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Is Brain Gym an Effective Educational Intervention?

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Abstract

Brain Gym® (BG) (BGI, 2008) is a popular commercial program sold by Brain Gym® International (BGI). Making extravagant claims for improved intellectual and physical development, it used in more than 80 countries. While BGI's claims are persuasive, to date there is little empirical evidence validating the approach. We examine some theoretical assumptions from which BGI was developed, review the efficacy literature, and provide suggestions for making informed decisions about the judiciousness of investing time and resources in this program.

Key words: Brain Gym® International, educational kinesiology (Edu-K), brain-based learning, pseudo-science

Is Brain Gym® an Effective Educational Intervention?

Over the last several decades much attention has been devoted to connecting advances in neuroscience research to educational interventions for improved learning. Unsurprisingly, a whole industry, aggressively marketed, has developed to advance, among other ideas, the notion of 'brain based' learning (Ansari, 2008; Goswami, 2006). Brain Gym® International (BGI) is a program purportedly based on theories of neuroscience and educational kinesiology (Dennison, 2006) that has gained significant acceptance among athletic and corporate trainers, educators, and educational consultants in the United States and abroad. However, while BGI claims are persuasive and proponents' anecdotes attractive, to date there is little sound empirical research supporting BGI's developmental or educational claims.

We briefly examine the phenomenon of brain-based learning, the theoretical assumptions from which BGI was developed, standards for establishing intervention efficacy in special education, and the application of these standards for evaluating BGI interventions. We conclude by providing suggestions for making informed decisions about the judiciousness of investing time and resources in this program.

Neuroscience and Education

Over the last several decades, neuroscience research has enhanced medical and psychological understandings about how the brain develops and functions (Wolfe & Brandt, 1998). For example, neurological imaging studies have identified regions of the brain connected to a host of physical, psychological, and learning processes (Goswami, 2006). Moreover, this knowledge has resulted in more effective and efficient treatments for both physical and psychological disorders (Wolfe & Brandt, 1998).

A major speculative area in this regard relates to efforts to harness neurological findings as applied to learning, albeit with the caveat that direct, empirical evidence directly linking neurological behavior to actual learning outcomes is extremely limited (Goswami, 2006; Wolfe & Brandt, 1998). Consequently, claims of educational outcomes connected to neurological function, as is the claim made generally by ‘brain-based’ learning, and BGI specifically, almost always overreach (Alferink & Farmer-Dugan, this issue; Bruer, 1999; Wolfe & Brandt, 1998), tending to misrepresent and simplify neuroscience/educational outcome connections, which “are appealing, yet fundamentally inaccurate” (Ansari, 2008, p. 9).

However, tenuous connections between concepts have not, historically, prevented proponents of any particular educational intervention from forging ahead motivated by their convictions rather than reliance on replicable, empirical evidence of efficacy (Kavale & Mostert, 2004). Nor have proponents of largely intuitive, usually empirically untested interventions, hesitated in making their claims commercially profitable, as is the case with several popular commercial programs emphasizing brain-based learning (Goswami, 2006). Many empirically unsubstantiated claims of these programs are often presented as factual data to appeal to customers who find purportedly ‘hard’ biological evidence more compelling than the ‘soft’ data produced by psychological and educational studies (Bruer, 1999). Consequently, despite limited empirical evidence demonstrating direct and straightforward connections between brain research and educational applications (Goswami, 2006), many educators have been quick to believe elaborate promises of improved student performance (Bruer, 1999; Hatton, 1993), creating a scenario where “expectations have run ahead of reality” (Haigh, 2007, p. 1).

In the case of Brain Gym®, BGI promises subscribers they can “learn ANYTHING faster and more easily, perform better at sports, be more focused and organized, start and finish projects with ease, overcome learning challenges, and reach new levels of excellence" (BGI, Official website, 2008, capitals in original).

