate that, prior to wearing ambient lenses, John's performance on visual reasoning tasks that did not require him to emit a vocal response was significantly better than his performance on reasoning tasks that required vocal responding. In addition, John performed significantly worse on visual tasks that emphasized speed of response as opposed to visual abstract reasoning tasks.

Materials

The neuropsychological component of the current study incorporated a battery of subtests from the WISC–IV (Wechsler et al., 2004) and NEPSY–II (Korkman, Kirk, & Kemp, 2007) designed to assess various aspects of visual-spatial attention and processing. An emphasis was placed on selecting measures that would purportedly map onto the "where" visual system of the brain, responsible for depth perception, tracking movement in space, and attention to spatial aspects of the environment, such as the location of an object and its directionality. Although the measures were designed to tap a variety of "cognitive skills" (e.g., remembering, processing speed, attention, etc.), all emphasized visual-spatial performance. In addition, two

Table 1. Test Descriptions and Scaled Score Performance Across Neuropsychological Assessments

Measure	Description	Time 1 08/08 (no lenses)	Time 2 03/09 (ambient lenses)	Time 3 03/09 (no lenses)	Time 4 03/10 (no lenses)
WISC–IV Integrated					
Digit Span	Increasingly long strings of numbers are read aloud by the examiner and then repeated by the participant in the order presented or in reverse order.	1	1	1	1
Letter-Number Sequencing	Participant rearranges and speaks aloud strings of intermixed letters and numbers that are read aloud by the examiner.	1	1	1	1
Spatial Span Forward	Participant repeats a series of block taps performed by the examiner using a board with rows of blocks.	1	1	1	3
Spatial Span Backward	Participant observes a series of block taps made by the examiner and then attempts to tap the same blocks in reverse order.	1	1	1	1
Coding	Participant matches symbols with numbers while visually scanning back-and-forth between a key at the top of the page and the response area below.	1	1	1	1
Symbol Search	Participant determines whether either symbol from a pair on the left side of the page appears in an array on the right side of the page.	1	1	1	1
Cancellation	Involves crossing out pictures of animals that are presented amongst other objects within a time limit.	1	2	1	1
Block Design	Based upon a model, the participant arranges blocks to match an abstract geometric design.	4	7 ^a	9	9
NEPSY–II					
Arrows	The participant is asked to determine which of the arrows from an array would hit a bull's-eye if they continued on their current path.	3	1	1	1
Picture Puzzles	Involves matching individual pieces of a picture to their location on a complete array in the center of the page.	9	12 ^a	14	12
Designs-Content	Content memory for abstract designs.	3	2	1	1
Designs-Spatial	Spatial memory for abstract designs.	1	6 ^a	4	5

^a Scaled score difference from previous assessments is ≥ 1 standard deviation.

measures of auditory attention (Digit Span and Letter-Number Sequencing) were included for comparison purposes with the assumption that no improvement would be noted given the lack of visual-spatial tracking and analysis required for these tasks. Table 1 displays the neuropsychological measures used in this study, along with a short description of each task.

To examine balance, coordination, and motor skills, four tasks—a balance beam walk, ball catching, money sorting, and shooting a basketball—were used. The balance beam measured 4 m (length) x 18 cm (width) x 18 cm (height). For ball catching, an orange Wiffle® ball with a .3 m circumference was tethered to a rope and suspended from a ceiling support. Play money (5 cm x 10 cm) was used during the money-sorting task and included denominations of 1, 5, 10, and 20 dollars. The imagery on the bills matched that of traditional bills from the United States, except for color (the play money was printed in black and white). A storage receptacle for the bills was used during the task and measured 20 cm (length) x 15 cm (height). A standard size men's basketball (.8 m circumference) was used during the basketball-shooting task. The height of the basketball hoop was 2.3 m and the diameter of the hoop was .5 m.

Measurement, Design, and Procedures

John initially participated in a comprehensive neuropsychological evaluation prior to being prescribed ambient lenses. As a complement to these standardized measures, the experimenters created a set of balance and coordination tasks to evaluate John's performance with and without the lenses. These motor tasks were initially presented in tandem with the neuropsychological assessments, but the methodological approach that was selected had several limitations.² Therefore, John's performance on the balance and coordination tasks was reevaluated approximately one-year later using a more rigorous methodological design. It is these data that are reported.

