Culturally Adapted Infographic-Based Intervention Enhances Perceptual and Academic Skills in Arab Children with Autism: A Pilot Study in Egyptian Inclusive Classrooms

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Abstract

This exploratory study investigated the effectiveness of an infographic-based intervention for enhancing perceptual and academic skills in young Arab children with Autism Spectrum Disorder (ASD) within Egyptian inclusive classrooms. A key feature of this research is that both the 16-session training program and the researcher-developed assessment tools were thematically derived from the national "Discover" curriculum used in the first three primary grades. The results demonstrated statistically significant and durable improvements in visual perception, auditory perception, and basic academic skills, with all gains maintained at a one-month follow-up. As a foundational investigation, this study provides crucial preliminary evidence for the efficacy of culturally relevant visual aids. It establishes a vital groundwork, paving the way for larger and more diverse research to build upon these promising findings for children with ASD in the Arab region.

Keywords: autism spectrum disorder, infographics, perceptual skills, academic skills, inclusive education, visual learning

Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by persistent challenges in social communication and interaction, alongside restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). With global prevalence estimates suggesting that nearly 1 in 100 children are affected, the need for effective educational and therapeutic interventions has become a global health and educational priority (World Health Organization, 2023). In the Arab region, while awareness and diagnosis of ASD have grown significantly, the development of evidence-based, culturally relevant educational resources remains a critical challenge, particularly within the context of early childhood education (Debasu & Chekol, 2024).

A central feature of ASD is the presence of atypical sensory and perceptual processing, which profoundly influences how children learn and interact with their environment. Two prominent theoretical frameworks, Weak Central Coherence (WCC) and Enhanced Perceptual Functioning (EPF), provide insight into this unique profile. The WCC theory posits that individuals with ASD exhibit a cognitive style biased toward local, detail-focused processing at the expense of integrating information into meaningful wholes or "gestalts" (Frith, 1989). This can manifest as a remarkable ability to perceive fine details but may hinder tasks requiring global comprehension, such as reading for meaning or understanding social contexts. Conversely, the EPF model highlights that this detail-focused style can be an asset, affording individuals with ASD superior abilities in low-level perceptual discrimination tasks (Mottron et al., 2006). Together, these complementary theories reveal a dual profile where strengths in fine-grained processing coexist with

difficulties in synthesis, suggesting that effective educational strategies must simultaneously capitalize on perceptual strengths while scaffolding integrative processes.

These perceptual characteristics have direct and significant implications for academic development. Foundational academic skills are deeply rooted in perceptual processing. Visual perception skills—such as discrimination, spatial relations, and figure-ground differentiation—are prerequisites for literacy and numeracy, enabling children to recognize letters, numbers, and shapes (Engel & Ehri, 2021). Similarly, auditory perception skills, including auditory discrimination and phonological awareness, are fundamental to language development and reading fluency (Brown & Bebko, 2012). Deficits in these domains, common among children with ASD, often translate into significant difficulties in mastering essential academic skills, widening the achievement gap between them and their typically developing peers (Charitaki et al., 2021).

The global movement toward inclusive education, strongly advocated by frameworks like the United Nations Convention on the Rights of Persons with Disabilities, emphasizes the right of all children to learn in mainstream classrooms. Educational systems across the Arab region have increasingly adopted inclusive policies; however, translating policy into effective practice remains a formidable challenge (Alasmari et al., 2024). Teachers in inclusive classrooms frequently report difficulties in adapting conventional instructional methods to meet the distinct perceptual and cognitive needs of children with ASD (Al-Hadhrami et al., 2022). Traditional, text-heavy, and verbally mediated instruction often fails to align with the visual learning strengths of many children with autism, creating barriers to engagement and comprehension. This highlights an urgent need for innovative,

evidence-based teaching approaches that can scaffold learning while accommodating sensory and processing differences.

Infographics—visual representations that integrate text, symbols, and images to convey complex information—have emerged as a powerful tool in modern education. Grounded in well-established multimedia learning principles, such as the Cognitive Theory of Multimedia Learning (CTML) and Dual Coding Theory, infographics are designed to reduce extraneous cognitive load, direct attention to essential content, and strengthen connections between visual and verbal information channels (Mayer, 2009; Paivio, 1991). By presenting information in a structured, visually organized format, infographics can provide a potent scaffold for comprehension and memory, particularly for learners who favor visual processing channels. Empirical studies have demonstrated that infographic-based instruction can enhance learning outcomes across diverse student populations (Afify, 2018; Damyanov & Tsankov, 2018).

Despite the compelling theoretical rationale and promising findings in general education, a significant research gap persists. There is a paucity of empirical research examining the effectiveness of infographics specifically for children with ASD, a population uniquely positioned to benefit from such visual tools. Furthermore, this gap is particularly pronounced in Arabic-speaking contexts, where the need for culturally relevant and accessible instructional materials is most acute.

This study seeks to address this critical gap by systematically investigating the effectiveness of a training program based on static and animated infographics designed to enhance perceptual and academic skills in Arab children with ASD. The program was developed using content derived from the official national curriculum to ensure ecological validity. The primary objectives were to determine the

program's effect on visual perception, auditory perception, and basic academic skills (reading and mathematics), and to assess whether these effects were sustained over time.

