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ATTENTION DEFICITS, ATTENTION-DEFICIT HYPERACTIVITY DISORDER, AND INTELLECTUAL DISABILITIES

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Abstract

Attention-deficit Hyperactivity Disorder (ADHD) and its earlier nosologic classifications have been extensively investigated since the 1960s, with PubMed listings alone exceeding 13,000 entries. Strides have been made in the diagnosis and treatment of ADHD in individuals with intellectual function in the normal range, as described in companion reviews in this special issue. In contrast, comparatively little is known about ADHD in Intellectual Developmental Disabilities (IDD) despite the possibility that ADHD is statistically overrepresented among individuals with IDD [Pearson et al., 1997; Pearson et al., 2000].

Here we provide a review of diagnostic controversies in ADHD with IDD, and discuss several topics that are currently attracting research efforts in the field. These include behavioral phenotyping and attempts to come to grips with problems of behavioral and etiologic heterogeneity. Additionally, we consider issues relating to methodologically sound assessment of attention disorders and evidence-based intervention procedures that may clarify and/or ameliorate attention deficits in individuals with IDD.

Keywords

Developmental Disabilities; Attention; Attention-deficit Hyperactivity Disorder; Autism; Behavior Analysis; Behavioral Phenotypes; Comorbidity; Dual-diagnosis; Psychiatric diagnosis; Psychopharmacology; Single-subject methodology

INTRODUCTION

In this review, we discuss the special case of attention deficits among individuals with Intellectual Developmental Disabilities (IDD). Delineating attention deficits against a backdrop of generalized intellectual impairment has been controversial. There remain as well unresolved issues surrounding Attention-deficit Hyperactivity Disorder (ADHD) specifically in IDD [Pearson et al., 1997; Pearson et al., 2000]. Our review will revisit a number of issues that have emerged in the course of recent research and others that remain unresolved despite efforts over the past half century.

Some of the issues that we touch on are drawing increasing attention in the study of psychiatric conditions comorbid with IDD [Di Nuovo and Buono, 2007; Einfeld et al., 2006]. After laying out some of the issues surrounding the diagnosis of ADHD in IDD, we consider their historical background, the use of behavioral phenotyping approaches for ADHD, the role of etiologic heterogeneity of ADHD among IDD conditions, and approaches to subgrouping attention deficits to help resolve heterogeneity of phenotypes. Finally, we review research concerning behavioral analysis of attention deficits in IDD and behavioral and pharmacological approaches that may be useful in their amelioration –

approaches that may be rendered more effective when they come to grips with the problem of heterogeneity.

DIAGNOSIS AND EVALUATION

The longstanding controversy about the definition of attention deficits in IDD stems from a widely-held opinion that such deficits are inherent to intellectual disabilities [Bergen and Mosley, 1994; House et al., 1979; House and Zeaman, 1963; Melnyk and Das, 1992; Merrill and Taube, 1996]. Indeed, as the IDD field assembled itself in the 1960s and 1970s, deficits of attention were deemed to a defining difference between persons with and without IDD (then termed “mental retardation”). Melnyk and Das [1992] wrote, for example, that attention deficit is “characteristic of individuals with mental retardation.” Bergen and Mosley [1994] felt that these subjects “consistently demonstrate attentional deficiencies”. This view has been termed the *Difference (or Defect) Model* by Burack and colleagues [2001].

But is it the case that all individuals with IDD have an accompanying attention dysfunction? This depends on how the question is logically framed. Proponents of the *Difference Model* tend to compare IDD samples to a Chronological Age- (CA-) matched control/contrast group. In such a comparison, it seems unremarkable to find that there are behavioral impairments among individuals with IDD – not only on tasks presented to assess general intellectual functioning (e.g., IQ tests), but also on a range of tasks presented to assess various domains of attention specifically [Parasuraman, 1998]. Assessed by these metrics, attention deficits and the symptomatology associated with ADHD indeed appear with greater frequency in IDD samples than in CA-matched samples drawn from the general population [Aman et al., 1996; Epstein et al., 1986; Masi, 1998; Pearson et al., 2000].