These balance and coordination tasks were presented during a "no-lenses" condition (i.e., baseline) until steady state responding was evident. We identified steady state responding as three consecutive data points (from a series of a minimum of five data points) in which changes in the dependent variable varied by no more than one whole unit of measurement (e.g., seconds, falls, bills sorted, etc.) or if the trend of the final three data points indicated worsening performance. Afterward, the same tasks were presented while alternating between the control (no lenses) condition, a placebo-lenses condition, and an ambient-lenses condition. The experimenters provided the placebo lenses (no visual correction). An effort was made to match the style, size, etc. of the placebo lenses to the participant's ophthalmologist-prescribed ambient lenses to reduce any differences (beyond vision correction) between the two sets of glasses. Doing so allowed us to isolate the modification of the prescription lenses as an independent variable. Improved performance in the ambient lenses conditions relative to the placebo condition would suggest that the ambient lenses were having an impact on John's behavior and perhaps his visual

processing. Improved performance in both the placebo and ambient conditions relative to the control condition would suggest that simply wearing glasses (whether they were modified or not) led to an improvement in John's performance. A lack of differential responding between the three conditions would indicate that neither ambient lenses nor glasses were having an impact on performance. Finally, improved performance in the placebo and control conditions relative to the ambient lenses condition would suggest that the ambient lenses were negatively impacting John's performances and perhaps his visual processing.

Neuropsychological assessment. A series of cognitive tasks was presented across four distinct testing sessions. John was initially assessed with no glasses seven months prior to wearing ambient lenses as part of a comprehensive neuropsychological evaluation (Time 1). A select group of subtests used in that evaluation was re-administered to the participant while he was wearing ambient lenses seven months later (Time 2), and again two days later, with no lenses (Time 3). One year later, a final evaluation was conducted to determine if any improvements noted while the student was wearing ambient lenses on a regular basis persisted following long-term disuse of the lenses (Time 4). The scaled scores for the subtests served as the dependent variables for this component of the study. John's motor skills and skills related to visual processing were then assessed during four separate exercises created by the experimenters.

Balance and coordination. John's balance and coordination was assessed with a ball catching task and a beam walking exercise. These tasks were designed to be similar to those previously employed by other researchers examining the effects of ambient lenses (Carmody et al., 2001; Kaplan et al., 1996; Kaplan et al., 1998). One of the three experimental conditions—control (no lenses), ambient lenses, placebo lenses—was conducted each school day, and each session consisted of 10 trials of each task. In addition, the balance beam walk occurred first on six of the days and the ball catching exercise occurred first on the other six days.

The ball catch exercise was arranged by looping rope through a Wiffle® ball and fastening it to a ceiling support. The ball, in its hanging position, was approximately 1.3 m away from John's standing location (marked with an "X" on the floor) so that when the ball reached John it was at chest level. At the start of each ball-catch trial, one of the experimenters would pull the ball backward (2.7 m away from the participant), say "John, catch," and then release the ball.

The number of catches and the number of misses were assessed during ball catch sessions. A catch was defined as John making hand-to-ball contact upon the initial approach of the ball and grasping the ball with at least one hand for at least 1 s. The ball could be bobbled provided it did not move more than .3 m away from the hands or body. A miss was defined as John catching the ball by the rope or, after the ball made physical contact, catching it with a body part other than the hands. Misses also included instances of trapping the ball against the

Figure 1. A multielement evaluation of ball catching during sessions in control, placebo lenses, and ambient lenses conditions.

Figure 2. A multielement evaluation of balance beam walking (duration in top panel, falls in bottom panel) during sessions in control, placebo lenses, and ambient lenses conditions.

body and instances in which the ball was deflected or bobbled more than .3 m away from the hands or body. For ease of data depiction and interpretation, we only report the data for ball catches.

The balance beam walk began by having John stand on the end of the balance beam. One of the experimenters would then state, “John, walk” and begin timing with a stopwatch. Time of completion, defined as the amount of time (in hundredths of seconds) it took John to walk from the starting position to the end of the balance beam, was collected with a stopwatch, and the number of falls, defined as the number of times John’s foot touched the ground during the walk, were collected via paper and pencil.

Money sorting. A money-sorting task was chosen as an outcome measure because it was one of John’s vocational activities and because it involved visual scanning. John’s teacher reported that he could discriminate between the denominations used in this assessment. During this task, the same set of play money was randomly distributed each trial within a .6 m (length) by .6 m (width) area on a table. At the start of each trial, an experimenter asked John to “find all of the one’s and put them in the bin.” One of the experimenters then started a timer and John had 15 s to find and place the one-dollar bills in the bin. Only those bills that had crossed the threshold of the bin within 15 s were counted. The number of one-dollar bills in the bin at the end of the interval was recorded. Errors would have been recorded, but none were observed across sessions.

