SHORT TERM MEMORY: AN OVERVIEW OF THE IMPLICATION FOR EDUCATION AND HEALTH

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Abstract
Everyone has those moments where you forget something either important or trivial. However, when the moments that you forget outnumber the moments you remember, there may be cause for concern. There are several reasons that you may be experiencing short-term memory loss. To better understand if you have a problem and what to do about it, it is a good idea to arm yourself with information before going to the doctor. This paper therefore explores the processs of short-term memory and highlights the implications for education and health.

Introduction

It is now generally agreed that two temporally distinct neural processes contribute to the acquisition and expression of brain functions. Transient variations of membrane potential (neuronal activity), with a time scale of milliseconds, reflect the flow of information from neuron to neuron and define the function of neuronal networks. These variations can result in long-lasting (and maybe permanent) alterations in neuronal operations, for instance through activity-dependent changes in synaptic transmission. There is now strong evidence for a complementary process, acting over an intermediate time scale (short-term memory, STM). This process is involved in performing tasks requiring temporary storage and manipulation of information to guide appropriate actions (Goldman-Rakic 1987; Baddeley 1992). Two main issues call for attention when studying STM: (1) How is neural information selected for storage and temporarily stored in STM for future use in a temporal sequence of sensorimotor events, and how is a large amount of information buffered when its future use is not known? (2) How can a long-term memory (LTM) representation of temporal sequences of events be constructed, and how can information selected by STM process be transferred to LTM?

'Short-term memory' refers to memory over a short time interval, usually 30s or less. Another term for the same concept is 'immediate memory.' Both of these terms have been distinguished from the related terms ‘short-term store’ and ‘primary memory,’ each of which refers to a hypothetical temporary memory system. However, the term‘short-term memory’ has also been used by many authors to refer to the temporary memory system. Thus, here, the term ‘short-term memory’ is used in both senses. It is important to distinguish ‘short-term memory’ from the related concepts ‘working memory’ (see Working Memory, Psychology of) and ‘sensory memory’. Some authors have used the terms ‘short-term memory’ and ‘working memory’ synonymously, and indeed the term ‘working memory’ has been gradually replacing the term ‘short-term memory’ in the literature (and some authors now refer to ‘short-term working memory’; see Estes 1999). However, ‘working memory’ was originally adopted to convey the idea that active processing as well as passive storage is involved in temporary memory. ‘Sensory memory’ refers to memory that is even shorter in duration than short-term memory. Further, sensory memory reflects the original sensation or perception of a stimulus and is specific to the modality in which the stimulus was presented, whereas information in short-term memory has been coded so that it is in a format different from that originally perceived.(. Healy,2001)

Short-term memory (STM) is also known as working or active memory. It holds the information you are currently thinking about. This information will quickly be forgotten unless you make a conscious effort to retain it. Like sensory memory, short-term memory holds information temporarily, pending further processing. However, unlike sensory memory which holds the complete image received by your senses, short-term memory only stores your interpretation of the image.

Atkinson and Shiffin(1968) partitioned short-term memories into sensory registers and an auditory-verbal-linguistic component. Research over the years since then suggests that this view was misleadingly simple. The rules governing short-term residence can be examined for every kind and level of information that can produce activation. It seems clear now, on logical grounds as well as the weight of evidence, that short-term memory is the accumulation of all of these. The degree to which the rules governing residence, rehearsal, coding, attention, and so forth, differ for all these is far from clear. However, some differences are clearly identifiable. For example, researchers have proposed and collected evidence for a phonological buffer and/or articulatory loop (e.g., Baddeley, 1986) with residence times near 2 sec.

However, there are numerous other forms of short-term memory, with both Martin (1993) and Potter (1993) arguing that other short-term memories (e.g., involving routes from visual inputs to conceptual and language forms) are far more important for normal human functioning. Even these short-term forms do not come close to exhausting the possibilities for which evidence has been collected, including various sensory systems (such as those we described in 1968, by sensory registers), with residence times in the hundreds of milliseconds, visual-spatial sketchpads, veridical-visual versus abstract-visual codes (e.g., Posner, 1969), and others. The kinds of information stored may depend on the task, the subjects, the instructions, and the subjects' intentions (e.g., store inputs for implicit or explicit tests), and may be used differentially depending on the test at retrieval (e.g., stem completion vs. serial recall).

