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HOT TOPIC

Toward a Strengths-Based Cognitive Profile of Children with Fetal Alcohol Spectrum Disorders: Implications for Intervention

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Abstract

Background Fetal alcohol spectrum disorder (FASD) is characterized by a complex profile of cognitive and behavioural impairments. Although understanding impairment guides diagnosis, little attention has been devoted to considering areas of intact functioning and strengths.

Method This review focused on identifying areas of typical performance and/or relative strength in the FASD cognitive profile literature (up to November 2019), specifically the domains of intelligence, executive function, learning and memory.

Results There is considerable variability in the FASD cognitive profile. Unequivocal areas of strength were not identified. However, we noted several FASD group trends, including stronger nonverbal reasoning, learning, and memory abilities than verbal abilities; better performance on verbal learning and memory tasks that embed strategies; and better performance on less cognitively demanding tasks.

Conclusions Identifying areas of relative strength provides promising avenues for intervention. Future research should explore areas of intact functioning and relative strength among children with FASD more explicitly, alongside areas of difficulty.

Keywords Fetal alcohol spectrum disorder · Cognitive profile · Strengths · Executive function

Introduction

An estimated 3 to 5% of North Americans have a fetal alcohol spectrum disorder (FASD; [62]), a condition characterized by a range of cognitive, behavioural, and physical disabilities that result from prenatal alcohol exposure (PAE; [60]). The prevalence of FASD, coupled with the significant challenges that individuals with FASD may experience, makes this a pressing concern in educational, health, and social contexts.

Since FASD was identified in the early 1970s (e.g., [25]), researchers have endeavored to define an FASD cognitive profile to guide assessment, diagnosis, and intervention. Syntheses of four decades of research suggest a highly heterogeneous cognitive profile characterized by a range of mild to severe deficits in intellectual ability, executive function (EF), learning, memory, attention, visual-spatial processing, academic achievement, delayed motor and language development, and adaptive functioning (e.g., [34.•, 36, 42]). A generalized deficit in processing and integrating information, particularly as task demands increase, has also been proposed [28, 34.•, 42]). One limitation of the current FASD cognitive profile is that it is unbalanced: deficits are well documented, but *strengths* are not routinely examined or discussed. This may impede a well-rounded diagnostic picture and ultimately affect treatment. When cognitive and behavioural deficits are significant, as in FASD, a compensatory approach where strengths are leveraged from intact functional systems can be used to enhance treatment outcomes [23]. Along with others (e.g., [16.•]), we propose that identifying group-level areas of strength may provide important information to consider in working clinically with individuals, as well as guiding future research.

The goal of this paper was to review literature on the FASD cognitive profile with a focus on *intact functioning* and *relative strength*. We defined *intact functioning* as group performance where standardized scores: (i) did not differ statistically from typically developing controls; or (ii) fell within the normative Average range, regardless of

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how performance differed from controls. *Relative strength* describes specific scores *within* an FASD group that were significantly higher than other aspects of performance in that group, regardless of where scores fell normatively or in comparison to controls [46].

Psychometric Terminology

Studies selected for review reported standardized scores, percentiles, or qualitative descriptors of standard scores. Standardized scores included standard scores ($M = 100$; $SD = 15$), scaled scores ($M = 10$; $SD = 3$), and t-scores ($M = 50$; $SD = 10$). Standardized scores and percentiles were categorized as within the normative Average range using criteria outlined by individual test manuals (where available), or based on guidelines described by Sattler [63] using scores that fell within one standard deviation of the mean. In articles where no standardized scores were included, reported qualitative score descriptors (e.g., Average range) were used.

Diagnostic Terminology

The studies reviewed utilized a variety of diagnostic terminology, reflective of different categorization systems and evolving diagnostic practices. All diagnostic terms fall under the broader umbrella term of FASD. Fetal alcohol syndrome (FAS) is the most severe consequence of PAE: affected individuals present with severe growth deficiency, facial dysmorphology, and significant damage to the central nervous system (CNS). Individuals with partial fetal alcohol syndrome (pFAS) exhibit some, but not all, physical features of FAS. In this review, the term "dysmorphic FASD" refers to individuals with FAS and/or pFAS. The term "non-dysmorphic FASD" refers to individuals with alcohol-related neurodevelopmental disorder (ARND) who lack dysmorphic physical features but still experience significant neurobehavioural deficits. We use the term "FASD" to describe samples that consider both individuals with dysmorphic and non-dysmorphic FASD together.