The picture becomes somewhat different, however, when IDD samples are compared to Mental Age- (MA-) matched control/contrast groups. Proponents of this approach contend that attention deficits are not intrinsic to IDD. Rather, individuals with IDD are thought to develop similarly to persons who are intellectually “typically-developing”, except at a slower rate --- that is, they have experienced a developmental lag with a lower asymptote (termed the *Developmental Model*; [Burack et al., 2001]). Below we review these models with respect to performance on tests of attention, following that with consideration of ADHD as diagnosed by DSM criteria.

Attention Deficit

The predictions made by the *Difference* and *Developmental Models* can be empirically tested. Iarocci and Burack [1998] did so through a meta-analysis of research findings based on an extensive search of the literature. They identified 26 studies that compared attention performance of persons with and without “familial mental retardation” (IDD attributed to cultural-familial or psycho-social influences rather than “organic” causes such as specific genetic syndromes, exposure to teratogens, inborn errors of metabolism, and other biochemical factors). They argued that there was much support for the *Developmental Model*. That is, attention performance in IDD samples was judged similar or occasionally even superior to the MA-matched contrast groups of individuals without IDD. Interestingly, there was some mixed support for the *Difference Model*, with similar levels of performance sometimes observed in both the IDD and CA-matched control/contrast groups, and sometimes not. The latter findings do seem to challenge the purest version of a *Developmental Model*, which broadly relates functioning in persons with IDD to those of individuals with comparable MAs, not CAs.

There are some provisos to be considered when reviewing this research, some of which were noted or implied in the meta-analysis by Iarocci and Burack.

1. One key consideration is that outcome may differ as a function of the degree of heterogeneity in IDD. Conditioning on subtype (e.g., hyperactivity, impulsivity, autistic-spectrum attention problems) or on specific etiologies may yield distinctive behavioral phenotypes, including those pertinent to attention functioning and disorders. “Familial mental retardation” as it was described in the meta-analysis seems likely to have included a miscellany of specific (but at the time undiagnosed) conditions – the influence of which may have been a variable in those instances in which the *Difference Model* was supported or not. For example, if the attention task required detecting elements within a visually complex pattern and if the sample inadvertently overrepresented autism spectrum disorders, then one might find masking of attention differences that might have been observed had the attention test been different [Motttron et al., 2003].
2. Also acknowledged by Iarocci and Burack was the fact that there are many forms of attention to be studied (e.g., selective, sustained; see *Quantification of attentional phenotypes* below). The outcome of a meta-analysis is likely to hang on what manifestation of attention is under study.
3. Further, the construct of “mental age” itself requires consideration in relation to IDD. This construct seems so broadly construed that it can be ambiguous: it can be a single number, such as an age-equivalent score (e.g., as in the Peabody Picture Vocabulary Test [Dunn and Dunn, 2007]) or alternatively a collection of behavioral measures. Moreover, there is also an underlying potential confound between attention and MA, since attention itself could be figured into a measure of MA.

Attention Deficit hyperactivity disorder

The *Diagnostic and Statistical Manual* has long supported the *Developmental Model*. This is because, starting with the DSM-III-R [1987], and extending through the DSM-IV [1994] and DSM-IV-TR [2000], children and adolescents with “mental retardation” were diagnosed with ADHD only if the relevant symptoms significantly exceeded those compatible with the individual’s MA [Green, 2006]. However, the means of implementing this diagnostic algorithm are limited.

For group studies contrasting IDD versus samples with intellectual functioning in the normal range, it is difficult to assert that there is an overrepresentation of an ADHD. The epidemiology of ADHD in IDD is at a very early stage of development, and we currently do not have good estimates of the base-rates of ADHD symptoms in IDD [Antshel et al., 2006]. It is also important in modeling group contrasts to consider whether ADHD as manifested in IDD is similar to that seen in individuals with IQs in the normal range. This question was addressed recently by Simonoff and colleagues [2007] in the United Kingdom. They asked whether ADHD symptoms were different in subjects with mild intellectual disability (assessed by the WISC-III-UK), compared to subjects with typical ability. From a population sample of 2,726 children aged 12–15, they identified a stratified sub-sample enriched for mild intellectual disability; this yielded 192 individuals for analysis. Neither profiles of ADHD symptoms, assessed using the Strengths and Difficulties Questionnaire, nor co-morbidity with emotional or behavioral problems, differed as a function of intellectual disability.