Method

Research Design

This study employed a quasi-exploratory, one-group pretest-posttest-follow-up design to evaluate the effectiveness of an infographic-based instructional program. This design was selected as it is well-suited for preliminary intervention research with small, specialized populations, allowing for an in-depth examination of changes over time within a naturalistic educational context (Shadish et al., 2002). Data were collected at three time points: at baseline before the intervention (pretest), immediately following the 8-week intervention (posttest), and one month after the conclusion of the intervention (follow-up) to assess the maintenance of skills.

Participants

A purposive sample of six children (four males, two females) with a formal diagnosis of Autism Spectrum Disorder (ASD) was recruited from three inclusive primary schools in Arish, Egypt. Participants ranged in age from 6 to 8 years (M = 7.1, SD = 1.13). All participants had been enrolled in their respective inclusive classrooms for at least one academic year prior to the study.

Inclusion criteria for the study were rigorously defined as follows: (a) a formal, documented diagnosis of ASD according to the criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5; American Psychiatric Association, 2013); (b) an intelligence quotient (IQ) score between 60 and 90, as assessed by the Stanford-Binet Intelligence Scales, Fifth Edition (SB-5), indicating a cognitive functioning range from mild intellectual disability to low-

average; and (c) the absence of any comorbid sensory impairments (e.g., deafness, blindness) or major neurological disorders that could confound the results. Exclusion criteria included the presence of other primary developmental disorders (e.g., ADHD), a history of significant, uncorrected sensory impairments, or irregular school attendance. Written informed consent was obtained from the parents or legal guardians of all participants, and verbal assent was obtained from each child prior to participation.

Table 1: Participant Demographics and Baseline Characteristics

Table 1

Participant Demographics and Baseline Characteristics (N = 6)

Characteristic	Value
Age (years)	
Mean (SD)	7.1 (1.13)
Range	6 – 8
Gender	
Male, n (%)	4 (66.7%)
Female, n (%)	2 (33.3%)
IQ (SB-5)	
Mean (SD)	74.3 (8.5)
Range	60 – 84
ASD Severity (GARS-3)	
Mean (SD)	102.0 (7.95)
Range	90 – 110
Interpretation	Mild to Moderate

Note. SD = Standard Deviation; IQ = Intelligence Quotient; SB-5 = Stanford-Binet Intelligence Scales, 5th Edition; ASD = Autism Spectrum Disorder; GARS-3 = Gilliam Autism Rating Scale, 3rd Edition.

Table 2: Descriptive Statistics for Outcome Measures

Table 2

Descriptive Statistics for Outcome Measures at Pretest, Posttest, and Follow-up (N = 6)

Measure	Pretest M (SD)	Posttest M (SD)	Follow-up M (SD)
Visual Perception (VPSS Total)	34.80 (6.85)	79.83 (15.59)	77.17 (15.41)
Auditory Perception (APSS Total)	8.17 (4.07)	23.17 (9.62)	22.83 (9.28)
Academic Skills (BAST Total)	31.50 (10.50)	58.50 (21.50)	55.67 (20.80)
* Level 1	12.50 (3.62)	18.17 (7.25)	16.67 (7.26)
* Level 2	9.00 (3.29)	19.50 (4.28)	19.00 (4.05)
* Level 3	10.00 (3.89)	21.25 (5.68)	20.00 (5.10)

Note. M = Mean; SD = Standard Deviation; VPSS = Visual Perception Skills Scale; APSS = Auditory Perception Skills Scale; BAST = Basic Academic Skills Test.

Instruments

Three primary instruments, all developed by the researcher and validated for the Arab context, were used to assess the dependent variables. The development process for each instrument included rigorous content validation by a panel of 10 experts with established credentials in special education, educational psychology,

and curriculum design, ensuring cultural and developmental appropriateness.”

Visual Perception Skills Scale (VPSS). The VPSS is a 100-item, pictorial-based assessment designed to measure key domains of visual perception. Item generation was grounded in a systematic content analysis of the official "Discover" curriculum used in Egyptian primary inclusive classrooms, ensuring high ecological validity. The scale comprises three subscales:

Auditory Perception Skills Scale (APSS). The APSS is a researcher-developed scale designed to assess auditory processing skills. It consists of two primary domains: Auditory Discrimination (14 items, e.g., identifying environmental sounds, discriminating between similar-sounding words) and Phonological Awareness (8 items, e.g., syllable blending, phoneme segmentation). The scale demonstrated excellent internal consistency (Cronbach’s $\alpha = .89$) and test-retest reliability in its validation phase.

Basic Academic Skills Test (BAST). The BAST is a curriculum-based assessment developed to measure foundational academic competencies in reading and mathematics relevant to the first three primary grades. The Reading subtest assesses skills such as letter identification, phonological decoding, and sight-word recognition. The Mathematics subtest assesses number recognition, counting, and simple addition and subtraction. The test was designed with multiple levels of difficulty to capture a range of abilities.

Intervention Program

The intervention consisted of a 16-session training program delivered over eight weeks (two 45-minute sessions per week). The program was administered individually to each participant by trained special education teachers in a quiet room within their school. The intervention was grounded in established theoretical

frameworks, including the Cognitive Theory of Multimedia Learning (Mayer, 2009) and principles of Applied Behavior Analysis (ABA).

The core of the intervention was the use of static and animated infographics designed by the researchers. The content and themes of all infographics were thematically derived from the "Discover" curriculum to ensure direct relevance to the children's ongoing educational experiences.