According to Kirkpatrick (2018), there are many possible causes of short-term memory loss. Some causes of short-term memory loss are only temporary and can be remedied. However, many of the medical conditions that cause short-term memory loss are permanent and will eventually lead to long-term memory loss as well. Short-term memory loss is often the first sign of many conditions.

A Brain Aneurysm

A brain aneurysm is a weak or bulging spot on the walls of arteries in the brain. These aneurysms do not always rupture, but when they do they cause a pool of blood around the brain that can clot and cause mental deficiencies and killing of brain cells. This can lead to short-term and potentially long-term memory loss. Only about 30 percent of patients with a ruptured brain aneurysm regain their short-term memory, and it can take several weeks to do so.

Brain Tumor

A brain tumor that affects the prefrontal cortex can also affect short-term memory. If the tumor is putting pressure on the prefrontal cortex, or if it is stopping the neural pathways in that area of the brain, you may not be able to remember things short-term. You may also have difficulty recalling information from long-term memory. Sometimes removal of the tumor can restore memory, but not always.

Amnesia

Amnesia is a loss of memory and can frequently be permanent. People with amnesia have poor short-term memory and have difficulty creating new memories. Amnesia can be caused by some medical conditions or injuries, including brain trauma, drug overdose, stroke, Alzheimer's, a brain infection, or severe emotional shock.

Alzheimer's and Dementia

Alzheimer's disease is a deterioration of cognitive abilities that usually starts with short-term memory loss. Other signs of Alzheimer's disease include behavioral changes such as increased aggression, mood swings, jumbled speech, loss of appetite, and an inability to combine muscle movements. Dementia is the official term for the loss of memory and confusion that is the result of Alzheimer's disease. Dementia can occur in other patients as well, however, such as patients with multiple strokes or other medical conditions.

Sleep Apnea

Sleep apnea is a medical disorder in which you stop breathing during sleep. There have been cases where people experienced symptoms of short-term memory loss and dementia as a result of this disorder. Some people are misdiagnosed as having early onset Alzheimer's disease because of the symptoms that sleep apnea can cause. Essentially, the disorder causes sleep deprivation, which leads to the short-term memory loss. Typically, if the patient corrects their sleep with a CPAP or similar equipment, their memory does return over time.

Silent Stroke

Silent strokes are small strokes that can happen undetected. Sometimes people have small strokes while sleeping or even while awake that are so mild they do not exhibit any stroke symptoms at the time. However, the temporary blockage of blood vessels in the brain can cause some brain damage, including short-term memory loss. Multiple silent strokes can exacerbate these symptoms. Typically, the damage done is irreversible.

Medications

Many medications can affect short-term memory. You may find that if you take any of these medications for a long period, you could experience short-term memory loss. This memory loss is typically temporary, and memory returns after the medications are stopped.

Some examples of medications that cause short-term memory loss according to the FDA are:Sleeping pills;Antihistamines;Antidepressants;Anti-anxiety medications;Prescription painkillers, particularly opioids; Diabetes medication; Cholesterol medication, particularly statins.

Nutritional Deficiency

Certain nutritional deficiencies can cause short-term memory loss. Severe deficiencies in vitamin B12 have been linked to short-term memory loss, confusion, and even leading to dementia. Usually, if you correct the deficiency and can get the right amount of B12 in your system, you should be able to regain your short-term memory. If none of the other causes in this list seems plausible, try adding a B12 or B-complex vitamin to your daily regimen and see if your memory improves.