Search Process and Criteria

A literature search for cognitive and neurobehavioural profile research in FASD populations was initially conducted using two search engines: Blacklight and Google Scholar. Follow-up searches were completed using two databases: PsycInfo and PubMed. Only peer-reviewed articles reporting standardized scores, percentiles, or qualitative score descriptors (e.g., Average range) published through November 2019 were included. We excluded articles that focused on assessment of adults with FASD. The areas of cognitive functioning affected among those with FASD are broad; as such, we focused on the domains of functioning with greatest empirical support and relevance to psychological assessment: intellectual functioning, executive function, attention, and learning and memory.

Profile of Relative Strengths

General Intelligence (IQ)

Common intelligence test batteries (e.g., Wechsler Intelligence Scales for Children [WISC], Stanford Binet) measure various broad abilities as an indication of general cognitive ability, or IQ. Each IQ test battery is structured differently; however, two major factors are consistently measured: (1) verbal reasoning ("crystallized intelligence," referred to as Verbal Intelligence Quotient [VIQ] or Verbal Comprehension Index [VCI] in this section); and (2) non-verbal reasoning ("fluid intelligence," referred to as the Performance Intelligence Quotient [PIQ] or Perceptual Reasoning Index [PRI]). Performance in these areas is typically combined with other scores to yield a Full-Scale IQ (FSIQ) standard score. Many IQ batteries also assess (visual) processing speed and working memory. Processing speed will be discussed in this section; however, working memory is usually studied as part of executive function in the FASD literature and will thus be discussed in that section.

Lowered IQ in contrast to same-age peers is commonly documented in individuals with FASD, but the majority of individuals diagnosed with FASD are not intellectually disabled (i.e., FSIQ < 70 plus adaptive functioning impairment). A recent meta-analysis found that the average FSIQ of both dysmorphic and non-dysmorphic individuals with FASD fell within the Low Average normative range [dysmorphic FASD $M(SD) = 83.5$ (12.95), range = 64.40–98.04; non-dysmorphic FASD $M(SD) = 84.2$ (12.57), range = 72.20–99.46 [72]]. Although few reports provide a specific IQ profile analysis of summary scale and subtest scores, a review by Mattson and Riley [38] reported that differences in verbal reasoning and non-verbal reasoning were common. However, the direction of this difference was inconsistent.

Several studies have published IQ profiles demonstrating a general trend toward relative strengths in nonverbal reasoning (PIQ/PRI) and aspects of visual processing speed for children with non-dysmorphic FASD, although this pattern is much more variable for children with dysmorphic FASD. In an early study, Conry [12] compared a clinical sample of 19 children with FAS ($n = 13$) or non-dysmorphic FASD ($n = 6$) to age- and sex-matched typically developing controls on a battery of intellectual and neuropsychological tests. Although children with FAS demonstrated FSIQ, VIQ,

and PIQ scores in the Extremely Low range (< 70; significantly below children with non-dysmorphic FASD as well as typical controls), children with non-dysmorphic FASD performed commensurately with controls. The mean FSIQ and VIQ of the non-dysmorphic group fell in the Low Average range, whereas nonverbal abilities were relatively stronger, falling in the normative Average range. Similarly, a study of 50 clinically referred children aged 6 to 15 with FASD demonstrated relatively stronger mean nonverbal reasoning scores ($M = 87.5$) than verbal reasoning scores ($M = 78.7$) on the Wechsler scales [55]. Within the non-verbal reasoning domain, the FASD group performed in the normative Average range on two of the three non-verbal reasoning subtests. Similarly, Carr and colleagues [7] found that that children with pFAS had significantly lower mean PIQ scores than children with non-dysmorphic FASD; however, mean PIQ scores among the latter group fell well within the Average range ($M = 101.2$). Both groups also demonstrated mean PIQ scores that were more than one standard deviation higher than mean VIQ scores.

