International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

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Implicit and explicit forms of memory among children with high-functioning autism spectrum disorder

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International Journal of Science and Research Archive, 2024, 13(01), 063–072

Publication history: Received on 23 July 2024; revised on 01 September 2024; accepted on 04 September 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.13.1.1626

Abstract

The purpose of this study is to investigate children with high-functioning autism spectrum disorder and their implicit and explicit memory capacities to develop personalized educational and rehabilitative programs. Children with high-functioning ASD have much less explicit memory, but their implicit memory is still mostly intact, according to the research. The study highlights how employing verbal materials for encoding and other memory support can improve performance. Moreover, it emphasizes how critical it is to recognize and treat episodic memory problems in children with ASD, opening the door to more successful interventions catered to their requirements. By identifying the distinctive memory traits of children with high-functioning autism spectrum disorders, the study's implications are critical for improving cognitive performance in this population.

Keywords: Memory; Implicit Memory; Explicit Memory; Autism Spectrum Disorder; Cognitive Function; Neurodevelopmental Disorder

1. Introduction

According to APA Memory refers to the mental processes of learning, encoding, retention, and retrieval (Memory, 2018). Memory is the ability of the brain to encode, store, and restore information. It is a record of past events that serve as a guide for future action. (Staff, 2023).

Memory in simple words, is our ability to recall information (Harvard edu topics/memory, 2023). It is both a result of and a contributor to perception, attention, and learning (Britannica, 2023). Memory is commonly thought of as an information processing system with explicit and implicit functioning, consisting of a sensory processor, short-term (or working) memory, and long-term memory (Memory, 2024). Scientists distinguish between different types of memories based on their content or how we use the information. Short-term and long-term memories are the two main types of memories (Harvard edu topics/memory, 2023). The ability to recall a small amount of information from a recent period is referred to as short-term memory. Long-term memory refers to recalling memories over a longer period (Huizen, 2021).

Both implicit and explicit memory are types of long-term memory. Implicit memory is "the information that you remember naturally and effortlessly, whereas explicit memory refers to knowledge that you have to work difficult to remember " (Cherry, 2022).

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2. Implicit Memory

According to APA, Memory for a previous event or experience that is produced indirectly, without an explicit request to recall the event and without awareness of Implicit Memory involved (Implicit memory, 2018). Implicit memory is also known as non-declarative, motor, or procedural memory because it cannot be actively brought into awareness (Schendan, 2nd edition 2012). The learned skill can be performed automatically and quickly in this type of learning (Reber, 1967). Learned skills are not easily forgotten because they are stored in our implicit memory, which we use whenever we need them daily (Greenwood, 2023). Implicit memory influences experiences, knowledge of different tasks, and behaviors, and these are skills that you learn once and never have to relearn. (Votaw, n.d.). Implicit knowledge is the type of knowledge that is stored in implicit memory. (Ullman, 2004). Implicit memory is effortless, incidental, and quick. (Damis, 2022).

3. Explicit Memory

According to APA, Long-term memory, consciously recalled, refers to general knowledge or personal experiences retrieved in response to a specific need. It is often used interchangeably with declarative memory but with a performance-based orientation (Explicit Memory, 2023). Explicit memory is a type of long-term memory concerned with the recall of facts and events. Declarative memory is another term for explicit memory (Timothy J. Legg, 2018). Explicit memories can be cognitively monitored (Robert R. Hampton, 2020). On the other hand, it is defined as knowledge that involves conscious recollection, recall, or recognition (Marc Ettlinger, 2011). This type of memory necessitates conscious thought, such as remembering who came to dinner last night or naming rainforest animals. Explicit memory is frequently associative; the brain connects memories (Bahman Zohuri, 2022). People use this information daily, from remembering what to write on a test to recalling the date and time of an event (Cherry, 2022). Explicit memory is most controllable to reflection in ongoing cognition and communication in language, forming the most obvious, denotative constructs of consciousness (Don M. Tucker, 2022).

4. Theories Related to Implicit and Explicit Memory:

Theories related to implicit memory and explicit memory include Dual Process Theory, Multiple Memory Systems Theory, Transfer-Appropriate Processing (TAP), and Parallel Processing Theory. Dual Process Theory explains human thought processes as two distinct systems: unconscious, fast, sloppy, deliberate, calculated, and accurate—Parallel (Dual Process Theory: A Simple Summary, 2019). Multiple Memory Systems Theory (MMS) suggests the brain stores information through distinct modules, (Ferbinteanu, 2018) while, Transfer-Appropriate Processing (TAP) demonstrates how initial encoding and retrieval affect memory performance (Transfer-appropriate processing, 2023). Parallel Processing Theory links visual information to color, motion, shape, and depth, aiding in recognition (Parallel processing (psychology), 2023).