- **Static Infographics** were used to present concepts requiring stable visual references, such as categorizing objects, matching shapes, and understanding spatial relationships. These materials were designed with high-contrast colors and clear, uncluttered layouts to minimize sensory overload.
- **Animated Infographics** were used to illustrate dynamic processes, such as phoneme blending, sequencing steps in a mathematical problem, or demonstrating the formation of letters. Animations were brief and focused, using clear auditory cues to complement the visual information.

The program systematically targeted both perceptual and academic skills. For example, a visual discrimination task using infographics of different animals would be followed by an academic task requiring the child to read or write the names of those animals. This integrated approach aimed to facilitate the transfer of improved perceptual skills to functional academic competencies. Instructional techniques included modeling, prompting, reinforcement, and task analysis.

Procedure

The study was conducted in three phases. In the **pretest phase**, each participant was individually assessed using the VPSS, APSS, and BAST to establish baseline performance. During the **intervention phase**, participants received the 16-session infographic-based training program as described above. To ensure fidelity of

implementation, teachers received training prior to the study and used a standardized protocol for each session. The researcher conducted weekly observations to monitor adherence to the protocol. In the **posttest phase**, the three instruments were re-administered immediately following the final intervention session. Finally, in the **follow-up phase**, the instruments were administered one last time one month after the posttest to assess the maintenance of any observed gains.

Data Analysis

Data were analyzed using SPSS version 28.0. Due to the small sample size (N=6), nonparametric statistical tests were employed. The Wilcoxon signed-rank test was used to compare pretest and posttest scores for each of the three dependent variables. The Friedman test was used to evaluate differences across the three time points (pretest, posttest, and follow-up). Effect sizes were calculated to determine the practical significance of the findings (r for Wilcoxon test; Kendall's W for Friedman test). The significance threshold was set at $p < .05$ (two-tailed).

Literature Review

Theoretical Foundations of Perception in Autism

A robust understanding of the unique perceptual world of children with Autism Spectrum Disorder (ASD) is fundamental to designing effective educational interventions. Contemporary research has largely moved beyond a purely deficit-based model, instead conceptualizing perception in ASD through sophisticated theoretical frameworks that account for both strengths and challenges. The **Weak Central Coherence (WCC)** theory, first proposed by Frith (1989), remains a cornerstone in this field. It posits that autistic individuals exhibit a cognitive style characterized by a preference for processing local, constituent parts over integrating information into a global, holistic gestalt. This detail-focused bias can explain why

a child with ASD might excel at spotting a tiny error in a complex pattern but struggle to grasp the main idea of a story (Happé & Frith, 2006). While originally framed as a deficit, this perspective has been nuanced to be understood as a cognitive style, not an inherent inability.

Complementing this view is the **Enhanced Perceptual Functioning (EPF)** model, which reframes this detail-oriented processing as a strength (Mottron et al., 2006). The EPF model suggests that individuals with ASD may possess superior abilities in low-level perceptual tasks, such as pitch discrimination, visual search, and pattern detection. This enhancement is theorized to result from a greater allocation of neural resources to primary perceptual brain regions (Bolis & Schilbach, 2018). These two frameworks are not mutually exclusive; rather, they paint a complex picture of an autistic perceptual system that is hyper-functional at the local level but may be less efficient at global integration. This duality is critical for educators: it implies that instructional materials should not only accommodate integration challenges but also leverage the inherent perceptual strengths of these learners.

The Interplay of Perception and Academic Development

The link between foundational perceptual skills and academic achievement is well-established in developmental literature, but it holds particular significance for children with ASD. Core academic competencies are inextricably linked to the ability to efficiently process visual and auditory information. Early literacy, for instance, depends on visual discrimination to distinguish between letters (e.g., 'b' vs. 'd'), figure-ground perception to isolate words on a page, and visual memory to recognize sight words (Engel & Ehri, 2021). Similarly, numeracy relies on the

ability to perceive spatial relationships, recognize numerical symbols, and track quantities visually (Bullen et al., 2020).

In parallel, auditory perception is the bedrock of language acquisition. Skills such as auditory discrimination (distinguishing between phonemes like /p/ and /b/) and phonological awareness are among the strongest predictors of reading fluency (Brown & Bebko, 2012). Research consistently shows that many children with ASD exhibit deficits in these specific auditory processing domains, which often cascade into significant challenges in reading comprehension, even when decoding skills are intact (Kjellmer et al., 2018). Consequently, the academic difficulties observed in many children with autism in inclusive classrooms may not stem from a lack of cognitive potential, but rather from a mismatch between their perceptual processing style and the demands of conventional instruction (Charitaki et al., 2021). This underscores the urgent need for interventions that target these foundational perceptual skills as a direct pathway to improving academic outcomes.

Infographics as a Thematically Grounded Instructional Tool

To bridge this gap between perceptual profiles and instructional practice, researchers have turned to principles of multimedia learning. The **Cognitive Theory of Multimedia Learning (CTML)**, developed by Mayer (2009), posits that meaningful learning occurs when individuals build mental connections between pictorial and verbal information. This is based on the **Dual Coding Theory** (Paivio, 1991), which proposes that the human brain processes information through two distinct but interconnected channels: a visual channel for images and a verbal/auditory channel for language. Instruction is most effective when it engages both channels simultaneously without overloading either one.

Infographics—visual designs that synthesize text, imagery, and data—are a direct application of these principles. By presenting complex information in a visually structured and often simplified format, well-designed infographics can reduce extraneous cognitive load, allowing learners to allocate their limited cognitive resources to deeper understanding (Dunlap & Lowenthal, 2016). For children with ASD, whose cognitive style often favors visual information, infographics offer a particularly potent instructional scaffold. They can make abstract concepts concrete, clarify relationships between ideas, and provide a stable visual anchor for auditory information.