Astley's [4] retrospective profile analysis of 1400 patients with FASD reported greater differences between VIQ and PIQ for non-dysmorphic individuals with FASD compared to those with dysmorphic FASD. In addition, individuals with milder forms of non-dysmorphic FASD demonstrated VIQ and PIQ scores in the normative Average range. For all diagnostic groups, highest subtest scores were observed on a nonverbal subtest (Picture Completion), although performance fell in the Low Average range for individuals with dysmorphic FASD, while pooled scores of children with mild and severe non-dysmorphic FASD fell in the normative Average range. A follow-up assessment of 65 of these patients (20 with dysmorphic FASD, 45 with non-dysmorphic FASD) revealed a similar profile, with higher PIQ scores than VIQ scores [5]. Additionally, PIQ and Processing Speed scores were the highest summary scores across all groups, falling in the Low Average range in the dysmorphic FASD and severe non-dysmorphic FASD groups (compared to other within-group summary scores in the Borderline range) and in the normative Average range for the mild non-dysmorphic FASD group.

More recently, Flannigan and colleagues [16.•] conducted a retrospective chart review of 38 young offenders with FASD ($n = 38$; age 12–18). Compared to a sample of young offenders without FASD, the FASD group showed significantly weaker VIQ scores, but comparable PIQ scores (Low Average range), again suggesting relative perceptual reasoning strengths.

Although many studies have reported relative strengths—and even typical performance—in aspects of non-verbal reasoning compared to verbal reasoning among children with FASD, results are not definitive. Several studies have documented little difference between verbal and non-verbal reasoning among children with FASD [2, 19, 26, 48]. For example, both Aragón and colleagues [2] and Nash and colleagues [48] found that the group mean WISC FSIQ, VIQ, and PIQ scores of children with FASD fell in the Average range, with no statistically differences between VIQ and PIQ. Other studies have documented below average IQ composite scores, with no significant differences between verbal and non-verbal reasoning (e.g., [26]).

Processing Speed

Among studies reporting full IQ test battery scores, several reported group mean Processing Speed index scores in the Low Average to Average range for children with FASD [5, 19, 48, 55]. More specifically, it appears that children with FASD may perform best on simple visual processing speed tasks with reduced demands on visual-motor integration. To illustrate, one study found overall processing speed to be a relative strength for children with and without dysmorphic features of FASD [24]. In fact, as a group, children with dysmorphic FASD scored nearly two-thirds of a standard deviation higher on the Processing Speed Index (PSI) than on any of the other WISC-III summary scales, with an overall group mean score in the normative Low Average range ($M = 81.15$). Children with non-dysmorphic FASD also demonstrated highest group mean scores on the Processing Speed Index, with mean scores in the normative Average range ($M = 91.77$).

In contrast, Flannigan and colleagues [16.•] found that young offenders with FASD showed significantly weaker performance on several tasks of processing speed (Wechsler scales, Stroop Color and Word conditions) than an unaffected comparison group, with the exception of a simple speeded task (Trails A).

Executive Function

Executive Function (EF) is a complex construct encompassing planning, set-shifting, inhibition, strategy deployment, flexible thinking, and working memory. EF also involves the integration of other processes such as memory, attention, sensation, perception, and motor activity [71]. EF is generally measured via subjective ratings of observable behaviour (i.e., behavioural rating scales) or performance-based measures.

Behavioural Ratings of EF

Children with FASD often show greater impairment on parent and teacher behavioural rating scales of EF than on performance-based measures of EF (e.g., [5, 21]. This difference may be attributable to a variety of factors. First, EF rating scales are designed to enhance ecological validity and

capture overt behavioural manifestations in clinical populations, whereas objective measures are not [18]. That is, the sampling frames for the two types of data differ: data from performance-based measures are collected in controlled, structured settings whereas rating scales collect data based on behaviour in less-predictable, more complex real-world situations [1]. That said, many researchers do not yet support this assertion of ecological validity, stating that we lack definitive understanding of what exactly is being measured when objective EF tools are employed in developmental populations and how scores relate to behaviour (Mattson & Riley, 2011). Second, scores may be poorer on subjective reports in clinic-referred samples (common in FASD) due to rater variables, such as increased rater stress and frustration associated with dealing with the severe symptomology characteristic of clinic-referred samples [21].

Nevertheless, behavioural reports of EF may be useful in FASD assessment as they may more accurately discriminate children with PAE from non-exposed peers with ADHD and controls than objective measures [49] and are also able to better capture daily functioning [21]. All locatable studies of EF rating scales among children with FASD used the Behavioural Rating Inventory of Executive Function (BRIEF; parent and teacher report), with the majority reporting significant global impairment. Not all studies reported specific subscale scores, but among those that provided a detailed profile [44, 55, 56], "Organization of Materials" emerged as the least impaired subscale. This subscale taps the most concrete task demand among the EFs assessed.