Quantification of Attentional Phenotypes: Tests of Attention

The *Developmental Model* requires that the level of attention be titrated for MA. To render adjustment objective, however, quantitative measures would be required with an

accompanying normative database. It is not currently possible to meet this requirement fully for several reasons.

1. Widely used tests of attention of the type used in typical research on ADHD are not appropriate across the range of functioning encompassing IDD, which ranges from mild to severe disabilities. Most current tests rely training via demonstration, modeling, and/or syntactically complex verbal instructions (e.g., “I want you to observe the computer screen, push the button whenever you see an X, but don’t push it if you see any other letter.”). To the extent that a given sample is comprised of individuals whose observing and/or language skills are questionable, it is not possible to conclude that any deficits revealed by attention testing actually are specific to attention processes *per se*. A valid, reliable evaluation would require instructional techniques tailor-made for individuals with limitations of intellectual functioning – a testing prerequisite that seems downplayed and sometimes virtually ignored in literature reviewed here.
2. Also downplayed are attempts to assure comparable motivation when contrasting samples of individuals with IDD to CA- or MA-matched groups, an issue that may be important also in comparisons involving otherwise intellectually typically developing individuals with ADHD and non-ADHD contrast groups. When motivational comparability is not verified during testing, it becomes difficult to separate attention deficits *per se* from deficits in social control of behavior and/or other aspects of motivation. This issue too has a long history in the IDD field. Behavior deficits of persons with IDD in general have been attributed to motivational deficits, and this position continues to be influential in the IDD field (see Switzky et al [2006] for a recent treatment of motivational issues in IDD). Notably, many widely used therapeutic procedures for persons with IDD, especially those exhibiting communication deficits, derive from applied behavior analysis, a discipline that emphasizes analyses of motivational variables and behavioral functions.
3. A broad range of attention tests of the types described in this special issue of *DDRR*, is needed, thus affording the opportunity to evaluate multiple models of attention [Epstein et al., 2006; Sergeant, 2005; Swanson et al., 2000]. Thus, there is a long list of procedural prerequisites to consider before a systematic attempt can be made to quantify behavioral phenotypes in IDD in terms of characteristic attention profiles [McIlvane and Deutsch, 2004; McIlvane et al., 1996]. It is worth noting, however, that so far the subspecification of attentional measures in ADHD with or without accompanying IDD has provided little explanatory power for diagnosis or pathophysiology.

Quantification of Attentional Phenotypes: ADHD Diagnostic Scales

The diagnosis of ADHD for IDD using the *Developmental Model* DSM schemata requires adjudication of symptomatology based on MA-appropriate norms. Though a clinical impression can be formed, formal quantitative methods are not yet available. Population norms for ADHD symptomatology using DSM criteria would be useful for computing individual scores for ADHD; conceivably, the range of assessment could then be extended for valid applications to IDD populations. This would be a *tour de force*; however, there are hopeful developments that might eventually yield norms for ADHD symptomatology appropriate to IDD, e.g., along the lines of the Diagnostic Criteria for Learning Disabilities/ Mental Retardation (DC-LD) [Seager and O’Brien, 2003]. Analogous norms might be developed for ADHD questionnaires as well. There is increasing use of ADHD checklists in evaluation of IDD groups, including the Conners Parent-Teacher Questionnaires [Handen et

al., 1994] and the Aberrant Behavior Checklist-Community [Miller et al., 2004], and these could be used in an effort to quantify specific attentional phenotypes.