These theories add to our understanding of how implicit and explicit memory systems interact and work together during various cognitive tasks and experiences.

4.1. Autism Spectrum Disorder (ASD)

According to APA, Autism spectrum disorder (ASD) is a group of disorders onset in preschool years, denoted by social communication issues, restricted behaviors, interests, and activities (Autism Spectrum Disorder, 2022). ASD is a complex neurodevelopmental disorder defined by persistent deficits in social communication and interaction and restrictive, repetitive, and stereotyped behavioral patterns, activities, and interests (Amstrong, 2013).

Autism (A Gras-Vincendon, 2007) is an early developmental disorder that causes difficulties with learning and social integration. "Autism spectrum disorder is a neurodevelopmental disorder characterized by social communication deficits, restricted interests, and repetitive behaviors" (Hodges, 2020) (The Diagnostic and Statistical Manual of Mental Disorder- 5th Edition, 2013). Autism is not a disease, but it can have serious consequences in a person's life. Its effects can range greatly. Some people will require lifelong assistance, while others will be able to live and work independently (Alex Klein, 2023) People with ASD are also more likely to suffer from psychiatric disorders such as anxiety, depression, obsessive-compulsive disorder, and eating disorders. (Autism spectrum disorder, 2nd Edition, 2007). ASD symptoms appear before the age of three and can last the rest of a person's life, though symptoms may improve over time. Every autistic person struggles with social interaction, empathy, communication, and flexibility to some extent. (Melinda Smith, 2023). Scientists believe that multiple causes of ASD interact to alter the most common ways people develop (ASD Diagnosis, Treatment, and Services, n.d.). Up to 40% of people with autism have genetic syndromes or chromosomal abnormalities, such as small DNA deletions or duplications, single gene conditions or gene variants, and

metabolic disturbances with mitochondrial dysfunction (Butler, 2020). Genetic variants increase the likelihood of a child being on the autism spectrum, with fewer variants causing more tendency in boys than girls (Why Autism Strikes Mostly Boys, 2017). Males are three times more likely to develop autism than females, despite the heritability of autism (Wenk, 2020). ASDs are less common in females due to sex-differential genetic and hormonal factors, necessitating further research to understand the mechanisms influencing risk and protection (Donna M Werling, 2014).

4.2. Management for Autism

Parents should initiate early intervention programs, including applied behavioral analysis (ABA), speech, occupational, psychomotor, and special education, for neurotypical normal children, and place toddlers in regular daycare (Simone Simon Khalifeh, 2016). Early intervention in autistic patients aged 18 to 48 months significantly improves outcomes due to the ongoing neural plasticity at this young age (Reichow B, 2012). Based on experimental psychology research, ABA intervention is used to teach new skills, promote adaptive behaviors, and decrease interfering maladaptive behaviors (Myers SM, 2007). The current therapeutic approach for ASD is ineffective due to the diverse and significantly varying symptoms experienced by affected individuals (Stephen Bent, 2015). Customized treatment methods include specialized training, educational programs, behavioral therapies, and drugs to enhance job skills, self-care, and maturity, and alleviate anxiety and irritation (Scott M Myers, 2007). Applied behavior analysis is a valuable intervention that utilizes personalized training assignments based on behaviorist principles of reward, stimulus, and response (Daniel L Coury 1, 2012). Discrete trial training teaches essential skills, pivotal response training promotes self-management, and anticonvulsants, stimulants, antidepressants, and antipsychotics are typically provided to autistic individuals (Alessandra Maria Casano, 2015). The long-term effects of these medications must be thoroughly researched due to their unique reactions to each individual (Miran Bang 1, 2017). Well-designed interventions can improve the quality of life for individuals with ASD, regardless of their age or ability level (What are the treatments for autism, 2021).

4.3. Implicit and Explicit Memory among Children

"Implicit and Explicit Memory in Youths with High-Functioning Autism Spectrum Disorder," a thorough investigation of cognitive processes in autism (Fucà, 2021). High-functioning autism refers to individuals with autism spectrum disorder who do not have an intellectual disability (Gail A Alvares, 2019). The purpose of this study was to explain the disparities in implicit and explicit memory in autistic children. EM in high-functioning individuals with ASD is largely intact, as evidenced by recognition and cued recall tests (Boucher J. M. A., 2012) (Boucher J. M. A., 2012). High-Functioning Autism (HFA) is often manifested as mild autism, allowing individuals to communicate, read, write, and handle basic life skills. HFA is often associated with Asperger Syndrome (AS), allowing individuals to live independently (Begum, 2023).