Performance-Based EF

Across numerous studies, children with FASD have demonstrated difficulties with performance-based EF tasks including measures of verbal and non-verbal fluency, problem-solving and planning, cognitive flexibility, inhibition, and working memory compared to typically developing children (Kingdon et al., 2015). Some have suggested that EFs may be especially sensitive to prenatal alcohol exposure and can play a role in accurately identifying individuals who have been prenatally exposed to alcohol, regardless of dysmorphology (e.g., [42]. Yet, a closer look at studies reporting detailed results from multiple measures of EF suggests a more nuanced EF profile with pockets of relative strength.

Fluency Children with FASD tend to demonstrate general impairment in both verbal and non-verbal fluency, although some aspects of fluency are relatively stronger than others. In regard to verbal fluency, across several studies children with FASD demonstrated difficulties with both letter and category fluency, with some exceptions. For example, Astley and colleagues (2009) found that the group mean scores for children across the FASD spectrum fell in the normative Average range for accuracy on the D-KEFS Verbal Fluency Switching Task, with the mild non-dysmorphic FASD group scoring at the same level as typical controls. Others have found that, as a group, children with FASD perform relatively better on category fluency tasks than letter fluency tasks [29, 40, 54, 64, 67]. In fact, Aragón and colleagues [3] found that a group of children with FASD were indistinguishable from controls on category fluency, but not letter fluency. Category fluency tasks are less demanding than letter fluency tasks because they have inherent structure and require less abstract verbal abilities [32]. Relative strengths in category fluency suggest that, rather than being affected by an overall language or verbal fluency deficit, individuals with FASD may struggle with EF mediated aspects of verbal abilities. Therefore, they may perform better when presented with more concrete language tasks or when they are provided with clear, external organization techniques such as semantic clustering.

Within the nonverbal fluency domain, findings are equivocal. One study documented impaired design fluency on the Delis-Kaplan Executive Function System (DKEFS) among children with FASD compared to controls [64], whereas two other studies found that groups of children with FASD did not display deficits relative to the normative average on the NEPSY-II or DKEFS design fluency subtests [30, 54]. Although the latter two studies did not compare performance to control groups, the first included primarily more severely affected children with FAS, making it difficult to compare these studies. Ware and colleagues (2012) found that although children with FASD scored significantly lower than typical controls on DKEFS design fluency, the group mean scaled score still fell within the normative Average range. Conversely, in a similar study, mean scores on this same subtest were below the normative Average as well as below controls [19].

Problem-Solving and Planning The D-KEFS Tower Test and Wisconsin Card Sorting Task (WCST) have been frequently used with children with FASD to examine problem-solving and planning with mixed results. Compared to control groups, in many studies, children with FASD tend to perseverate on incorrect strategies, get fewer items correct overall, and use less initial time to plan how to approach a problem [3, 20, 45, 67]. However, despite demonstrating significantly lower scores than controls, some investigations revealed FASD group mean standard scores in the normative Average range on the WSCT [45, 67].

Several recent studies, including large multi-site investigations, found that group performance of children with FASD (particularly those without co-morbid ADHD) was not significantly different from controls on Tower Task move accuracy or total score, with mean scores falling in the normative Average range [5, 19, 49]. In fact, of all subtests on

the D-KEFS, Glass and colleagues found that Towers was the only EF test in which alcohol-exposed participants did not differ significantly from controls. Another study reported that the mean scores of children across the FASD spectrum fell in the Average range for errors on the WCST, with the group performance of children with mild ARND being indistinguishable from typical controls [5].

Cognitive Flexibility and Concept Formation Trail-making tests have been used in several studies as measures of both simpler cognitive abilities such as speed of processing (Trails A) as well as EFs such as cognitive flexibility or set-shifting (Trails B). Children with FASD show relative strength on Trails A, typically performing as a group similarly to controls [17, 54, 67]. However, FASD group performance is typically impaired relative to controls and the normative mean on Trails B [19, 43, 49, 52]. This provides further evidence for relatively intact speed of processing on simple visual-motor tasks, but difficulties on tasks that require the integration of multiple sub-skills or heavier reliance on EF [36].