Basketball shooting. A basketball-shooting task was chosen because John enjoyed shooting basketballs during his leisure time in the gym. In addition, the task involves depth perception and motor coordination. At the start of each trial, John was asked to stand 2.3 m from the base of the basketball hoop and the experimenter said “try and get the ball in the hoop.” Each session consisted of John taking 20 shots and the percentage of shots made, defined as the entire basketball passing through the hoop, was recorded.

Interobserver agreement (IOA). Interobserver agreement (IOA) was calculated by comparing two independent observers’ data across 100% of sessions for each dependent variable. For ball catches and misses, balance beam walk falls, correctly sorted bills, and basketball shots, total count IOA was calculated for each session by dividing the smaller of the two counts by the larger of the two counts and multiplying by 100. Means were then calculated for each dependent variable by dividing the sum of the total count-per-session IOA scores by the total number of sessions, and multiplying by 100. The IOA scores were 96% for ball catches, 99% for ball catch misses, 100% for balance beam walk falls, 100% for correctly sorted bills, and 100% for basketball shots. For balance beam walk durations, total duration IOA was calculated for each session by dividing the shorter of the two total durations by the larger and multiplying by 100. The mean IOA was calculated by dividing the sum of the total duration IOA by the total number of sessions

and multiplying by 100. The mean IOA for the balance beam walk duration was 98%.

Results

Neuropsychological Assessment

Table 1 displays the participant’s neuropsychological data across the four assessments. The subtest scores used in this assessment have a range of 1 to 19, a mean of 10, and a standard deviation of 3; changes of three or greater were judged to be indicative of significant change. As displayed in Table 2, there was little change in performance for the majority of subtests across the assessments. There was no change in auditory attention performance as measured by the Digit Span and Letter–Number Sequencing subtests. With regard to visual-spatial processing tasks, there was improvement in performance on three subtests (Block Design, Memory for Designs–Spatial, Picture Puzzles) between Time 1 and Time 2, but no meaningful decline in performance at Time 3 when the glasses were ambient lenses were removed just prior to testing.

Because the assessment at Time 3 occurred within days of the Time 2 assessment, another evaluation was conducted one year later, again with no lenses (Time 4). This final assessment was necessary for determining whether potential treatment effects that occurred when John was wearing ambient lenses might have generalized to the no lenses condition. In other words, perhaps some advantage conferred by wearing ambient lenses led to better performance during the subsequent assessment when they were removed. If this was the case, we would have expected to see John’s scores significantly decline since the Time 3 assessment. In contrast, if his improved performance was related to practice effects, we would have expected his performance to remain stable or improve. As can be seen from Table 1, John’s performance across all of the neuropsychological measures remained stable at Time 4. Therefore, it appears there were no carryover effects of the ambient lenses across the neuropsychological testing conditions and the improved scores are likely attributable to practice effects.

Balance and Coordination

Figure 1 depicts John’s performance during ball catch sessions across each of the three experimental conditions (ambient lenses, placebo lenses, control). John initially caught the ball often during baseline. When alternating between the placebo lenses, ambient lenses, and control conditions, John’s performance remained stable in the control conditions; however, a substantial decrease in performance was observed in all sessions in which ambient lenses were worn.

Figure 2 shows that the relative durations of balance beam walking were similar across conditions. The number of falls during walks was more variable, but there was no discernable pattern indicating better performance in any one condition.

Figure 3. A multi-element evaluation of money sorting during sessions in control, placebo lenses, and ambient lenses conditions.

Figure 4. An evaluation of basketball shooting accuracy in control, placebo lenses, and ambient lenses conditions.

Money Sorting

With respect to accurately sorting \$1 bills, John was observed sorting the same amount across all conditions (Figure 3).

Basketball Shooting

Figure 4 shows that John shot basketballs with 10% to 60% accuracy in baseline. There was no reliable difference in his shooting accuracy from baseline during the evaluation or across the three conditions, although there appeared to be a downward trend in his accuracy in the ambient lenses condition.

Discussion

The current neuropsychological data indicate that the use of ambient lenses did not confer any advantage in the areas of functioning they were meant to target (visual-spatial performances). Across a variety of tasks that purportedly tap multiple neuropsychological functions (e.g., memory, processing speed, attention), yet share the common element of being reliant upon visual-spatial performance, performance was largely consistent across assessments. Improvements noted when wearing ambient lenses at Time 2 were likely the result of practice effects given that performance either improved or stabilized during subsequent assessments without the lenses.