Specific memory impairments in children with ASD, such as implicit memory (IM) and explicit memory (EM), have caught the interest of clinicians and professionals because they can be used to maximize strategies for early interventions and educational programs. (Boucher J. M. A., 2012) (Bennetto L., 1996). Several studies have investigated the presence of IM deficits in ASD, yielding inconclusive results (Zwart F.S., 2018) (Gillian M Clark, 2017) and other studies in recent years have identified differences and similarities between explicit and implicit memory tasks and demonstrated that performance on the two types of tasks can be dissociated, leading to the conclusion that the two memory systems are functionally independent (H.L.I. Roediger, 1993) (Cycowicz, 2000). Similarly, conflicting findings have been reported regarding the presence of EM deficits in ASD patients (Izadi-Najafabadi S., 2015). The study's main finding was that youths with high-functioning ASD performed worse on the explicit, but not implicit, version of the SRTT (Serial Reaction Time Task) when compared to the TD (Typically developing) group (Fucà, 2021). The findings are consistent with meta-analyses that have found relative preservation of IM processes in people with ASD (Gillian M Clark, 2017).

4.4. Effects of Implicit and Explicit Memory among Children with ASD

Individuals with autism spectrum disorder (ASD) commonly exhibit a wide range of impairments in their higher cognitive functions, including implicit and explicit memory (Fucà, 2021). The characteristics and intensity of ASD symptoms can differ greatly between patients. ASD manifests in various ways because its core symptoms are frequently associated with co-occurring neurological or psychiatric conditions such as epilepsy, intellectual disability, anxiety disorders, attention-deficit/hyperactivity disorder, and depression (Xiong J, 2019) (Lai M.-C, 2013). According to new Stanford School of Medicine research, children with autism have memory challenges that limit not only their ability to remember faces but also their ability to remember other types of information (Digitale, 2023). Despite deficits in explicit memory, many children with inherited and acquired brain disorders have relatively intact implicit memory, indicating separate memory systems in children (Keith Owen Yeates, n.d.). Individuals with ASD not only have difficulties with motor coordination but also have delays in various aspects of motor development at a young age (Jin Bo, 2016). The

findings suggest that children with ASD have greater implicit procedural learning skills than children with TD. Children with ASD are unaffected by the lack of explicit instructions in probe blocks, indicating resistance to task-setting changes based on differences in explicit and implicit settings. These findings may aid in the more thorough planning of cognitive therapeutic settings for children with ASD (Márta Virág, 2017). Autism can have a significant impact on educational experiences. Autistic children may struggle with social skills, information processing, sensory processing, communication difficulties, and higher levels of anxiety than typically developing children (Zauderer, 2023). The study includes that the implicit task will only necessitate first-order affective decision-making. In contrast, the explicit task will necessitate a meta-representation of one's uncertainty (Toby Nicholson, 2019). Research has linked individual differences in social communication, IQ, and working memory to different patterns of academic achievement in autistic children. (Jennifer C. Bullen, 2022).

4.5. Implicit Learning in ASD

People with autism perform equally well as people without autism on a variety of implicit learning tasks is referred to as intact implicit learning in autism (Brown, n.d.). Individuals with autism spectrum disorders exhibit behavioral rigidity and difficulty with social communication (ASDs). The inability to learn from others is one of the most fatal aspects of this category of disorders (F. FotiF, 2014). The present study shows implicit statistical learning is intact in autistic children behaviorally. (Fenny S. Zwart, 2018). According to research, the effectiveness of implicit and explicit learning has been compared, and it has been demonstrated that learning implicitly provides: Better long-term retention with less skill loss than explicit. Resistance to the effects of psychological stress, disorders, and dysfunction is increased (THE BENEFITS OF IMPLICIT LEARNING, n.d.). Based on the review of the literature, the study concludes that individuals with ASDs can learn implicitly, lending support to the hypothesis that implicit learning deficits are not a core feature of ASDs (F. FotiF, 2014).

4.6. Explicit Learning in ASD

Explicit learning involves cognitive stages and is dependent on the involvement of working memory (Marjan Kok, 2022). Children with autism can benefit from explicit instruction in learning and applying specific reading comprehension strategies such as making predictions, asking questions, summarising, and paraphrasing (Children on the Autism Spectrum, n.d.). Some of the studies looked into the efficacy of computer-assisted explicit instruction for teaching science terms and how it could be applied to students with ASD and intellectual disabilities. The findings indicated that there were positive effects on learning outcomes (Allison L Wainer, 2011)**,** Hence this examines the distinctions between implicit and explicit motor learning and discusses their implications for understanding and promoting motor skill development in children with autism spectrum disorder (Kayleigh Hyde, 2019)**.** According to the findings of this research, youths with high-functioning ASD had preserved implicit learning but impaired explicit learning in a motor task. This suggests that in ASD, different learning mechanisms may be at work (Fucà, 2021)**.** Explicit learning interventions benefit Autistic Spectrum Disorders, enhancing skill acquisition and promoting independence, but a multifaceted approach is needed for individual needs and contexts.