Ideally, it would be possible to compute standardized scores for attention performance and ADHD symptomatology, conditioned on age, just as it is possible to calculate them for full-scale IQ scores/subtests. Such a computation would permit objective determination of how an attention phenotype in an individual with IDD compares to an MA-matched sample. Statistical methods for comparing across attention and IQ-based measures, which in some cases may be correlated [Seager and O'Brien, 2003; Simonoff et al., 2007], are in place [O'Brien et al., 2006].

ETIOLOGIC HETEROGENEITY OF ADHD AMONG IDD CONDITIONS

There are many sources of heterogeneity to consider when characterizing attention in IDD, and distinctive phenotypes may emerge when specific conditions and subtypes are considered [Burack et al., 2001]. The best documented form of heterogeneity in ADHD with IDD is etiologic. As in other complex psychiatric disorders (e.g., autism), a miscellany of syndromes feature attention deficits as key behavioral phenotypes [Deutsch et al., 2008; McCaffery and Deutsch, 2005; McIlvane and Deutsch, 2004]. Examples include the interstitial duplication of Chromosome 15q (15q11-q13) [Thomas et al., 2003], boys with Fragile X syndrome (FXS) [Backes et al., 2000], Aarskog-Scott syndrome (due to a novel FGD1 gene mutation) [Orrico et al., 2005], and Williams syndrome (microdeletion of 7q11.23) [Einfeld et al., 2001].

It is also the case that a single etiological subtype may produce a broad range of phenotypes that includes ADHD and IDD, but also a diverse range of accompanying abnormalities. A recent example that has come to light may be found among the recurrent rearrangements of Chromosome 1q21.1 [Mefford et al., 2008, in press; see accompanying editorial by Ledbetter, 2008]. These investigators tested for the presence of microdeletions and microduplications of this region of Chromosome 1, and found a remarkable array of problems, including IDD, ADHD, autism, craniofacial dysmorphology, and cardiac defects.

In evaluating ADHD comorbidity with IDD, care must be taken to evaluate attention deficits in the context of complex behavioral phenotypes. Williams syndrome provides a case in point. The seemingly advanced social and communication skills relative to cognitive abilities in this condition [Mervis, 2003] may inflate educators' impression of these children's MA. Given the inflated MA estimate, children with Williams syndrome may be placed in educational settings that are beyond their actual abilities. Failure to perform as expected in these situations may lead to restlessness and off-task behaviors --- behaviors that may lead directly to the clinical impression of ADHD (see [Zwaigenbaum et al., 2006] for further discussion of this issue).

SUBTYPES OF ATTENTION DISORDERS

Patterns of ADHD symptomatology may cohere within not only specific, well-defined etiologic conditions, but also within more generalized behavioral subgroups. These subgroups may be thought of as behavioral syndromes that include a rich assortment of etiologic conditions. A case in point concerns the neurocognitive phenotypes that overlap in ADHD and autism, a topic currently attracting much attention [Happé et al., 2006]. Correlational analyses have shown that children with IDD and an autism diagnosis are rated as having more ADHD/hyperactivity symptoms [Hastings et al., 2005]. There is increasing interest in comorbid ADHD symptomatology in children with autism spectrum disorders (ASDs). It is now thought that almost half of children with ASDs exhibit hyperactivity, inattention and impulsivity [Sinzig et al., 2008]. In this light, subtyping IDD individuals by

behavioral syndromes such as autism may potentially elucidate distinctive behavioral phenotypes of attention deficit. Subtyping may afford increased statistical power to detect group differences in biobehavioral correlates. Further, more resolute phenotypes may provide tools in resolving etiologic factors for complex disorders.