Stress, Anxiety, and Depression

Significant amounts of stress, anxiety and severe depression can lead to short-term memory loss. Worsening the condition, many people with these symptoms do not sleep well, adding sleep deprivation as a cause of the short-term memory loss. While a mood disorder may be to blame, you may benefit from simply managing your stress and anxiety through therapy and other methods. Medications should be the last resort if you are having memory problems, as these can also cause short-term memory loss and may not remedy the root problem.

Alcohol Abuse

Studies have found that short-term memory loss is a common symptom of alcohol abuse. Most alcoholics have difficulty remembering what happened while they were intoxicated. However, hangovers and other symptoms of the addiction can also contribute to daily short-term memory loss. Typically, the memory loss associated with alcoholism can be reversed with long-term sobriety.

Aging

Studies have shown that short-term memory does begin to show as we age. There may not be much of anything wrong with you as far as medical conditions, but you could still have problems with short-term memory loss. Studies show that retrieval of information in healthy seniors is much slower or impossible than in younger people. It could be that your short-term memory problems are simply the result of natural aging, in which case there is little that can be done.

Improving short-term memory

One of the most common suggestions for improving short-term memory is to use mnemonics. Mnemonics is the technique of attaching a word, phrase or image to an object. One example of a mnemonic is the trick to remember how many days are in a month. “Thirty days hath September, April, June and November …” You can also use the trick to remember things such as a name, such as "Rob wore a red shirt."

Another trick is to have someone put a number of objects out on a table. Give yourself 30 seconds to memorize them. Then take the objects away and try to write down as many as you can in 30 seconds .Doing activities that engage your brain, such as Sudoku and crossword puzzles, and reading in general can also help improve your memory.(Zimmermann,2017)

The Structure of Short-Term Memory

In his *Principles of Psychology*, William (1890) articulated the view that short-term (“primary”) memory is qualitatively different from long-term (“secondary”) memory (see also Hebb 1949). The most influential successor to this view is the model of STM developed by Baddeley and colleagues (e.g., Baddeley 1986, 1992; Baddeley & Hitch 1974; Repov & Baddeley 2006).

According to Baddeley’s model, there are separate buffers for different forms of information. These buffers, in turn, are separate from LTM. A verbal buffer, the phonological loop, is assumed to hold information that can be rehearsed verbally (letters, digits). A visuospatial sketchpad is assumed to maintain visual information and can be further fractionated into visual/object and spatial stores (Repov & Baddeley 2006, Smith et al. 1995). An episodic buffer that draws on the other buffers and LTM has been added to account for the retention of multimodal information (Baddeley 2000). In addition to the storage buffers described above, a central executive is proposed to organize the interplay between the various buffers and LTM and is implicated in controlled processing.

Studies of brain-injured patients who show a deficit in STM but not LTM or vice versa lead to the implication that STM and LTM are separate systems.1 Patients with parietal and temporal lobe damage show impaired short-term phonological capabilities but intact LTM(Shallice & Warrington, 1970; Vallar & Papagno 2002). Conversely, it is often claimed that patients with medial temporal lobe (MTL) damage demonstrate impaired LTM but preserved STM (e.g.,Baddeley & Warrington, 1970; Scoville & Milner, 1957)

The idea that STM can be parceled into information-specific buffers first received support from a series of studies of selective interference (e.g., Brooks, 1968; den Heyer & Barrett, 1971). These studies relied on the logic that if two tasks use the same processing mechanisms, they should show interfering effects on one another if performed concurrently. This work showed a double dissociation: Verbal tasks interfered with verbal STM but not visual STM, and visual tasks interfered with visual STM but not verbal STM, lending support to the idea of separable memory systems (Baddeley, 1986 and Baddeley & Hitch 1974).

Baddeley's multistore model assumes that a collection of processes act upon the information stored in the various buffers. Jointly termed the "central executive," these processes are assumed to be separate from the storage buffers and have been associated with the frontal lobes. Both lesion and neuroimaging data support the distinction between storage and executive processes. For example, patients with frontal damage have intact STM under conditions of low distraction (D'Esposito & Postle 1999, 2000; Malmo,1942). However, when distraction is inserted during a delay interval, thereby requiring the need for executive processes to overcome interference, patients with frontal damage show significant memory deficits (D'Esposito & Postle 1999, 2000). By contrast, patients with left temporo-parietal damage show deficits in phonological storage, regardless of the effects of interference (Vallar & Baddeley,1984; Vallar & Papagno 2002).

