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# THE RELATIONSHIP BETWEEN HIGH IQ, WORKING MEMORY, AND DOUBLE EXCEPTIONALITY

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**Abstract:** Working memory, understood as a system for processing and temporarily storing information, is composed of distinct subsystems: the phonological loop, responsible for verbal and auditory processing; the visuospatial sketchpad, which maintains and manipulates mental representations; and the central executive, which regulates the allocation of cognitive resources and inhibitory control. Although individuals with high IQs often demonstrate superiority in complex cognitive tasks, the relationship between intelligence and working memory is not homogeneous. Some studies indicate that processing speed can compensate for limitations in certain modalities of working memory, while others suggest that difficulties in inhibitory control can compromise performance in situations of high cognitive load. An emerging aspect of this research involves individuals with dual exceptionality, that is, those who combine high cognitive abilities with learning disorders such as dyslexia, Autism Spectrum Disorder, or Attention Deficit Hyperactivity Disorder (ADHD). In these populations, working memory may exhibit heterogeneous patterns, with enhanced abilities in fluid reasoning and complex problem solving, but deficits in sequential retention and simultaneous management of multiple stimuli. The lack of scientific consensus indicates that the relationship between high IQ and working memory should be analyzed from a multidimensional perspective. The interaction between different neural networks, environmental factors, and neuroplasticity mechanisms can significantly modulate this relationship. Future research should incorporate advanced methodologies, such as functional neuroimaging and longitudinal studies, to deepen understanding of the processes underlying working memory in individuals with superior intelligence.

**Keywords:** Intelligence; Working memory; High IQ; Double exceptionality; Cognitive processing; Phonological loop; Visuospatial block; Central executive; Inhibitory control; Fluid reasoning; ADHD; Dyslexia; Neuroplasticity; Complex cognition; Neuroimaging; Cognitive models; Stimulus interference; Sequential retention; Executive function; Information processing.

## Introduction

Research indicates that high IQ and working memory have a complex association that varies according to the type of memory assessed and the characteristics of the task. Although intelligence has historically been related to greater information processing and retention capacity, recent evidence suggests that this relationship is not linear and may be influenced by a number of factors, such as age, type of stimulus, cognitive load of the task, and individual differences (Blokland et al., 2017).

Working memory, responsible for the temporary storage and manipulation of information, is often cited as one of the main predictors of fluid intelligence, the ability to solve new problems without relying on prior knowledge (Chen et al., 2021). However, short-term memory, which involves only passive retention of information, seems to have a less direct relationship with high IQ, being more susceptible to emotional variations and excessive simultaneous information (Nakahara et al., 2018). Long-term memory, responsible for consolidating and retrieving information over time, shows a more robust positive correlation with individuals with high IQ, suggesting that know-

ledge storage and retrieval strategies play a key role in the cognitive superiority of these individuals.

The relationship between IQ, working memory, and short-term memory becomes even more complex when analyzed in the context of dual exceptionality, a condition in which individuals have high IQ combined with learning disorders or neurodivergences, such as autism, ADHD, and dyslexia. In these cases, a heterogeneous cognitive profile is observed, with challenges in working memory and short-term memory, but significant advantages in long-term memory and the use of efficient compensatory strategies (Blokland et al., 2017).

Given this scenario, the present study seeks to analyze the relationship between intelligence and different types of memory, exploring how individuals with high IQs behave in working memory, short-term memory, and long-term memory tasks. In addition, it investigates how this heterogenous profile manifests itself in individuals with dual exceptionality, considering the possible difficulties and cognitive adaptations that emerge from this interaction.

## THE RELATIONSHIP BETWEEN WORKING MEMORY AND INTELLIGENCE: A SYSTEMATIC ANALYSIS

The relationship between working memory and intelligence is a complex association that varies according to different components and conditions. The studies analyzed demonstrate that the relationship between working memory and intelligence is not uniform, presenting significant variations depending on several factors. Colom and Flores-Mendoza (2006) identified robust correlations between working memory and general intelligence (g), with coefficients ranging from 0.36 to 0.96, showing that working memory is a more effective predictor of general intelligence than short-term memory. Working memory, unlike short-term memory, not only stores information temporarily, but also actively manipulates it, which explains its stronger correlation with general intelligence, as evidenced by Colom and Flores-Mendoza (2006).

Short-term memory refers to the ability to temporarily store a limited amount of information for a short period of time, without necessarily manipulating it, while working memory involves both storing and actively manipulating this information to perform complex cognitive tasks. For example, when you hear a phone number and memorize it just long enough to dial it, you are using short-term memory. If you need to mentally calculate the change for a purchase, keeping the amounts in mind while performing the operations, you are using working memory, as you need to process and reorganize the information to obtain a result.

Cansino and Ramos (2011) observed that aging impacts different types of memory differently, with older adults performing worse on visuospatial working memory, especially on highly complex tasks, while maintaining performance similar to that of young people on verbal short-term memory. This suggests that the ability to store and manipulate visual and spatial information declines with age, while passive retention of verbal information remains preserved. For example, an older adult may easily remember a short list of words (shor-

t-term memory) but may have difficulty mentally organizing a route on a map without visual reference (visuospatial working memory). Corroborating these findings, Espírito-Santo et al. (2016) identified agesion as a significant predictor for different memory modalities, reinforcing the idea that the impact of aging on cognition varies according to the nature of the task required.