BEHAVIORAL ANALYSIS OF ATTENTION DEFICITS IN IDD

Earlier, we referenced the highly influential work of Zeaman and his colleagues in the 1960s and 1970s – work that was instrumental in initiating the debate between advocates of the *Developmental* and *Difference* models. In efforts to characterize the learning deficits of persons with IDD, Zeaman and House [1979] presented an analysis that is compatible with the distractibility and impersistence that is noted in IDD individuals who carry ADHD diagnoses. These investigators argued that learning was impaired in these individuals because they did not attend to the relevant dimension(s) of learning tasks in the typical fashion. Instead, task-irrelevant stimuli/dimensions captured their attending and thus distracted them from achieving solutions in problem-solving tasks. Even when the data suggested that task-relevant attending had been established, a subset of individuals with IDD continued to exhibit only intermediate levels of performance, suggesting ongoing distraction from task-irrelevant stimuli/dimensions; others never seemed to attend to task-relevant stimuli, instead persisting in attending to task-irrelevant stimuli and never showing improvement despite very extensive training (see House, Hanley, & Magid [1979] for an example of both types of performance by persons with moderate IDD on a simple oddity task).

Behavior analytic methodology has been widely applied to the study of attention deficits within children diagnosed with comorbid autism and IDD. This initiative has a long history. During the 1960's, Lovaas and his colleagues initiated a program of behavioral analysis and intervention with these children. He described one aspect of their behavior as follows: "Operationally, our data show that when autistic children are presented with multiple stimulus inputs, their behavior comes under the control of a range of input that is too restricted." This problem was referred to as *stimulus overselectivity* [Lovaas et al., 1971; cf. Liss et al., 2006]. Since then, overselectivity has frequently been associated with autism and IDD more generally [Wilhelm and Lovaas, 1976]. Taken as a whole, therefore, the studies in the available literature do tend to show that dysregulation of attention is a frequently occurring phenomenon in IDD. Some studies report attending that seems highly variable and/or poorly organized and others report what seems to be overly narrow and perseverative attending. Not clear from the present literature, however, is whether these findings indicate fundamental differences in the attention profiles of the specific individuals studied or merely different behavioral responses to different testing procedures in individuals exhibiting more general problems in the regulation of attention.

In broadest overview, behavioral analysis of attention in individuals with IDD indicates some of the same or very similar patterns of dysregulated attention that are observed in otherwise typically developing persons with ADHD, supporting the notion of comorbidity of IDD and ADHD. This position becomes all the more attractive to the extent that one can document common etiological and biobehavioral processes that contribute to the dysregulation of attention. There good reason to believe that such processes will become more firmly established. For example, the "executive function deficits" that are common in ADHD [Denckla, 1996] are also common among individuals with IDD syndromes. Such deficits, which describe ineffective or inefficient neural control processes that normally interconnect, prioritize, and integrate other brain functions, are clearly amenable to study via increasingly capable methods of cognitive neuroscience (e.g., multimodal imaging technologies [Sharon et al., 2007]).

IMPLICATIONS FOR TREATMENT OF ADHD SYMPTOMATOLOGY IN IDD

Given that both ADHD and IDD present behaviorally heterogeneous profiles, it follows that behavioral heterogeneity will also characterize also individuals with comorbid diagnoses of ADHD and IDD. Therefore, treatments to ameliorate attention deficits ideally should be tailored to address the specific symptomatology exhibited by the *individual* – not the ADHD/IDD group as a whole. As in the treatment of ADHD without IDD, there are two general approaches to treatments, pharmacological and behavioral.

Pharmacological Approaches

In recent years, a small but growing literature has assessed the effects of stimulant medication assessment in ADHD with IDD. Methylphenidate has been the focus of most of these studies, which tend to be smaller scale clinical efforts with functionally heterogeneous samples (e.g., Aman, Buican, & Arnold, [2003]). In one of the larger available studies, Pearson and colleagues [2004a,b] found that successively higher methylphenidate doses were associated with gains in cognitive task performance, with optimal performance noted at the highest dose. This pattern is consistent with findings in the Multimodal Treatment Study of typically-developing children with ADHD [Swanson et al., 2008]. Dose-response curves revealed significant linear components of trend on measures tapping sustained attention, visual selective attention, auditory selective attention, as well as delay of gratification and matching-to-sample (one of a number of discrimination learning tasks that are frequently used to study aspects of attention in IDD [McIlvane et al., 1996]).