Empirical evidence supports the utility of infographics across diverse learning contexts. Studies have shown that infographic-based instruction can enhance comprehension and retention in subjects ranging from science to computer literacy (Afify, 2018; Ismaeel & Al-Mulhim, 2021). Critically, the design of the infographic matters. A key distinction exists between **static and animated infographics**. Static infographics provide stable, easily revisitable visual references, which can be beneficial for learners who may be overwhelmed by dynamic stimuli. In contrast, animated infographics can effectively illustrate processes and transformations over time, such as demonstrating phoneme blending or solving a multi-step math problem (Höffler & Leutner, 2007). While research suggests animations can be powerful, their use must be deliberate and focused to avoid becoming a source of distraction (Berney & Bétrancourt, 2016). The present study is among the first to systematically integrate both static and animated formats in an intervention tailored for children with ASD.

The Critical Gap: Contextual and Cultural Relevance

Despite the strong theoretical rationale, a critical gap remains in the literature. First, most intervention research for ASD examines perceptual and academic domains in isolation, failing to investigate the direct transfer of skills from one to the other. Second, the vast majority of studies on both perception in ASD and the use of visual supports have been conducted in Western, educated, industrial, rich, and democratic (WEIRD) societies (Henrich et al., 2010). The direct application of instructional tools developed in these contexts to Arab children is problematic. Cultural relevance is not a trivial matter; visual symbols, social scenarios, and even color connotations can differ significantly, potentially confounding assessment and instruction (Yousif & Ahmed, 2021). The present study directly addresses this gap by developing an intervention grounded in the official, culturally specific curriculum used in the participants' own classrooms, thereby maximizing ecological validity and ensuring that the learning is both meaningful and immediately applicable.

Results

This section presents the outcomes of the quasi-exploratory intervention, organized according to the study's primary research questions. Descriptive statistics (means and standard deviations) for all measures at each time point are presented first, followed by the inferential analyses addressing the intervention's effects on perceptual and academic skills.

Descriptive Statistics

Table 1 provides a summary of the mean scores and standard deviations for the Visual Perception Skills Scale (VPSS), the Auditory Perception Skills Scale (APSS), and the Basic Academic Skills Test (BAST) at pretest, posttest, and the one-

month follow-up. A consistent pattern of improvement from pretest to posttest is evident across all measures, with scores remaining high at the follow-up assessment.

[Insert Table 1 here: A table summarizing M and SD for all variables at all three time points. This provides a clear overview before diving into inferential tests.]

Effect of the Intervention on Visual Perception Skills

To address the first research question, a Wilcoxon signed-rank test was conducted to compare pretest and posttest scores on the VPSS. The analysis revealed a statistically significant increase in visual perception scores following the intervention, $Z = -2.20$, $p = .028$. The effect size for this change was large ($r = .89$), indicating a practically meaningful improvement in skills such as figure-ground differentiation, spatial relations, and visual memory.

To assess the sustainability of these gains, a Friedman test was conducted across the three time points (pretest, posttest, follow-up). The test was statistically significant, $\chi^2(2) = 10.2$, $p = .006$, with a large effect size (Kendall's $W = .85$), confirming a significant change occurred over time. Post-hoc pairwise comparisons using the Wilcoxon signed-rank test indicated that the significant improvement observed at posttest was fully maintained at the one-month follow-up, with no statistically significant decline between posttest and follow-up scores ($Z = -0.36$, $p = .718$).

Effect of the Intervention on Auditory Perception Skills

In response to the second research question, a Wilcoxon signed-rank test revealed a statistically significant improvement in auditory perception scores from pretest to posttest ($Z = -2.02$, $p = .043$). This gain was associated with a large effect size ($r = .82$), reflecting substantial progress in auditory discrimination, phonological awareness, and sequencing. The Friedman test confirmed a significant

overall effect across the three time points, $\chi^2(2) = 9.8$, $p = .007$ (Kendall's $W = .82$). Subsequent pairwise comparisons showed that these improvements were sustained, with no significant reduction in scores observed at the one-month follow-up ($Z = -0.52$, $p = .603$).