Inhibition In their meta-analysis, Kingdon and colleagues (2015) found that children with FASD showed less consistent impairment relative to controls on inhibition tasks. Children with FASD typically performed below controls and the normative mean on Stroop tasks, particularly during switching and interference conditions [37, 47, 54]. However, three large multi-site investigations found that although children with FASD performed below controls on the D-KEFS Colour-Word Interference Inhibition task in completion time and total errors, mean scaled scores fell within the normative Average range, especially for those with non-dysmorphic FASD without ADHD [19, 49, 68]. Astley et al. [5] found no significant differences between children with non-dysmorphic FASD and controls on this task, with group mean performance again in the normative Average range. Similarly, Flannigan and colleagues [16.•] found that young offenders with and without FASD showed similar performance on Stroop Color/Word, with group mean performance within the normative Average range.

Working Memory Children with FASD tend to exhibit robust deficits in the ability to hold and manipulate information in working memory (Kingdon et al., 2015, 34.•, 36, 53]. Impairment appears fairly uniform, both relative to controls and to the normative mean, at least in digit and spatial span tasks (e.g., [13, 15]).

Attention

Children with FASD typically demonstrate robust impairment in attention (e.g., [16.•, 36]). However, some aspects of attention may be less impaired than others. For example, simple auditory attention may be a relative strength (e.g., [57]), at least in contrast to visual attention [11, 35] or auditory attention tasks with more complex task demands such as response inhibition [57]. Nash and colleagues [47] found that children with FASD performed very poorly on the Test of Everyday Attention for Children (TEA-Ch)'s visual attention task (scaled scores ~ 4), but scored significantly higher on the TEA-CH's auditory attention task, though still below the normative Average range (scaled scores ~ 7). Further, Kingdon and colleagues' 2015 meta-analysis found there were no statistically significant differences on measures of attentional vigilance between non-dysmorphic individuals (but not dysmorphic individuals) with FASD and healthy controls.

Learning and Memory

Verbal Learning and Memory

In general, children with FASD have difficulty with both learning and recall of verbal information. However, some research indicates that although children with FASD may learn and recall less verbal information compared to controls, on verbal tests with implicit strategies (e.g., word-list learning tests with semantic clustering or grouping of words by superordinate category, such as the California Verbal Learning Test—Children's Version [CVLT-C]) children with FASD may learn *relatively* more information and may actually retain as much information as peers when initial learning is taken into account [26, 39, 41, 69] compared to word-list learning tests without implicit strategies (e.g., the Verbal Learning subtest of the Wide Range Assessment of Memory and Learning,WRAML; [61]. Specifically, greater use of semantic clustering strategies was shown by Roebuck-Spencer and Mattson [61] to be related to enhanced learning and retention of information on the CVLT-C in children with FASD. The utility of leveraging strength through strategy use is further illustrated by the finding that despite children with FASD seeming to plateau earlier on the CVLT-C (third trial), compared to continued learning throughout all four WRAML trials [41, 61], they still acquired more information in those three trials on the CVLT-C. This suggests that using strategies optimized learning.

As a group, children with FASD have also shown stronger immediate and delayed memory for stories compared to word lists or pairs [51, 55]. Some studies have also documented unimpaired verbal recognition memory [40, 55]. For example, Rasmussen and colleagues found that group memory performance increased on Recognition trials, particularly for word pairs (increasing from a scaled score of 6.65 to 8.90). Taken together, this suggests adding meaningful structure to tasks (e.g., embedding information in a story)

or providing support through cueing helps with learning, retention, and recall for this population.

Nonverbal Learning and Memory

Children with FASD have shown group-level strengths on some aspects of nonverbal learning and memory. The Rey Complex Figure Test (RCFT) is a measure of visual-motor/visual organization abilities as well as visual short-term and long-term memory. Multiple studies have reported lowered performance (≥ 1 SD below the normative mean, as well as in comparison to controls) by FASD groups on the Copy, Immediate Recall, and Delayed Recall tasks [4, 5, 50, 69]. Pei and colleagues [50] proposed that these delays may reflect difficulties in initial encoding or organization of information, rather than memory decay. Kully-Martens [30] extended these findings, reporting that although the FASD group showed impaired performance on the Immediate and Delayed recall trials of the RCFT compared to the normative mean, when administered the Recognition trial (i.e., provided cues for recognizing visual elements), they performed within the normative Average range. This lends support to the theory that poor recall performance may reflect, at least in part, 'disorganized' encoding due to visual-perceptual organization and integration difficulties, which then results in disorganized storage and subsequent complications in retrieval unless cues are given to organize and scaffold retrieval.