From the Short-term Memory Model (Atkinson and Shiffrin, 1968), Baddeley and Hitch (1974) developed the Working Memory Model. Baddeley and Hitch claimed that the idea of primary memory (Cowan, 2008) and the Atkinson and Hitch model lacked the inclusion of consciousness. In the Working Memory Model, WM defined the part of memory needed to organize and complete an action. The central executive component, the main component of the Working Memory Model, functioned more like a connecting piece, using visuo-spatial and phonological connections to link information between the long-term memory and working memory.

Short-Term Memory and Working Memory

The terms STM and working memory (WM) are often used interchangeably, and also inconsistently. In this article the primary focus is on whether there are distinct short- and long-term stores. Working memory is usually thought of as a much broader concept, often encompassing processing as well as storage. For example, both the Baddeley and Hitch (1974) and the Cowan (1988) WM models include a central executive component which can operate on the contents of STM. In the Baddeley and Hitch model, modality-specific short-term stores form part of the overall WM system. The distinguishing feature of WM is that it provides a 'mental workspace' (Logie, 2003) that can hold information in a temporary form that can be manipulated and updated. Although there are different views on exactly what constitutes WM (Aben, Stapert, & Blokland, 2012), the common feature of these views is that rather than being simply a passive store, WM is a system that allows information to be actively manipulated. For example, in the context of visual Luck and Vogel (2013) defined WM "as the active maintenance of visual information to serve the needs of ongoing tasks" . Baddeley (1992) described WM as a "system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning."

The interchangeable use of STM, WM, simple span tasks, and complex span tasks encountered in contemporary literature indicates that the differentiation between STM and WM is far from clear. Although they may be conceptually distinctive, the interchange- able use of STM and WM is more or less understandable since there clearly is a large overlap between both. So far, studies using correlational designs have not consistently succeeded to unequivocally differentiate between STM andWM.(Bart , Sven and Arjan, 2012).

Short-Term Memory Disorders

Impaired short-term memory is reflected by a reduced ability to temporarily store and reproduce verbal and/or visuospatial information that has just been presented.Children with impaired verbal short-term memory will thus show poor ability in the immediate reproduction of verbal sequences (e.g., lists of digits, words or unfamiliar words) and/or visuospatial patterns (e.g., object copying, spatial sequence reproduction). Given the importance of short-term memory as a first step toward long-term learning of new information, these children will typically also have difficulties in learning new verbal information such as a new vocabulary, new definitions, and in learning associations between abstract concepts as for example needed in chemistry (Baddeley et al., 1998). Furthermore given the implication of short-term memory during mental calculation and reasoning, difficulties will also be observed in arithmetic and sentence comprehension. The deficit can be selective for verbal or visual information, or involve both modalities. Although short-term memory deficits do not prevent successful completion of primary and secondary school education, they will nevertheless cause a significant handicap by slowing the affected child's learning rate and his/her comprehension of the explanations and task assignments provided by the teaching staff (Majerus & Van Der Linden, 2013).

Short-term memory disorders are most often observed in association with broader cognitive impairment. Children with specific language impairment and children with dyslexia typically show poor verbal short-term memory and working memory spans; the reduction in verbal short-term memory in these populations cannot be fully explained by their poor language abilities, and hence it is likely that the short-term memory deficits further contribute to the already protracted language development in these children. More generally, verbal short-term memory deficits are a residual deficit in many populations which initially presented more global language impairment patients who presented specific language impairment. Childhood aphasia, or epileptic childhood aphasia (Landau-Kleffner syndrome) during childhood can show relatively good language recovery at adulthood but verbal short-term memory impairment will still be present (Majerus et al., 2004).