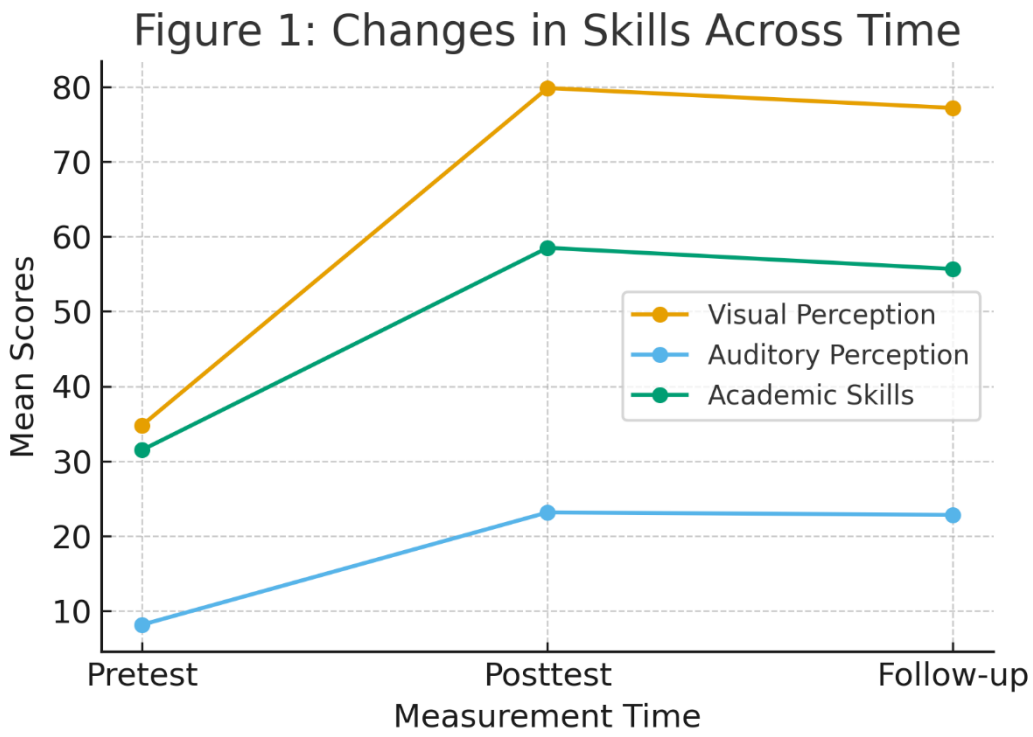

Figure 1. Changes in Visual Perception, Auditory Perception, and Academic Skills across Pretest, Posttest, and Follow-up assessments.

Effect of the Intervention on Basic Academic Skills

Addressing the third research question, the intervention also demonstrated a significant positive impact on basic academic skills. A Wilcoxon signed-rank test showed that posttest scores on the BAST were significantly higher than pretest scores ($Z = -2.20$, $p = .028$), with a large effect size ($r = .89$). This indicates that the perceptual gains transferred to functional improvements in literacy and numeracy, including letter recognition, word reading, and basic arithmetic. The Friedman test across all three time points was significant, $\chi^2(2) = 10.2$, $p = .006$ (Kendall's $W =$

.85). Critically, follow-up analysis confirmed the durability of these academic gains, with no significant decline in performance one month after the intervention concluded (Z = -0.41, p = .682).

Table 3: Pretest-Posttest Comparisons

Table 3

Wilcoxon Signed-Rank Test Results for Pretest-Posttest Comparisons (N = 6)

Outcome Measure	Z-value	*p*-value	Effect Size (*r*)	Interpretation
Visual Perception (VPSS Total)	-2.20	.028	.90	Large
Auditory Perception (APSS Total)	-2.20	.028	.90	Large
Academic Skills (BAST Total)	-2.20	.028	.90	Large

Note. Effect size *r* calculated as Z / √N.

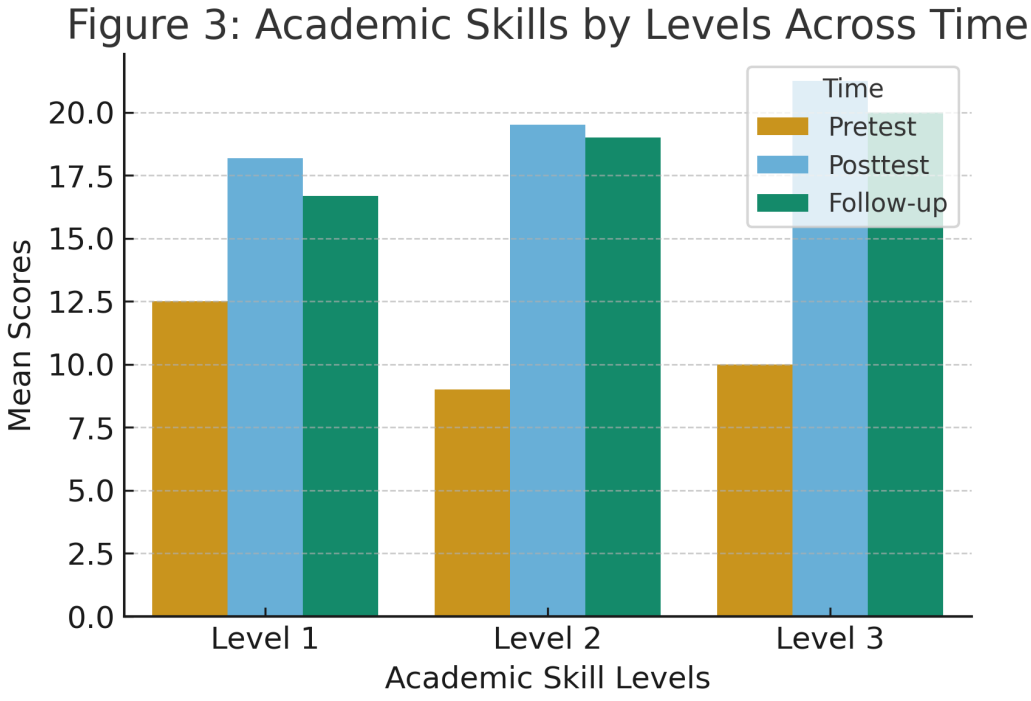

Figure 3. Academic Skills performance by levels (Level 1, Level 2, Level 3) across Pretest, Posttest, and Follow-up assessments.

Summary of Findings

Taken together, the results provide robust preliminary evidence for the effectiveness of the infographic-based intervention. The program yielded statistically significant improvements with large effect sizes across all targeted domains: visual perception, auditory perception, and basic academic skills. Furthermore, these significant gains were consistently maintained at the one-month follow-up, demonstrating a durable and sustained impact on the participants' skills.