Brain Gym® International

Since first being developed in the 1970s, Brain Gym® has rapidly expanded in the United States and abroad, claiming success in more than 80 countries. This translates into Brain Gym® being used in thousands of public and private schools across the globe, as well as in corporate and performing arts studies curricula, and athletic training programs (BGI Website, 2008; Dennison, 2006). BGI reports there are over 500 trained BGI instructors in the United States alone, with approximately 200 training courses scheduled for 2009 across the United States (162), Canada (27), China (1), Hungary (2), Greece (4), Germany (2), India (1), and Slovenia (1). BGI also conducts consultations, teaches instructional courses (5 levels), and has other presentations scheduled across the US, as well as in Canada, Australia, Germany, South Africa, and Indonesia (BGI, 2008).

BGI claims that Brain Gym® has "a sound basis in neuroscience" (Dennison, 2006, p. 1), and consists of "integrated, cross-lateral, balance-requiring movements that mechanically activate both hemispheres of the brain via the motor and sensory cortexes, stimulate the vestibular (balance) system for equilibrium, and decrease the fight or flight mechanism" (Dennison, 2006, p. 8).

BGI's Theoretical Foundations

Having struggled with learning difficulties at school, and seeking to help others with similar learning disabilities, BGI founder Paul Dennison (2006) asserted that by the 1970s he wanted to "understand even more deeply the process of learning and the factors that inhibit it" (p. 18). Drawing conclusions from the reading and applied brain research literatures, as well as research examining the use of movement to enhance learning, Dennison developed theories of ‘learning through movement’ termed *educational kinesiology* (Edu-K, Dennison & Dennison, 1994). Edu-K is defined on the BGI website (2008) as “the study of drawing out innate intelligence through natural movement experience.” The underlying theory behind Edu-K is that simple exercises and body movements help integrate the left and right sides of the brain, thereby remediating learning problems and helping the subject reduce psychological and emotional stress.

Edu-K is the foundation for the 26 Brain Gym® activities that are now marketed through BGI (Dennison & Dennison, 1994). BGI claims that these 26 Brain Gym® activities are “based on empirical experience rather than neurological research” (BGI website, 2008). Closer examination shows that Edu-K and the Brain Gym® activities emphasize processes such as ‘balancing’ the brain and ‘repatterning’ behavioral processes which appear to be grounded in (a) Orton’s (1937) work with mixed cerebral dominance, (b) theoretical bases related to perceptual motor training theories (e.g. Barsch, 1965; Kephart, 1963), and (c) the neurological repatterning ideas promoted by Doman and Delacato (1959).

Mixed Cerebral Dominance

Orton (1937) attempted to explain reading difficulties via cerebral dominance, assuming that left-handedness, eyedness, or footedness, or mixed preferences, were responsible for reading difficulties as demonstrated in problems with whole-word recognition, reversals, and letter sequencing, all symptoms he did not observe among those who were consistently right-handed, footed, and eyed.

Orton (1937) suggested, therefore, that the most effective way to teach reading was to integrate the right and left-brain functions by combining kinesthetic and tactile learning strategies with visual and auditory exercises. For example, students were taught to say the names and sounds of letters while tracing or writing the letters in the air. Orton's emphasis on kinesthetics and integrating the left and right hemispheres of the brain is apparent in Brain Gym® activities, where the overall purpose of the 26 activities is to activate and integrate all parts of the brain so that the whole brain is 'turned on' and 'balanced,' allowing students access to all areas of the brain for improved learning.

The empirical evidence, however, has largely refuted left/right dominance as a mediator in reading difficulties (see Kavale & Forness, 1995; Kavale & Mostert, 2004; Goswami, 2006; Stichter, Conroy, & Kauffman, 2008). Although few subscribe to theories of cerebral dominance today (Hallahan & Mercer, 2001), this theory persists as a foundation for Brain Gym® activities.