Pearson and her colleagues suggest that cognitive testing, together with behavioral and medical assessment, can be an effective tool in assessing stimulant response in children with ADHD in IDD. One challenge is doing medication assessment studies with many persons with IDD was mentioned earlier – the challenge of securing procedural control by the assessment methodology. Unless such procedural control is established, there is no way to assess – except via informant-based methodology – whether or not the pharmacotherapy is having its intended effects in the remediation attention deficits. Here, methods of applied behavior analysis offer promise that useful protocols can be developed that will render medication assessment more objective and reliable. Indeed, such protocols should make it possible to evaluate medication effects on a single-case basis, using exact nonparametric statistical techniques [Deutsch et al., 2001]. Careful double-blind medication-placebo crossover assessment has proven a useful model for establishing drug response. Such careful assessment may be particularly important for individuals having comorbid IDD and ADHD, because some studies have found that these patients may be particularly susceptible to adverse medication side effects [Handen et al., 1999]. In the section that follows, we will cover certain behavior analytic methodologies that appear relevant to the development of improved protocols for defining, studying, and potentially ameliorating ADHD symptomatology in IDD.

Translational and Applied Behavior Analysis

The field of applied behavior analysis is familiar to many practitioners in the IDD field and, as other chapters in this volume illustrate, use of behavioral methods is also well-represented in the ADHD field. The essence of applied behavior analytic methodology is the analysis of stimulus and/or response functions as operationalized within three-term contingencies of reinforcement (so-called ABC [antecedent-behavior-consequence] analysis; cf. [Hanley et al., 2003]). Much of the behavior analytic literature concerns the clinical management of undesirable behavior such as aggression or self-injury, although some of it addresses behavioral deficits that could be considered consistent with comorbidity of IDD and ADHD,

as we describe below. However, regarding assessment and amelioration of specific ADHD-related attention deficits, the available literature is sparse.

By contrast, translational behavior analysis [McIlvane et al., in press] is less widely known and practiced, occupying a position that directly parallels the translational biomedical initiatives at the National Institutes of Health [Birmingham, 2002]. As quoted in Dr. Birmingham's review, Dr. Lee Nadler (Dana Farber Cancer Institute, Boston) provides this definition: "A translational researcher is someone who takes something from basic research to a patient and measures an endpoint in a patient." Within the field of IDD, much of this translational investigation is conducted under quasi-laboratory conditions in clinical or educational settings that serve persons with IDD. In contrast with ABA analysis, much current translational behavior analysis concerns itself specifically with the behavior analysis and amelioration of attention deficits and other aspects of cognitive performance, including that influenced by psychoactive medication [Williams and Saunders, 1997]. Below we illustrate aspects of this research that have implications for treatment.

Remediation of Attentional Dysfunction in IDD

Perhaps the central question in the behavior analysis of attention deficits in IDD is the degree to which they can be overcome through special education procedures. Following Denckla's [1996] suggestion that attention deficits can be traced in part to executive function deficits, for example, can such procedures serve in place of executive functions, either as an interim step in training or as prostheses in support of improved behavioral functioning?

Can the attending of persons with IDD be directed to relevant aspects of tasks that require disregarding irrelevant aspects? Yes, providing that training procedures are designed to render relevant differences obvious, and if potentially distracting stimuli are introduced gradually (see [McIlvane, 1992; McIlvane et al., 1996] for treatments of the shaping of attending in IDD). Indeed, given such training, even individuals with severe IDD can acquire tasks requiring selective attending with few or no errors and exhibit very high levels of accuracy of terminal accuracy.

ABA methods have also been used to improve impulsivity, a cardinal feature of ADHD. Recent research has shown that behavior analytic procedures can manage and potentially correct impulsive behavior in persons with IDD, for example, by means of *delayed stimulus presentation procedures* (e.g., McIlvane, Kledaras, Callahan, & Dube, 2002). Briefly, such procedures separate selective attention tasks into two components: one in which the attending target is absent from a display that contains two or more choices, and another delayed component which presents the target as a possible choice only if the individual refrains from responding until that presentation has occurred. That is, all pre-target responses delay the presentation of the target until pre-target responses do not occur for at least a brief period of time. Performance on such procedures is contrasted with that on procedures that immediately present the target as a valid choice. Many individuals with IDD exhibit persistently low or intermediate accuracy in target detection under the latter conditions. Under the former condition, however, initial high levels of responding to non-target displays are gradually replaced by appropriate waiting for the target. Target detection accuracy in the second component is typically high in delayed presentation procedures – even when the individual is still exhibiting pre-target responding in the first component.