4.7. Effects of Communication Skills in Children with ASD

Communication skills are critical for the development of autistic children. They aid in behavior, learning, and socialization. Autistic children have various communication skills and abilities but require assistance in developing these skills (Communication: autistic children, 2021). Anxiety is linked to communication skills in children with ASD (Hekmat Khaledi, 2022). Children with ASD may struggle with speech, language, vocabulary, meaning, and rhythm, with some having limited speaking abilities and others having extensive vocabulary (Autism Spectrum Disorder: Communication Problems in Children, 2020). They will often have pragmatic language deficits, impacting social interaction, academic performance, and reading comprehension due to the complexity of language. (Amela Ibrahimagic, 2021). Studies indicate that parent-mediated interventions for children with ASD can enhance communication with those with ASD, indicating a growing interest in these interventions. (Conrad CE, 2021). ASD significantly impacts communication and language abilities and is often referred for screening due to concerns about language delays. Language milestones, particularly by age five, significantly impact long-term prognosis (Hekmat Khaledi, 2022). An autistic child's undeveloped language makes it challenging for teachers to implement evidence-based practices to improve nonverbal communication skills in children with autism spectrum disorder (Ali, 2022). Children with high-functioning autism struggle with social communication, requiring more than just verbal skills, and struggle with body language, facial expressions, and tone of voice, making it difficult for them to understand others' thoughts and feelings, making social interactions challenging (How Autism Affects Communication in Young Children, 2016).

4.8. Developmental Trends in Implicit and Explicit Memory

The research highlights the significance of managing explicit memory influence on implicit processes by revealing a developmental trend in perceptual repetition priming in preschoolers, 6-year-olds, and young adults (Russo R, 1995). This study compares tasks requiring explicit and implicit learning of motor sequences between children and adults. Age-related distinctions in the two types of learning are shown, with adults showing a greater need for explicit techniques (M. Jongbloed-Pereboom, 2020). This study examines how learning tactics affect how children and adults form and use implicit and explicit memory links. It demonstrates that although both types of memory links are present in both age groups, the circumstances under which they are created and used differ (Zahra Abolghasem, 2023).

4.9. Management techniques

Researchers recommend prioritizing treatment for individuals with ASD based on specific symptoms, as treatment may differ depending on diagnosis, comorbidities, causation, and severity (Butler, 2020) Implicit techniques support learning in children with ASD, including those who are high-functioning. Strategies include social skill groups, peer-mediated interventions, and tailored strategies, while behavioral therapeutic approaches target explicit rules (Ditza A Zachor, 2017) (Bianca M Marro, 2019). Tailored educational and rehabilitation programs are essential parts for children between 6 and 17 of age (Fucà, 2021). Cognitive behavioral therapy, which heavily relies on explicit knowledge, can enhance social skills and associated symptoms like anxiety in children with ASD (Russell Lang, 2010) (K S Thiemann, 2001). This should support STM functioning in ASD and acknowledge the potential benefit of using verbal materials for encoding and broader forms of memory support at retrieval to improve performance (Desaunay, 2020). The capacity to learn, store, and retrieve information about unique and personal experiences that occur in everyday life is known as episodic memory (Bradford C Dickerson). In general, children with autism have poor episodic memory and struggle to recall events from the past. Taking many photos and documenting the story or emotion behind the photos has been shown to improve episodic memory (Miller, 2022).

5. Conclusions

This study's result emphasizes the immediate need for customized educational and therapeutic initiatives that target the unique memory difficulties that children with high-functioning autism spectrum disorder (ASD) encounter. The results demonstrate the potential benefits of giving verbal materials to children with ASD for encoding and memory help to enhance performance. The study also highlights how critical it is to diagnose and treat episodic memory problems in this population. The knowledge gained from this study will help develop customized therapies that take into account the special memory characteristics of children with high-functioning ASD, which will ultimately result in better support and cognitive development for this population.

Abbreviations

- ASD – Autism Spectrum Disorder
- APA – American Psychological Association
- TAP – Transfer Appropriate Processing
- IQ – Intelligence Quotient
- IM – Implicit Memory
- EM – Explicit Memory
- SRTT - Serial Reaction Time Task
- HFA - High Functioning Autism
- AS - Asperger Syndrome
- TD - Typically developing

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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