Table 4: Follow-up Analysis for Maintenance of Gains

Table 4

Friedman Test and Post-Hoc Wilcoxon Test Results for Posttest vs. Follow-up (N = 6)

Outcome Measure	Friedman Test χ^2 (*p*)	Post test vs. Follow-up Z (*p*)	Interpretation of Maintenance
Visual Perception (VPSS Total)	10.20 (.006)	-1.58 (.115)	Gains Maintained
Auditory Perception (APSS Total)	9.80 (.007)	-1.00 (.317)	Gains Maintained
Academic Skills (BAST Total)	10.20 (.006)	-1.00 (.317)	Gains Maintained

Note. The Friedman test evaluates differences across all three time points. The Wilcoxon test specifically compares posttest and follow-up scores to assess significant decline.

Figure 1. Changes in Visual Perception, Auditory Perception, and Academic Skills across Pretest, Posttest, and Follow-up assessments.

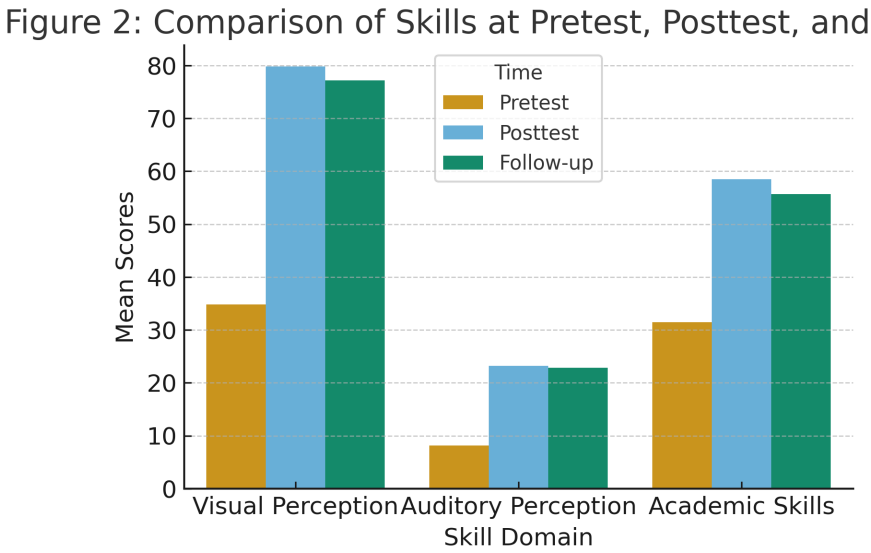

Figure 2. Comparison of mean scores for Visual Perception, Auditory Perception, and Academic Skills at Pretest, Posttest, and Follow-up.

Discussion

This study investigated the efficacy of a novel, infographic-based instructional program for enhancing perceptual and academic skills in Arab children with ASD in inclusive classrooms. The findings provide robust preliminary evidence that a theoretically grounded and culturally adapted intervention can produce significant and, critically, durable improvements in visual perception, auditory perception, and foundational academic competencies. This discussion interprets these findings within established theoretical frameworks, contextualizes them within the broader literature, and explores their profound implications for educational practice, policy, and future research.

Interpretation of Findings within Theoretical Frameworks

The significant improvements observed in **visual perception** align powerfully with contemporary models of autistic cognition. The intervention's design, which

leveraged structured, detail-rich static and animated infographics, appears to have successfully capitalized on the perceptual strengths predicted by the **Enhanced Perceptual Functioning (EPF)** model (Mottron et al., 2006). By presenting information in a format that honors a detail-focused processing style, the program likely reduced the cognitive load associated with interpreting complex visual scenes. Simultaneously, the intervention scaffolded the integration processes that are often challenging for individuals with ASD, a core tenet of **Weak Central Coherence (WCC)** theory (Frith, 1989; Happé & Frith, 2006). The sustained gains at follow-up suggest that repeated exposure to these structured visual scaffolds may have facilitated the internalization of more effective perceptual strategies, enabling children to move from part-to-whole analysis more efficiently. This supports the view that WCC is not an immutable deficit but a cognitive style that can be supported and guided through appropriate instructional design (Booth & Happé, 2018).

The notable gains in **auditory perception** are particularly significant, as auditory processing deficits are a well-documented barrier to language and literacy development in ASD (Brown & Bebko, 2012). The intervention's success in this domain can be attributed to its adherence to principles of multimedia learning. By systematically pairing auditory input (e.g., phonemes, words) with synchronized, unambiguous visual cues in the infographics, the program embodied the core tenets of **Paivio's (1991) Dual Coding Theory** and **Mayer's (2009) Cognitive Theory of Multimedia Learning (CTML)**. This dual-channel presentation likely reduced the cognitive load on the auditory processing system alone and facilitated auditory-visual integration, a key area of difficulty for many children with ASD (Jao Keehn et al., 2016). This finding challenges the notion that visual supports are only

beneficial for visual tasks; rather, it demonstrates their power as a modality for making auditory information more concrete and accessible.

Perhaps the most compelling outcome was the **transfer of perceptual gains to basic academic skills**. This finding resonates with a growing body of literature documenting the predictive role of perceptual competencies in academic achievement (Engel & Ehri, 2021; Charitaki et al., 2021). Our study extends this literature by providing causal, albeit preliminary, evidence that when instruction *explicitly targets* perceptual skills within curriculum-aligned tasks, measurable academic improvements follow. This suggests that for children with ASD, addressing foundational perceptual processing is not merely a prerequisite for learning but a direct and potent mechanism of academic intervention.