Perceptual Motor Training

BGI has also drawn from the theoretical base of the proponents of perceptual motor training (e.g., Frostig & Maslow, 1973; Getman, 1965; Kephart, 1960). Among other assumptions, perceptual motor training held that students with learning disabilities were unable to effectively integrate visual and auditory perception with their motor skills. Perceptual motor training activities included crawling, walking on a balance beam, jumping, and bouncing balls, all activities aimed at developing more efficient of balance, laterality, relaxation, auditory development, kinesthetic awareness, and visual-motor coordination. By extension, increased ability in these foundational areas was assumed to result in more efficient reading ability.

Although clinical reports quickly popularized perceptual motor training as an effective intervention for students with learning disabilities (Hallahan & Cruickshank, 1973), empirical investigations were negative (e.g., Balow, 1971; Goodman & Hammill, 1973; Hammill, Goodman, & Weiderholt, 1974). Meta-analytical studies of perceptual training efficacy (e.g., Kavale & Mattson, 1983) found very small, negligible effects.

Despite little evidence validating the efficacy of perceptual motor training or substantiating perceptual-motor assessments for predicting later reading ability (Mercer & Pullen, 2009), it continues to have intuitive appeal for BGI, which incorporates perceptual motor training elements in its use of instructional procedures of vision therapy and modality assessment (visual, auditory, kinesthetic) (Hyatt, 2007).

Neurological Repatterning

BGI also incorporates elements of neurological repatterning made popular by Doman (1959; 1968; Doman, Spitz, Zucman, Delacato, & Doman, 1960), later commonly referred to as the Doman-Delacato Approach. The approach is based on the notion that children need to develop specific motor skills during specific developmental stages, cumulative from primitive to complex, for efficient neurological and intellectual development. The approach assumes that a lack of development at any stage generates more complex difficulties at later stages, eventually resulting in learning, psychological, and other difficulties that impact learning.

The Doman-Delacato approach seeks to remediate defective movement development with strict limb manipulation to develop neural pathways undeveloped at other stages of neurological development, beginning with the most primitive. The approach assumes that these manipulations will retroactively repattern neuron pathways in the brain, making the child “neurologically intact and ready to acquire academic skills” (Hyatt, 2007, p. 118). Similar to the act of ensuring the whole brain is ‘turned on’ through balance activities, repatterning activities are assumed to dislodge ‘learning blocks’ and unlock learner potential. Although these procedures were invalidated even prior to the inception of BGI (e.g., American Academy of

Pediatrics, 1968; Robbins, 1966; Stone & Pielstick, 1969), these procedures continue to be popular in both the United States and Europe, and remain a foundational theoretical base on which BGI is predicated.

Examples of the influence of theories of mixed cerebral dominance, perceptual motor elements, and neurological patterning are easily found in BGI's program and activity descriptions. For example, for the *Cross Crawl*, the client places the right hand across the body to the raised left knee. This is then repeated with the left hand to the right knee. This exercise is assumed to improve the flow of information between the two hemispheres of the brain. *Hook Ups* involves the client standing or sitting with the right leg crossed over the left at the ankles, crossing the right wrist over the left wrist and linking the fingers toward to the body until they rest on the center of the chest, while breathing evenly as a way of calming the mind and improving concentration. *Lazy Eights*, a movement designed for improving visual coordination skills for reading and writing, involves tracing the figure 8 turned on its side using large arm movements in the air, while following the movement with the eyes and limited or no head movement. These movements along with the rest of the 26 activities are taught in group settings or individually, and individuals are encouraged to use them independently when they feel 'stuck' on a particular learning task.

Despite unsupported claims of ameliorating learning challenges for children and adults with mild to moderate learning disabilities, BGI has expanded its applications to other more distant populations including athletes, business people, and musicians.

Standards for Establishing Intervention Efficacy

Since the early work of Itard (1806/1962) with Victor, the Wild Boy of Aveyron, the field of special education has long embraced the scientific method (Kauffman, 1987; Kavale,

2007) for empirically examining ‘what works.’ This emphasis on the scientific method and rigorous empiricism for determing the efficacy of special education interventions is upheld through United States federal legislation such as the No Child Left Behind Act (NCLB, 2001) and the latest reauthorization of the Individuals with Disabilities Education Act (IDEA, 2004). Both require the use of evidence-based practices, that is, teaching practices that have been empirically demonstrated to be effective.