Different patterns of performance have also been observed on various types of nonverbal learning and memory, including place learning, spatial recall, and object recall. In one study, children with FAS demonstrated impaired place learning on a virtual Morris water maze task in comparison to typically developing controls [22], although cueing boosted navigation recall in the FAS group to a level indistinguishable from controls. Other studies have noted impaired spatial recall in individuals with FASD, but intact recall for everyday objects [65, 66] and patterns [13].

Nonverbal learning and memory may, overall, represent a strength compared to verbal learning and memory. Groups of children with FASD often score higher on nonverbal tasks than verbal tasks, both within a single test battery as well as in studies including multiple measures. On the CMS, children with FASD have shown higher overall visual learning in comparison to verbal learning, with mean scores falling within the normative Average range for visual learning compared to the Low Average range for verbal learning [51, 55]. Visual immediate and delayed recall were also stronger than verbal recall in these studies. Furthermore, Mattson and Roebuck [41] found that on learning trials, a heavy PAE group performed somewhat better on a test of nonverbal learning (the Biber Figure Learning Test; BFLT) compared to a verbal learning test (the CVLT-C). In addition, they exhibited better delayed free recall on the BFLT (66.7% of items recalled; 73.7% when adjusted for initial learning) compared with the CVLT-C (54.5% recalled; 67.3% adjusted), although this was significantly less than controls. However, Kaemingk and colleagues (2003) found that while children with FASD scored nearly one standard deviation higher on the WRAML Visual Memory Index than the Verbal Memory Index, this difference was not significant.

Discussion

Researchers have spent decades trying to better understand the complex neuropsychological presentation of individuals with FASD. Commensurate with traditional neuropsychology approaches and to assist in diagnosis, these research efforts have primarily sought to document areas of impairment. This has often come at the expense of highlighting intact areas of functioning or aspects of relative strength in this population.

Our review did not find areas of *unequivocal* intact functioning or relative strength, although some interesting trends were noted. At a group level, in many of the studies reviewed, children with non-dysmorphic FASD demonstrated stronger nonverbal reasoning than verbal reasoning on IQ tests. Often, group mean scores fell within the normative Average range. This pattern was less consistent for dysmorphic FASD groups. Non-verbal learning and memory also appeared to be relatively stronger than verbal learning and memory among groups of children with FASD across several studies. One practical implication of this is that children with FASD may learn better when they are provided access to visuals and manipulatives, when verbal information is presented concurrently with graphics, or when they have the option to respond nonverbally [59, 73]. Interestingly, this practice is supported by gray literature regarding educational practices with children with FASD (e.g., [8]) and may be one factor underlying the successes of FASD cognitive rehabilitation programs (e.g., [9, 31] that use several visually mediated strategies.

In the domain of verbal learning and memory, groups of children with FASD also performed better on tasks that included embedded strategies such as semantic clustering (e.g., related word pairs) and tasks that lent themselves to inherent visualization and organization (e.g., the use of meaningfully connected information such as stories). As these tasks are structured in a way that cue retrieval or provide scaffolds for strategy deployment, it is possible that children with FASD may be able to better demonstrate their abilities in areas when tasks are structured to draw out these strengths. In the domain of fluency, children with FASD tended to demonstrate better group-level performance on tasks of category fluency than letter fluency. Although

category fluency is a verbal task, non-verbal strategies can be appropriated to enhance performance [58] as individuals may use visualization strategies to generate words for a given category. Encouraging children with FASD to engage in visualization as a memory or fluency aid (e.g., visual mnemonics) may be another way to use strengths to compensate for challenges—future research could examine this possibility. Cued recall trials also tended to bolster memory performance in both verbal and non-verbal domains. It is possible that building on this relative strength by providing children with FASD verbal or visual cues (e.g., academically through forced-choice questions/multiple choice instead of open-ended questions) may help remove impediments to retrieval and better allow children with FASD to demonstrate what they know.