Guerreiro et al. (2012) identified significant correlations between working memory capacity and performance on syllogistic reasoning tasks, with particularly significant effects among female participants. This finding suggests that the ability to maintain and manipulate temporary information is directly related to the ability to solve logical problems. Complementing this perspective, Harrison et al. (2013) demonstrated that working memory also has a strong correlation with fluid intelligence, which refers to the ability to solve new problems without relying on prior knowledge or experience. A practical example of fluid intelligence is the ability to identify patterns in an abstract sequence of symbols or find the solution to a logical puzzle without prior instructions. However, the authors noted that although specific training can improve working memory performance, this does not always result in generalized gains in fluid intelligence, indicating that this form of intelligence may have limits of cognitive plasticity.

Processing speed and cognitive load have emerged as crucial factors in the relationship between working memory and intelligence. Cansino and Ramos (2011) highlight that increasing task complexity disproportionately affects certain population groups, while Colom and Flores-Mendoza (2006) suggest that the strong relationship between working memory and general intelligence is fundamentally linked to short--term storage capacity and processing speed.

The study by McClay et al. (2011) investigated the relationship between genetics, working memory, and response to antipsychotic treatment in individuals with schizophrenia, using a genome-wide association study (GWAS) with 738 patients from the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE). The methodology involved the analysis of 492,000 single nucleotide polymorphisms (SNPs) and neurocognitive assessments over 18 months, focusing on five domains: processing speed, verbal memory, vigilance, reasoning, and working memory. The results indicated that genetic variations in genes such as EHF, SLC26A9, and IL1A influence cognitive response to different antipsychotics, particularly in working memory and processing speed. Working memory, a critical factor for executive functions and reasoning, proved to be sensitive to genetic influence, reinforcing its relationship with fluid intelligence and an individual's adaptive capacity. The research highlighted that, although intelligence and working memory are correlated, genetic modulation and the effects of antipsychotic s may differentially affect these domains, suggesting that personalized treatment may improve cognitive deficits in patients with schizophrenia. It is concluded that working memory is not only associated with intellectual performance but may also be a useful biomarker in predicting the efficacy of antipsychotic treatments, highlighting the need for further studies to validate genetic findings and their clinical implications.

Chen et al. (2021) investigated the relationship between anxiety and working memory (WM), exploring the genetic mo-

dulation of this interaction. Using a genome-wide association study (GWAS) with 1,115 healthy participants, the authors analyzed how genetic variants may influence the relationship between these two cognitive factors. The results revealed that the CPNE3 gene plays a moderating role, such that individuals with the TT genotype performed worse on WM tasks when anxious, while carriers of the CC allele demonstrated the opposite effect. The study reinforces the complexity of the interaction between working memory, intelligence, and emotional factors, suggesting that anxiety regulation may play an essential role in cognitive performance (Chen et al., 2021).

Blokland et al. (2017) conducted a genome-wide association study (GWAS) with 863 healthy twins and siblings, analyzing brain activation during working memory tasks using functional magnetic resonance imaging (fMRI). The study identified 31 genetic variants associated with activation of the left supramarginal gyrus, with the BANK1 gene, related to the dopaminergic pathway, emerging as a potential modulator of the BOLD response during cognitive tasks. Although no variant reached corrected statistical significance, the findings suggest that genetic factors influence neural efficiency in working memory, reinforcing its connection with fluid intelligence and executive function (Blokland et al., 2017).

Nakahara et al. (2018) analyzed deficits in cognitive domains, including working memory, in patients with schizophrenia using polygenic risk scores (PRS) and analysis of genes associated with cognition. The study used a genomic and neuropsychological database to investigate the influence of genetics on specific cognitive deficits. The results demonstrated that genetic variants associated with schizophrenia significantly impact working memory, with distinct effects in different subdomains, suggesting that cognitive plasticity in these patients may be genetically modulated (Nakahara et al., 2018).

## TABLES

| Type of Working Memory | Function |
|---|---|
| **Phonological Loop** | Stores and processes auditory and verbal information. |
| **Visuospatial Block** | Processes visual and spatial information. |
| **Central Executive** | Coordinates the different subsystems and controls attention. |
| **Episodic Buffer** | Integrates information from working memory and long-term memory. |

| Type of Memory | Do people with high IQs have an advantage? | Evidence |
|---|---|---|
| **Working Memory** | Yes, especially in tasks that require reasoning and active manipulation of information. | Genetic and neuroimaging studies indicate a strong correlation with fluid intelligence. |
| **Short--Term Memory** | Not necessarily. Simply retaining information without manipulating it is not strongly correlated with IQ. | Studies show no clear advantage, as high IQ seems to be more related to manipulation than passive storage. |
| **Long--Term Memory** | Yes. People with high IQs tend to consolidate and retrieve information more efficiently. | Evidence points to a clear advantage in knowledge retention and retrieval. |

## Working Memory in Individuals with Dual Exceptionality

Working memory, which involves the storage and active manipulation of information, tends to be a point of vulnerability for individuals with dual exceptionality, especially in conditions such as ADHD and dyslexia. Studies indicate that gifted individuals with ADHD may have deficits in working memory, particularly in the ability to focus on relevant stimuli and filter out irrelevant information (Blokland et al., 2017). However, high intelligence can compensate for these difficulties by allowing the use of more efficient cognitive strategies. This explains why many individuals with dual exceptionality demonstrate excellent academic performance despite difficulties in structured tasks that require rigorous attentional control.