In special education, guidelines exist for evaluating whether programs and interventions are evidence-based and effective. For example, Horner et al. (2005) propose two basic questions: (a) is there enough literature describing the essential features of the practice, and (b) are there enough studies of sufficient quality within this literature to impact judgments about the intervention’s effectiveness?

Brain Gym® International and Empirical Research

While much has been written about BGI and its applications in academic, athletic, and professional settings, the efficacy of Brain Gym® has generally *not* been subject to careful and rigorous investigation. Rather, most reports claiming program efficacy are disseminated in sympathetic publications funded by BGI, for example, the *Brain Gym® Journal*.

Given that the *Brain Gym® Journal* is a major source of information promulgating BG, we attempted to establish the publication’s bona fides. We could not locate published information about the review process for selecting articles for publication in the *Brain Gym® Journal*. We requested, and received, the following information directly from the journal’s publishers: (a) prospective authors are encouraged to submit any article of interest to the executive editor, (b) the executive editor reads each submission and then publishes the submission in the journal, which uses a thematic format, (c) aside from submission for publication, there are no other specific publication criteria, and (d) there is no peer review process. Although the *Brain Gym® Journal* lists a “Foundation Board of Directors,” “Faculty Representatives,” and a “Professional Advisory Board,” there is no indication either from their website or in our communication with the organization indicating any scholarly peer review involvement in the publishing process.

A review of the latest research published on the BGI (2008) website indicated that 64% of the “studies” were published in the *Brain Gym® Journal* or the *Brain Gym® Magazine*. Only 5 articles (13%) used an experimental research design, and 60% (n = 3) of these articles appeared in a BGI publication. Five articles (13%) relied on quasi-experimental research designs, with 40% (n = 2) appearing in a BGI publication. Sixteen articles (30%) used pre-experimental research designs, with 56% (n = 9) found in BGI publications. The remaining 17 studies (32%) consisted of academic papers, or descriptive or correlational research, with 82% (n = 14) published by BGI.

Evaluating the Evidence Base for BGI

While true experimental research is the benchmark for determining the value of a specific program or intervention, research reviews may be necessary to synthesize multiple research findings and to draw general conclusions about the efficacy of a program or intervention where there is not a critical mass of quantitative studies for more careful analysis (e.g., meta-analysis). While special education has begun to rely predominantly on the use of meta-analysis to combine research findings (Kavale, 2007), when a body of research on a topic contains a wide range of study designs (i.e., experimental, quasi-experimental, qualitative, and case study designs), meta-analysis may be impossible and “analytical narrative synthesis may well be the only way of evaluating research to generate usable knowledge” (Mostert & Kavale, 2001, p. 57).

Our comprehensive literature search using keywords and ancestral searches for BGI studies and reviews revealed one research synthesis examining the efficacy of BGI published in a peer-reviewed journal (Hyatt, 2007). Hyatt identified only five peer-reviewed journal articles that examined the efficacy of BGI. However, one of the articles (Wolfsont, 2002) was eliminated because the author was also a study participant. The remaining four articles (Cammisa, 1994; de los Santos, 2002; Khalsa, Morris, & Sifft, 1988; Sifft & Khalsa, 1991) were all methodologically problematic, especially in terms of implementation threats to internal validity across teachers and settings. None of the studies provided critical detail related to treatment fidelity, or discussion of how rival explanations were eliminated.

Generally, Hyatt (2007) concluded that all of the "articles contained serious methodological flaws" (p. 120), that the "data did not demonstrate that the Brain Gym® activities were superior to no treatment at all" (p. 121), and that the studies "clearly failed to support claims that Brain Gym® movements were effective interventions for academic learning" (p. 122).

Assessing BGI Efficacy: An Alternative Analysis

In our literature search preparing for this review, we did not uncover any additional peer-reviewed articles validating BGI claims since Hyatt's review, nor did we discover responses refuting or challenging Hyatt's conclusions on any grounds.