Returning to the case of overly narrow and perseverative attending described above, this is also amenable to behavior analysis and remediation. Research has shown that such behavior results from poorly organized and ineffective observing behavior and not a central deficit in attentional capacity. Studies conducted with eye-tracking methodologies have shown that

overselective responding in children with IDD can be closely linked to failures to observe all relevant features of complex stimuli [Dube et al., 1999]. Further, when those failures are corrected by interventions that induce adequate observing, overselectivity is eliminated. Procedures developed to combat overselectivity add *differential observing response* (DOR) requirements to typical training procedures in order control observing behavior and verify detection of all relevant stimuli. Examples of effective DORs include requiring individuals to make discriminations between stimuli to be attended to immediately prior to the attention test or requiring individual to name the stimuli on the test before responding. While the utility of such procedures was first documented in laboratory studies [e.g., Dube and McIlvane, 1999], recent research translation to applied settings has been successfully accomplished (e.g. Walpole et al., [2007]).

One challenge is to develop procedures that assure that performances established through training persist over time. While the DOR procedures, for example, have been demonstrated to be effective in reducing or eliminating overselective responding on specific attention tasks, effective observing behavior does not always persist in the absence of specific DOR requirements. Indeed, some individuals return to patterns of ineffective observing once DOR requirements are withdrawn [Dube and McIlvane, 1999]. Here, we make contact with another cardinal feature of ADHD – the impersistence of behavior. Translational behavior analytic research is also addressing this challenge, as follows.

Analysis of Behavioral Persistence/Impersistence: Behavioral Momentum

Clinical and educational interventions for individuals with IDD often involve efforts to alter the flexibility with which behavior is allocated in daily life. Increases in behavioral flexibility are desirable to, support transitions from one activity to another, for example, or to address the rigid and ritualistic aspects of autism spectrum disorders. In contrast, decreases in flexibility are sometimes desirable, e.g., to promote reliable work habits or to reduce distractibility in academic instruction. The latter application is relevant to the *DSM* characteristics of ADHD, “Often has trouble keeping attention on tasks or play activities” and “Is often easily distracted.” [American Psychiatric Association. and American Psychiatric Association. Task Force on DSM-IV., 2000]).

Behavioral flexibility can be measured in tests of behavioral persistence or resistance to disruption. To provide a formal model of flexibility, investigators have applied Behavioral Momentum Theory [Nevin and Grace, 2000] to describe the relationship between the characteristic level of reinforcement available in a situation and the behavioral resistance to disruption in that situation. It does so by drawing an analogy with the physics of motion. There, the momentum of a moving body is defined in classical mechanics as the product of mass and velocity. The degree to which an outside force can perturb the motion of a moving body depends upon its momentum; increasing mass while holding velocity constant increases the resistance to change. Behavioral Momentum Theory suggests a parallel in the domain of behavior: The rate of responding serves as an analogue of velocity, yet rate alone cannot be used to determine behavioral momentum, just as velocity alone cannot be used to compute physical momentum. This behavioral analogue of mass can be indexed by measuring the resistance of behavior to some operation that disrupts it.

Basic research with both humans, including persons with IDD, and nonhumans has shown that resistance to change (a) is positively related to the overall rate of reinforcement in the situation in which the behavior occurs and (b) is independent of response rate under most circumstances [Dube and McIlvane, 2006; Nevin and Grace, 2000]. In a prototypical momentum study, initial training conditions arrange a situation in which different rates of positive reinforcement occur in two alternating components signaled by distinctive cues. Then, test sessions arranged for some new event to disrupt behavior in both components; in

the studies with participants with IDD, the disruptive event was a potentially distracting event – a concurrent opportunity for some alternative behavior that generated reinforcement, either responding to a different task, or watching a video. According to the behavioral momentum analysis, behavioral mass should be greater in the component with the higher rate of reinforcement and thus the relative degree of disruption in test sessions is predicted to be smaller in the component with the higher rate. This prediction has been repeated confirmed in persons with IDD, although the magnitude of the effect varied across individuals (e.g., [Dube et al., 2003]).