In addition, the use of ambient lenses, in comparison to placebo lenses and no lenses, did not result in improved balance and coordination. John's performance was, however, reliably worse during the ball catching task when wearing the ambient lenses. The ball catching exercise was the only task presented to John in our study that involved him tracking an object moving toward him in space. It is possible that ambient lenses impede depth perception for moving objects or some other aspect related to this task, but a definitive conclusion cannot be made from our analyses.

It also is worth noting that our participant may have reached his peak performance during baseline for three of the four tasks (ball catching, balance beam walking, and money sorting). This is particularly problematic for the balance beam and money sorting tasks, as they might not have been challenging enough to evaluate the potential impact of ambient lenses on performance (i.e., John can only walk or sort money so fast). During the ball catching exercise, it is possible that even greater differentiation between the ambient lenses and the no lenses and placebo conditions might have occurred given his perfect or near-perfect performance in the latter conditions. Put simply, the "ceiling effect" for this particular exercise makes it difficult to determine whether differentiation between conditions would have occurred if the tasks were more difficult.

Despite the potential advantages of incorporating standardized assessments into the evaluation of alternative treatments, such tests are prone to practice effects, particularly when they are administered without a long delay between administrations. Even when alternate forms are available, practice effects can still be evident and thereby confound interpretation of the results (Beglinger et al., 2005). In addition, as is the case in our investigation, unequal time intervals between assessments can make changes across evaluations more difficult to interpret. We did not feel it was appropriate to wait seven months (the length between Time 1 and Time 2) to begin the Time 3 assessment because we were evaluating the immediate clinical utility of an intervention. However, once our clinical decision had been made, we conducted a follow-up assessment one year later to ensure that we did not see a decline in the student's performance. Should future investigations evaluate the impact of ambient lenses on cognitive functioning using standardized norm-referenced tools, equating the intervals between assessments would allow for a more controlled comparison. Achieving steady state responding prior to evaluating the effects of an intervention would have also strengthened the experimental rigor of the neuropsychological aspect of this investigation.

With respect to the feasibility of analyses of alternative treatments like the one described here, it should be noted that our agency, a private school with residential services, may be better equipped to ethically evaluate alternative treatments than other types of institutions. For example, given that our residential students receive many hours of instruction throughout

the week, the cost of having one of our students participate in the evaluation of an alternative treatment in lieu of receiving evidence-based services would not be as great as those studies done in a home program or public school. In each individual's particular situation, the benefit of evaluating alternative treatments with little to no empirical support must be balanced with cost of the student missing out on the application of evidence-based services.

Future studies should explore the transportability of our proposed assessment battery to other alternative therapies commonly prescribed to dependent populations. In closing, we reiterate our stance that any evaluation of an alternative therapy should be done as objectively as possible, using a battery of standardized norm-referenced tests and single-case experimental designs involving direct observations of educationally and socially important behavior. When possible, obtaining baseline data prior to the introduction of an alternative treatment and incorporating at least one subsequent reversal condition is ideal. Practitioners and researchers interested in this line of inquiry must carefully weigh the risks of such studies against the benefits with regards to impact on service-delivery and client outcomes. Finally, this is but one example of the failure of ambient lenses to improve socially relevant behaviors in an adolescent with autism and intellectual disability. We are not implying that these findings will inevitably generalize to other participants, populations, or contexts. However, we do hope that this evaluation of the effects of ambient lenses serves as a model for future investigations.

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Notes

¹Due to the concerns regarding empirical support detailed above, a number of professional organizations have decried the use of ambient lenses as a therapy for individuals with disabilities (e.g., Association for Science in Autism Treatment; see <http://www.asatonline.org/resources/treatments/vision.htm>). Moreover, a joint statement by the American Academy of Pediatrics (Section on Ophthalmology, Council on Children with Disabilities), American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists (see American Academy of Pediatrics, 2009) indicates that these professional organizations neither endorse nor recommend the use of ambient lenses—or other forms of behavioral vision therapy—for children with learning disabilities.

²John's performance in ball catching and balance beam walking was initially evaluated using a multielement design across (a) no lenses (i.e., control), (b) ambient lenses, and (c) placebo lenses conditions, administered in a randomized sequence. After an initial 12 sessions of each condition, it became apparent that performance was increasing irrespective of the treatment or baseline conditions. Therefore, John's improved performance was initially attributed to practice effects. Upon sharing the results with John's parents, a collective decision was made to discontinue John's use of ambient prism lenses. However, due to the limitation that our initial 12 sessions were not preceded by steady state responding in a control condition, we could not conclusively determine whether treatment effects were influencing performance during the control conditions. At this juncture, the team—along with John's parents—concluded that the only way to assess the effects of the ambient lenses would be to discontinue the use of lenses for some time and re-administer the tasks following a baseline condition.

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