Guidelines for evaluating whether programs and interventions are evidence-based have been developed and effectively applied in prominent peer-reviewed special education journals to evaluate evidence-based practices (e.g., *Exceptional Children*). For evaluating experimental and quasi-experimental research studies, Gersten, Fuchs, Compton, Coyne, Greenwood, and Innocenti (2005) suggested *essential* quality indicators for (a) describing participants, (b) implementation of intervention and description of comparison conditions, (c) outcome measures, and (d) data analysis, as well as *desirable* indicators (see Table 1).

According to Gersten et al. (2005), a study should fail no less than one of the Essential Quality Indicators and demonstrate at least four of the quality indicators listed as Desirable in order to be considered *high quality*. To be considered *acceptable quality*, a study should meet all but one of the Essential Quality Indicators and demonstrate at least one of the quality indicators listed as Desirable. Additionally, for an intervention or program to be considered an evidence-based practice, Gersten et al. suggested that there be a minimum of two *high quality* studies or four *acceptable* studies demonstrating its efficacy. This criterion has been effectively applied for evaluating other educational programs and interventions (see Baker, Chard, Ketterlin-Geller, Apichatabutra, & Doabler, 2009).

Applying the standards outlined by Gersten et al. (2005) to the studies in Hyatt's (2007) review reveals that every study failed to meet the threshold of Essential and Desirable Quality Indicators necessary to be considered both *high quality* or *acceptable* research (see Table 1).

Cammisa (1994) and Khalsa et al. (1988) met 4 (22%) and de los Santos et al. (2002) and Sifft and Khalsa (1991) met 3 (17%) of the Essential and Desirable Quality Indicators. Each study failed to implement proper procedures to ensure characteristics of the participants were comparable across conditions, neglected to provide sufficient information about the training provided or the procedures implemented, and failed to demonstrate how treatment fidelity was ensured.

No studies adequately described the nature of services provided in comparison conditions. Moreover, selected data analysis procedures were far from sound; no intervention effects were measured beyond an immediate post-test, and effect size statistics demonstrating the magnitude of treatment effects were not provided. Given the fact that there are no *high* quality or even *acceptable* studies validating the program, there is insufficient evidence (see Gersten et al., 2005) to conclude that BGI is an effective intervention.

These findings are important given the commercial reach of BGI, and also because to date we were unable to find any solid empirical evidence supporting BGI interventions. Additionally, given the current press for educational accountability at the federal, state, and district levels, and the concomitant emphasis on the use of evidence-based programs and interventions, we expected to see at least some confirmation that BGI has made significant attempts to empirically establish support for it claims, but this does not appear to be the case.

Ideology Over Empiricism

Rather than relying on experimental research designs that have been submitted to empirical standards and the rigor of the peer review process, BGI itself acknowledges that the *primary evidence* supporting the program “comes from the countless anecdotal stories reported to us since 1986” (BGI Website, 2008). Based on personal testimony and published anecdotes, BGI proponents appear, without exception, convinced the program works. BGI materials are replete with well-nigh miraculous anecdotes and personal examples of how student performances in math, reading, writing, and test taking improved drastically. Although BGI acknowledges that they cannot explain why these movements work, ‘evidence’ for the effects of these movements is provided on the website (BGI, 2008) through testimonials.

While these testimonial and anecdotal stories are persuasive, passionate, and compelling, they *do not* meet the established criteria for quality research in special education. Rather, most BGI articles are descriptive explanations of (a) what an individual experienced through participating in BGI activities or (b) how an educator, caregiver, or trainer used BGI activities with individuals in their workplace. Although the reports allege BGI efficacy, anecdotal evidence cannot control for threats to validity, thereby making it impossible to claim that the improvement can only be explained by participation in the program.