A final potential area of strength among children with FASD is in the domain of problem solving and planning as evidenced by group performance in the normative Average range and controls in some studies using Tower tests [19, 49]. Despite increased rule violations, children with FASD scored typically in move accuracy and total achievement but had difficulty with self-monitoring and inhibition [70]. Clinically, this again lends support to the importance of scaffolding and providing external guidance to individuals with FASD to help navigate situations and find alternatives when solving problems. This pattern of performance also supports current intervention initiatives aimed at increasing self-regulation through teaching self-monitoring strategies and problem-solving skills (e.g., [10, 33]). Further research examining problem solving and planning, particularly with regard to metacognitive skills, will allow for more understanding in terms of strengths and need across this domain.

In general, children with FASD performed better on simpler tasks, or when their performance is supported by cues or within-task scaffolding. Again, children with FASD may possess strengths in many component skills, but the expression of these skills may be stifled by other cognitive challenges (e.g., difficulty with integration; 'bottleneck' effects of limited working memory capacity) which become more apparent as task demands increase. Removing these barriers to execution may allow children with FASD to better demonstrate what they are capable of. For example, some studies found that attentional vigilance and speed of processing were relatively unimpaired when tasks were straightforward and simple. As a practical application, when processing speed or attention is impaired on complex tasks, it may be tempting to recommend that a child seek educational accommodation such as increased time to complete assignments. However, it may be prudent to just simplify task demands and decrease the loading of multiple component skills on a task at one time. A behavioural aspect of EF that often emerged as a relative strength in parent and teacher reports of behaviour was Organization of Materials. Given that this is report based and not performance based, the authors of these studies suggested that this may reflect greater structure imposed on the environments of children with FASD by their caregivers and educators (e.g., [55]). Though not examined in these studies, other research has noted the value of relational supports in helping children and youth with FASD best access and express their abilities (e.g., [6, 14, 27]).

Limitations, Future Directions, and Conclusion

Our profile of relative strengths is tentative for many reasons. First although clinical implications and recommendations are suggested, caution must be taken when applying this strengths profile clinically. Our conclusions are based on groups of children from a variety of studies that include diverse samples with differing intra-individual variables (e.g., amount and timing of alcohol exposure, age, diagnoses) and contextual factors (e.g., FASD is differently diagnosed and identified in various studies, geographic differences, environmental influences). The intent of this paper was not to demonstrate which strengths will be unequivocally observed in an individual FASD psychological assessment, but rather to suggest which areas may be more *likely,* at a *group* level, to emerge as strengths, and thus, which areas should be attended to when compiling or interpreting individual psychological assessments or intervention planning. Individual differences are inevitable, and these need to be taken into account clinically and in determining interventions and supports.

Second, our conclusions are limited by what was available in the literature. Several studies were excluded because they did not report scores, score descriptors, or detailed scores beyond single composites. We urge researchers to include scores where possible—including for measures where significant impairment or differences from controls are not found—to allow for better cross-study comparisons and meta-analysis. Third, and somewhat relatedly, it is possible that due to the deficit-focus of cognitive profile research, the body of literature may be subject to a 'file-drawer' effect, whereby studies finding similar performance between FASD groups and controls are not published because they are viewed as non-significant.

Fourth, as in clinical practice, subtests used in research batteries do not truly isolate individual cognitive abilities, and relatively weak or strong performance cannot be attributed to a single skill strength or weakness. This challenge in interpreting high and low test scores is particularly complicated when synthesizing group studies for several reasons, including: (i) individual profile variations may be obscured by use of group means; (ii) many studies omit certain parts of profiles, publish sections of profiles separately, or use varying sample sizes within a study for different measures within a profile; and (iii) profiles are interpreted in a

piecemeal instead of integrated fashion, which is necessary in review papers such as this.

Last, defining *relative strength* can be a personal matter that will vary based on clinical/practical orientation or research stance. The goal of this paper is not to delineate areas of excellence or splinter skills in children with FASD. Rather, we hope to stimulate a perceptual shift, broadening the conceptualization of FASD as primarily a disorder of general deficit to a condition with inherent abilities that should be celebrated, appreciated, and built upon, regardless of how individuals compare to their non-affected peers.

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Declarations

Conflict of Interest The authors have no conflict of interest to report.

Human and Animal Rights and Informed Consent This is a review paper; as such, research with human or animal subjects was not undertaken by the authors.

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