On the other hand, visuospatial working memory can be a strength for some individuals with dual exceptionality, allowing them to cope well with tasks involving abstract thinking, visual modeling, and creativity (Nakahara et al., 2018). Gifted dyslexic individuals, for example, may have difficulties with phonological memory, but compensate through more visual and associative thinking.

## Short-Term Memory and Dual Exceptionality

Short-term memory, which involves only the passive retention of information without manipulation, may also be atypical in these individuals. In people with ADHD, for example, short-term memory may be inconsistent, with failures in repetitive and structured tasks, but excellent retention of information of high personal interest (Chen et al., 2021). This suggests that emotional engagement and content relevance are crucial factors in determining short-term memory performance in individuals with dual exceptionality.

## Long-Term Memory in Individuals with Dual Exceptionality

Unlike short-term and working memory, long-term memory tends to be highly developed in these individuals. Many of them demonstrate hyperfocus and intense specialization in areas of interest, which leads to efficient and detailed long-term information storage. This characteristic can be observed in individuals with autism and giftedness, who frequently demonstrate extraordinary memory for facts and knowledge (semantic memory). However, they generally maintain the typical difficulties of ASD in autobiographical memory tasks and those that require rapid manipulation of information (Nakahara et al., 2018).

## Discussion

The relationship between high IQ, working memory, and short-term memory remains a debated issue in the scientific literature, with mixed evidence on cognitive superiority in different types of memory. However, there is a more solid consensus on the advantage of long-term memory in individuals with high IQ.

Working memory refers to the ability to actively store and manipulate information for short periods of time to perform cognitive tasks. Studies such as those by Blokland et al. (2017) show that people with high

IQs perform better on working memory tasks that involve logical reasoning and information manipulation, especially in the verbal and mathematic . However, visuospatial working memory may not present the same advantage, since its relationship with general intelligence varies according to the type of task involved (Blokland et al., 2017). It must be taken into account that emotional factors, such as anxiety, can negatively influence working memory performance in some individuals but improve it in others, depending on their genetic makeup, as observed in the study by Chen et al. (2021).

On the other hand, short-term memory, which involves the passive retention of information without the need for active processing, does not show a clear correlation with IQ. Nakahara et al. (2018) point out that although working memory is strongly associated with fluid intelligence and performance on cognitive tests, short-term memory does not show the same relationship. This suggests that individuals with high IQs can store information quickly, but if that information is not relevant for further processing, it can be forgotten just as quickly.

Long-term memory, which involves the consolidation and retrieval of information over time, is consistently superior in individuals with high IQs. Research indicates that these individuals use more effective strategies to encode, organize, and retrieve information, which is reflected in better academic performance and the ability to learn continuously (Nakahara et al., 2018). This factor may explain why individuals with high IQs tend to have greater knowledge retention over time, while the advantage in short-term memory is less evident.

Thus, it can be concluded that people with high IQs demonstrate more efficient working memory in tasks that require active information manipulation, but not necessarily better short-term memory. However, long-term memory is significantly more developed, allowing for effective retention of complex information and optimized knowledge retrieval.

The relationship between working memory, short-term memory, and intelligence in individuals with dual exceptionality—those who have high IQ combined with learning disorders or neurodivergences, such as ADHD, autism, and dyslexia—is even more complex and challenges traditional models of cognition. While these individuals have high intellectual potential, they often exhibit heterogeneous patterns of performance on tasks involving memory and executive control.

## Conclusion

The evidence reviewed demonstrates that the relationship between working memory and intelligence is complex and multifactorial, being modulated by variables such as age, gender, task complexity, and individual differences. The findings suggest that a more nuanced and specific approach is needed when investigating this connection, considering the different components of working memory and their particular interactions with different aspects of intelligence.

The review indicates that individuals with high IQs tend to have greater efficiency in working memory and long-term memory, which facilitates the retention and retrieval of information. However, short--term memory seems to be more sensitive to emotional factors and to an excess of simultaneous information and interests, which can result in performance similar to or even

inferior to that of neurotypical individuals in certain situations.

In the case of dual exceptionality, an atypical and heterogeneous cognitive profile is observed, characterized by difficulties in working memory and short-term memory, but significant advantages in long-term memory and the development of highly effective compensatory strategies. The interaction between high IQ and learning disorders leads these individuals to process and store information in an unconventional way, which often causes their true cognitive potential to be underestimated by standardized assessments.

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