Special Education Implications

Given the finite time children spend in classrooms, when teachers implement practices that *have not* been validated by empirical research, they are expending valuable time that could be spent implementing practices that *have* been empirically validated. This is particularly alarming when considering the challenges children with disabilities face. National studies reveal that there is an achievement gap between children with disabilities and those without, and this gap widens every year children are in school (Deschler et al., 2001). With a growing achievement gap every year, it is not surprising that young people with disabilities drop out of high school at twice the rate of their peers, and college enrollment for students with disabilities is 50% lower than that of the general population (NLTS2, 2005; U.S. Department of Education Office of Special Education, 2002). Consequently, special education has a heightened responsibility for being accountable because it "serves students and families who are especially dependent on receiving effective services and who are especially vulnerable to fraudulent treatment claims" (Malouf & Schiller, 1995, p. 223).

As this review and previous reviews (e.g., Hyatt, 2007) of the literature on the efficacy of Brain Gym® indicate, the treatment claims made by BGI are not supported by empirical data. Children and adults with learning disabilities (LD) are particularly vulnerable to the unsubstantiated claims Brain Gym® makes given Dennison's (2006) emphasis on finding more effective ways to help children and adults who have been identified as LD. The appearance of being scientifically based and claims of being grounded in neuroscience research cause Brain

Gym® to be incredibly appealing to teachers who are generally eager to find ways to improve student outcomes. Given that fact that special educators are largely considered "the final arbiters of how children with disabilities are taught" (Mostert & Crockett, 1999-2000, p. 130) and have a great deal of freedom to implement or adapt programs and practices as they see fit (Boardman et al., 2005), it is crucial that information about the efficacy of programs such as Brain Gym® be disseminated and available to teachers.

Conclusion

There is certainly great potential for improving teacher instruction and student learning through a better scientific understanding of how the brain functions (Ansari, 2008; Goswami, 2006) and how a technology-rich society may be changing the way the brain develops (Wolfe & Brandt, 1998). However, programs appearing to be founded on principles of brain-science, particularly BGI, should not be given a free pass solely based on claims of being 'brain-based,' but instead should be subject to the same standard of empiricism and scrutiny as other educational research.

Empirically based evidence is crucial in at least two respects: First, empirically based best practice will ensure that limited educational resources are not diverted to practices that lack empirical support, and second, to ensure that students are only exposed to educational practices that are in their best interests (Horner et al., 2005). In this regard, BGI fails in every respect. First, BGI was founded on long-invalidated theoretical assumptions, and second, there are no high quality, empirical research studies validating its claims.

Given this era of accountability and the legal emphasis on evidence-based practice, there are currently many programs and interventions that have been demonstrated through high quality studies to improve student outcomes. It seems imprudent, therefore, for consumers to invest hope, time, and resources in programs (i.e., BGI) that have not been validated through high quality, empirical studies.

We believe it is imperative for educators to "critically read and analyze the research in order to separate the wheat from the chaff" (Wolfe & Brandt, 1998, p. 10). The problem, however, is that parents and educators alike often lack *discriminative ability*—"the ability to know and understand what works effectively, what does not work effectively, and the ability to tell the difference" (Mostert, 1999-2000, p. 119). Along with the challenge to become critical consumers, teacher preparation programs should re-examine how they equip pre-service teachers to critically examine special education literature, and, similarly, parents and communities need much more accurate information to avoid promises for money that are completely unsustainable.

If we fail to accomplish these elementary but important goals we may well, as a field, continue to perpetuate ineffectiveness as best practice, an issue raised by Ravitch (1998), who described a personal medical emergency that aroused her thinking about how her medical team diagnosed and treated her condition. She then applied what she had observed to how a team of educators might have responded in similar circumstances:

> I looked appreciatively at the medical doctors around my bed, grateful to be surrounded by men and women who have a common vocabulary, a common body of knowledge, a shared set of criteria, and clear standards for recognizing and treating illnesses. They have access to reliable tests that tell them what the problem is, and they agree on treatments that have been validated over a long period of time. (p. 34)

Great efforts have been made in special education to determine if educational practices are evidence-based (e.g., Baker et al., 2009; Chard, Ketterlin-Geller, Baker, Doabler, & Apichatabutra, 2009; Ehri, Nunes, Stahl, & Willows, 2001; Lane, Kalberg, & Shepcaro, 2009;

Montague & Dietz, 2009). However, when held to established standards for evaluating high quality research (i.e., Gersten et al., 2005; Horner et al., 2005), those interventions that fail the test should not be marketed or implemented until more accurate answers are established, if possible.