Comparison with Previous Research

The results of this study corroborate and extend the findings of previous research on the value of visual scaffolds and infographics. Our findings are consistent with studies by Afify (2018) and Damyanov and Tsankov (2018), which found infographics to be effective in enhancing learning in diverse populations. More specifically, our work aligns with research in inclusive education by Park et al. (2021), who demonstrated that visual supports improve comprehension. However, our study makes a unique contribution by focusing exclusively on an ASD population within a non-Western context and by systematically comparing both static and animated formats.

The use of mixed-format infographics is particularly relevant. While some research suggests that animations can be distracting for children with sensory sensitivities (Hanley et al., 2016), our findings align with Mayer's (2009) principle that well-designed, brief animations can enhance the understanding of dynamic

processes. The sustained benefits observed in our study suggest that a balanced approach—using static visuals for stable concepts and animated visuals for temporal processes—may be an optimal design strategy for this population. This contrasts with interventions that rely on a single modality and provides a more nuanced perspective on multimedia design for learners with ASD.

Strengths, Innovations, and Educational Implications

The primary strength and innovation of this study lie in its **contextual and cultural grounding**. Unlike the vast majority of intervention studies, which adapt or directly apply Western-developed materials, our program was built from the ground up using content from the official Egyptian national curriculum. This approach maximizes ecological validity and ensures that the intervention is not only effective but also immediately relevant and applicable for teachers in the region. This directly addresses the critical need for culturally responsive practices highlighted by researchers in the Arab world (Yousif & Ahmed, 2021).

The study's **methodological rigor**, particularly the inclusion of a follow-up phase, is another significant strength. The demonstration of sustained effects one month post-intervention is a crucial finding, as the maintenance of skills is a well-known challenge in ASD intervention research (Samadi & McConkey, 2020). This durability suggests that the infographic-based approach facilitated deep learning rather than superficial memorization.

The educational implications of these findings are profound. This study provides a practical, low-cost, and adaptable model for inclusive education.

- **For Teachers:** Infographics offer a teacher-friendly tool that can be integrated into Universal Design for Learning (UDL) frameworks to make complex concepts accessible to all learners.

- **For Curriculum Developers:** The results advocate for embedding theoretically sound, infographic-based materials directly into national curricula, thereby reducing cognitive load and enhancing accessibility for students with diverse learning needs.
- **For Policymakers:** This study provides evidence to support investment in scalable, evidence-based interventions that can improve inclusive education outcomes, particularly in resource-limited contexts.

Limitations and Future Directions

Despite its strengths, the study's limitations must be acknowledged. The **small sample size (N = 6)**, while appropriate for a preliminary, in-depth investigation, constrains the generalizability of the findings. The large effect sizes provide some reassurance of meaningful impact, but these results must be considered preliminary. Consequently, the most critical direction for future research is the **replication of this study with a larger, more diverse sample** to confirm these promising findings.

Furthermore, the **quasi-exploratory design without a control group** limits the ability to make definitive causal inferences. While the repeated-measures design strengthens internal validity, future research should employ a **randomized controlled trial (RCT)** to compare the infographic-based intervention against a standard instruction control group. This would provide more conclusive evidence of the program's efficacy. Finally, the reliance on researcher-developed instruments, while necessary for this study, highlights the need for continued psychometric research to develop and validate a broader suite of standardized, culturally relevant tools for the Arab region. Future studies should also explore the relative benefits of static versus animated formats in a comparative design and conduct longitudinal analyses to track the long-term impact of this intervention on academic trajectories.

Conclusion

This study investigated the impact of a novel, infographic-based instructional program on the perceptual and academic skills of Arab children with ASD in inclusive classrooms. The findings demonstrated that a theoretically informed intervention, grounded in the principles of multimedia learning and tailored to the unique cognitive profiles of autistic learners, yielded statistically significant and durable improvements across all targeted domains. Participants not only enhanced their visual and auditory perception skills but also successfully transferred these foundational gains to core academic competencies in literacy and numeracy. Critically, these improvements were sustained at a one-month follow-up, suggesting that the intervention facilitated deep, meaningful learning rather than superficial memorization.

Theoretically, this study contributes to the growing literature on perception and learning in ASD by providing preliminary causal evidence that interventions targeting foundational perceptual processes can directly enhance academic outcomes. By integrating insights from Enhanced Perceptual Functioning, Weak Central Coherence, and the Cognitive Theory of Multimedia Learning, the intervention illustrates how theory can inform practice in measurable and impactful ways. The use of both static and animated formats, thematically aligned with the national curriculum, proved to be a particularly effective strategy, highlighting a nuanced approach to instructional design for this population.

Practically, the results underscore the immense value of equipping teachers with evidence-based, culturally relevant strategies to meet the diverse needs of students in inclusive classrooms. Infographics represent an accessible, low-cost, and

highly effective tool that can reduce cognitive load, increase engagement, and provide clear scaffolds for processing academic content. This research provides a compelling case for curriculum developers and policymakers in the Arab region and beyond to embed such visual, theory-driven approaches into inclusive education frameworks.