Translational research is still in the early stages but the basic findings have been replicated in humans with intellectual disabilities. Mace and colleagues [1990] reported the first non-laboratory demonstration of differential behavioral momentum in two adults with IDD. The baseline responses were sorting plastic dinnerware (a different color for each schedule component) and the disrupter was the concurrent presentation of an interesting video. Results showed that the sorting behavior in the component with the higher reinforcement rate was more resistant to disruption. Recently, this result was replicated systematically in special-educational classrooms with children with IDD [Parry-Cruwys et al., in press].

Concerning application to ADHD, momentum theory is beginning to attract the attention of researchers in child clinical psychology. For example, [Strand, 2000] applied momentum principles and perhaps directly related principles concerning behavior allocation in competing reinforcement situations [Fisher and Mazur, 1997] to the treatment of child conduct disorders. The latter principles have been applied in clinical research with children with ADHD [Murray and Kollins, 2000; Neef et al., 2005] to assess whether stimulant medication enhances the detection of changing reinforcement conditions and other determinants of impulsivity.

While behavioral momentum and choice principles have not yet inspired studies of attention processes and executive functions specifically in ADHD, they have found application in studies with IDD populations. In one case, behavioral momentum procedures and principles have been used to analyze and influence behavioral persistence in discrimination reversal tasks [Dube & McIlvane, 2002], which are often used as measures of simple executive functions in IDD (see Dube & McIlvane [2006] for a recent review of behavioral momentum and choice research in IDD). Given that behavior momentum principles provide a strong foundation in basic research and a growing literature in applications to address classroom and clinic problems, it is surprising that the literature does not yet include a formal momentum study --- one with children with ADHD assessing behavioral persistence and potential influences on attention processes.

Limits of Translational and Applied Behavioral Studies of Attention Deficits

Research studies and procedures discussed above establish the potential for behavior analytic methods to address attention dysfunction among persons with IDD. Left unresolved, however, is the issue of whether systematic training programs inspired by them can produce generalized improvements in ADHD symptomatology in individuals with IDD. Also unanswered in the current literature are questions concerning the long-term application of applied behavior analytic methods to reduce ADHD symptomatology in IDD. Finally, it is not yet known whether combinations of behavioral intervention and pharmacotherapy can have additive influences in the remediation or management of ADHD symptomatology in IDD.

SUMMARY AND CONCLUSION

In broad overview, symptomatology associated with ADHD (e.g., dysregulated attention, impulsivity, behavioral impersistence) is exhibited in many individuals with IDD. However, it remains controversial whether this symptomatology reflects a delayed typical or truly deviant developmental course. Resolving this and related conceptual issues is difficult from the available body of literature, much of which has been contributed without a full appreciation of the etiological heterogeneity of the IDD population (an issue that applies also to the ADHD population without IDD). Understanding the challenges of population heterogeneity will require not only clarification of the etiologic determinants of comorbid IDD and ADHD but also diagnostic and behavioral assessment methodologies that come to terms with the wide variation in behavioral functioning in the IDD population. As to therapeutic intervention, there is evidence that pharmacotherapy and behavioral therapy can lead to improvements in behavioral function in this group. Although methodologies have been established for individualized behavioral assessment and treatment evaluation of comorbid IDD and ADHD, applied behavior analysis has only rarely addressed in these individuals, particularly with respect to attentional dysfunction. There is a foundation, however, for potentially effective treatments for attention deficits in translational behavioral research, drawn from the armamentarium developed to improve behavior among individuals with IDD. Whether these interventions can be rendered broadly effective and clinically useful over the long term remains to be determined.

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