If we are unwilling to subject children and adults to experimental medical treatments that have not been validated through high quality, empirical research over a long period of time, we see no reason to be any more willing to subject students in our schools and classrooms (where they spend a significant number of their formative years) to educational interventions that remain similarly untested and not validated.

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Table 1

Essential and Quality Indicators (Gersten et al., 2005) Applied to BGI Research Studies

Essential Quality Indicators	Cammisa (1994)	de los Santos et al. (2002)	Khalsa et al. (1988)	Sifft & Khalsa (1991)
Quality Indicators for Describing Participants				
1. Was sufficient information provided to determine/confirm whether the participants demonstrated the disability(ies) or difficulties presented?	Yes	N/A	No	N/A
2. Were appropriate procedures used to increase the likelihood that relevant characteristics of participants in the sample were comparable across conditions?	No	No	No	No
3. Was sufficient information given characterizing the interventionists or teachers provided? Did it indicate whether they were comparable across conditions?	No	No	No	No
Quality Indicators for Implementation of the Intervention and Description of Comparison Conditions				
1. Was the intervention clearly described and specified?	No	No	Yes	Yes
2. Was the fidelity of implementation described and assessed?	No	No	No	No
3. Was the nature of services provided in comparison conditions described?	No	No	No	No
Quality Indicators for Outcome Measures				
1. Were multiple measures used to provide an appropriate balance between measures closely aligned with the intervention and measures of generalized performance? A study would be acceptable if it included only measures of generalized performance. It would not be acceptable if it only included measures that are tightly aligned.	Yes	Yes	No	No
2. Were outcomes for capturing the interventions effect measured at the appropriate times?	No	Yes	Yes	Yes
Quality Indicators for Data Analysis				
1. Were the data analysis techniques appropriately linked to key research questions and hypotheses? Were they appropriately linked to the unit of analysis in the study?	Yes	No	Yes	No
2. Did the research report include not only inferential statistics but also effect size calculations?	No	No	No	No

Desirable Quality Indicators	Cammisa (1994)	de los Santos et al. (2002)	Khalsa et al. (1988)	Sifft & Khalsa (1991)
1. Was data available on attrition rates among intervention samples? Was severe overall attrition documented? If so, is attrition comparable across samples? Is overall attrition less than 30%?	No	No	No	No
2. Did the study provide not only internal consistency reliability but also test-retest reliability and interrater reliability (when appropriate) for outcome measures? Were data collectors and/or scorers blind to study conditions and equally (un)familiar to examinees across study conditions	No	No	N/A	N/A
3. Were outcomes for capturing the interventions effect measured beyond an immediate posttest?	No	No	No	No
4. Was evidence of the criterion-related validity and construct validity of the measures provided?	No	No	N/A	N/A
5. Did the research team assess not only surface features of fidelity implementation (e.g., number of minutes allocated to the intervention or teacher/interventionist following procedures specified), but also examine quality of implementation?	No	No	No	No
6. Was any documentation of the nature of instruction or series provided in comparison conditions?	No	No	No	No
7. Did the research report include actual audio or videotape excerpts that capture the nature of the intervention?	No	No	No	No
8. Were results presented in a clear, coherent fashion?	Yes	Yes	Yes	Yes
Overall Achievement of Essential & Desirable Indicators (N = 18)	22% (n = 4)	17% (n = 3)	22% (n = 4)	17% (n = 3)

Note: From "Quality indicators for group experimental and quasi-experimental research in special education," by R. Gersten, L. S Fuchs, D. Compton, M. Coyne, C. Greenwood, & M. S. Innocenti, 2005, *Exceptional Children*, *71*, p. 151.