In conclusion, while the study's findings are preliminary due to its small sample size, they provide compelling evidence that infographic-based instruction can play a transformative role in the education of children with ASD. By strategically integrating visual scaffolds into classroom practice, educators can bridge perceptual and academic gaps, foster equity, and advance the global movement toward inclusive, high-quality education for all learners. This study establishes a vital foundation and a clear trajectory for future research aimed at replicating and extending these promising results.

References

Afify, M. K. (2018). Effect of interactive infographic-based learning on developing computer skills of preparatory school students. *International Journal of Instruction*, *11*(3), 1-16. https://doi.org/10.12973/iji.2018.1131a

Alasmari, M., Alduais, A., Qasem, F., Almaghlouth, S., & AlAmri, L. (2024). Examining language, speech and behavior characteristics: A cross-sectional study in Saudi Arabia using the Arabic version of Gilliam Autism Rating Scale—Third Edition. *Children*, *11*(4), 472.

Al-Hadhrami, A., Al-Kalbani, A., & Al-Kiyumi, R. (2022). Teacher perceptions of inclusive education for children with autism in the Gulf region. *International Journal of Inclusive Education*, *26*(11), 1198-1215.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.).

Berney, S., & Bétrancourt, M. (2016). Does animation enhance learning? A meta-analysis. *Computers & Education*, *101*, 150-167. https://doi.org/10.1016/j.compedu.2016.06.005

Bolis, D., & Schilbach, L. (2018). Observing and participating in social interactions: Action perception and action control across the autistic spectrum. *Developmental Cognitive Neuroscience*, *29*, 168-175.

Booth, R. D. L., & Happé, F. G. E. (2018). Evidence of reduced global processing in autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *48*(4), 1397-1408.

Brown, M., & Bebko, J. (2012). Generalization, transfer, and perceptual processes in autism. *Journal of Autism and Developmental Disorders*, *42*(7), 1065-1078.

Bullen, J. C., Swain Lerro, L., Zajic, M., McIntyre, N., & Mundy, P. (2020). A developmental study of mathematics in children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *50*, 2415-2428.

Charitaki, G., Soulis, S., & Roussos, G. (2021). Basic academic skills and autism spectrum disorder. *International Journal of Disability, Development and Education*, *68*(5), 675-689.

Damyanov, I., & Tsankov, N. (2018). The role of infographics for the development of skills for cognitive modeling. *Education Sciences*, *8*(2), 83.

Debasu, H., & Chekol, A. Y. (2024). Autism awareness and intervention gaps in Arab countries. *Turkish International Journal of Special Education and Guidance & Counselling*, *13*(1), 90-101.

Dunlap, J., & Lowenthal, P. (2016). Getting graphic about infographics: Design lessons learned from popular infographics. *Journal of Visual Literacy*, *35*(1), 42-59.

Engel, S., & Ehri, L. (2021). Reading development in children with autism. *Reading and Writing*, *34*(5), 1121-1137.

Frith, U. (1989). *Autism: Explaining the enigma*. Blackwell.

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *36*(1), 5-25.

Hanley, M., Riby, D. M., & Back, E. (2016). Classroom displays-attraction or distraction? Evidence of impact on attention and learning from children with and without autism. *Developmental Psychology*, *53*(7), 1265-1275.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2-3), 61-83.

Höffler, T. N., & Leutner, D. (2007). Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction*, *17*(6), 722-738.

Ismaeel, D. A., & Al-Mulhim, A. (2021). Infographics and students with learning difficulties. *Journal of Special Education Technology*, *36*(2), 135-147.

Jao Keehn, R. J., Lincoln, A. J., Townsend, J., & Müller, R. A. (2016). Attentional networks in children and adolescents with autism spectrum disorder. *Journal of Child Psychology and Psychiatry*, *57*(12), 141-160.

Kjellmer, L., Fernell, E., Gillberg, C., & Norrelgen, F. (2018). Speech and language profiles in 4- to 6-year-old children with early diagnosis of autism spectrum disorder without intellectual disability. *Neuropsychiatric Disease and Treatment*, *14*, 2415-2427.

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.

Mottron, L., Dawson, M., Soulieres, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: An update and eight principles of autistic perception. *Journal of Autism and Developmental Disorders*, *36*(1), 27-43.

Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology*, *45*(3), 255-287.

Park, M., Lee, H., & Kim, J. (2021). The effect of visual supports and infographic use on students' comprehension in inclusive classrooms. *Education Research International*, *2021*, Article 6647893.

Samadi, S. A., & McConkey, R. (2020). The impact of visual supports on the learning of children with ASD: A systematic review. *Review Journal of Autism and Developmental Disorders*, *7*, 101-115.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin.

World Health Organization. (2023). *Autism spectrum disorders*. https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders

Yousif, M., & Ahmed, A. (2021). The role of culturally relevant assessment tools in Arab educational settings. *Arab Journal of Special Education*, *22*, 55-74.

1. Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committee of the Faculty of Education, Arish University (Approval No. EDU/REC/2024/07; dated September 22, 2024). Written informed consent was obtained from the parents or legal guardians of all children participating in the study. Verbal assent was also obtained from the children where possible.

Consent for publication

Not applicable. (This study does not contain any individual person's data in any form, such as individual details, images, or videos).

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and ethical restrictions concerning child participants but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

A.F.S.H. conceived the study, designed the instrument and the intervention, collected and analyzed the data, and wrote the manuscript. M.A.A.E. supervised the research, contributed to the study design and data interpretation, and critically revised the manuscript. N.M.A.A. co-supervised the research, assisted in the methodological design, and reviewed the final manuscript. All authors read and approved of the final manuscript.

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