Short Term Memory and Education:

Students with a learning disability have difficulty with STM and WM memory, both academic and non-academic. Memory difficulties can also be inconsistent, making it challenging for teachers to identify when children need accommodations or who may have a reading disability that should be referred for special education screening (Garguilo, 2004). Given that students with a learning disability have more difficulty with STM than LM, students with an unidentified learning disorder may not present a disability immediately (Deiner, 2013). Gifted students who have an unidentified disability may appear to perform at the same rate as their peers, having developed self- techniques (VanTassel-Baska, 2012).

Ellison (2017) examines the differences of short-term memory capacity between intellectually gifted, general education, and students receiving special education services. Using foundations in memory and recall research by Atkinson and Shiffrin(1968) and Baddeley and Hitch(1974), data was collected by replication of a previous serial position effect research design. Participants were children in grades four through six located in the southern portion of the United States. An ANOVA analysis found a statistical significance between students receiving special education and general education and gifted students. A failure to reject of the null hypothesis supported that short-term memory capacity of gifted students is not different from general education students.

Students' difficulties in mathematics may be due to short-term memory failure. Studies show that students' performance in mathematics was significantly lower in students with difficulties in short-term memory function (Geary et al., 1991, 2000; Geary, Hoard, & Hamson, 1999; Hitch & McAuley, 1991; Passolunghi & Siegel, 2001). Short-term memory is differentiated from working memory since it is a passive storage system that requires the recall of information without the intervention of any mental work (Cantor, Engle, & Hamilton, 1991; Cornoldi & Vecchi, 2000; Engle, 2002; Vecchi & Cornoldi, 1999). These are the digit span forward method for auditory verbal short-term memory (VSTM), recollection of images for short-term semantic memory or frames for short-term non-semantic visual memory. Some researchers report that children with mathematical difficulties show weaknesses in auditory verbal short-term memory (Siegel & Ryan, 1989), while others argue that these children have a general deficiency over the entire range of short-term memory, namely auditory verbal and visual (Hitch & McAuley, 1991, Swanson, 1993; Turner & amp; Engle, 1989).

Short-Term Memory and Health

According to (Majerus& Van Der Linden, 2013) a number of genetic syndromes are also characterized by poor short-term memory spans, either for verbal short-term memory, such as in Down syndrome (trisomy21) or for visual short-term memory, such as in Williams syndrome (7q11.23) and X-related syndromes (Fragile X, Turner syndrome, Klinefelter syndrome, and Rettsyndrome).

Short-term memory in middle-aged individuals with different APOE alleles was examined using a recently developed task which is sensitive to medial temporal lobe (MTL) damage. Individuals (age-range: 40e51 years) with ε3/ε3, ε3/ε4 and ε4/ε4 APOE genotypes (N ¼ 60) performed a delayed estimation task with a sensitive continuous measure of report. The paradigm allowed us to measure memory for items and their locations, as well as maintenance of identity-location feature binding in memory. There was a significant genedosage dependent effect of the ε4 allele on performance: memory decay or forgetting was slower in ε4 carriers, as measured by localization error and after controlling for misbinding errors. Furthermore ε4 carriers made less misbinding errors. These findings were specific to male carriers only. Thus, male ε4 carriers are at a behavioral advantage in midlife on a sensitive task of short-term memory. The results would be consistent with an antagonistic pleiotropy hypothesis and hightight the interaction of gender on the influence of APOE in cognition.(Nahid and Zokaei,2017)

Visual Short-Term Memory and Alzheimer's Disease

Earlier investigations of Alzheimer's disease reported a general deficit in the central executive component of WM (Baddeley et al., 1986, 1991), rather than in maintenance.

Conclusion

In Alzheimer's disease, the hippocampus is one of the earliest structures affected by pathology (Bateman et al., 2012; Braak & Braak, 1991; Fox et al, 1996; Reiman et al., 2012). Indeed, longitudinal studies in familial Alzheimer's disease (FAD) cases have shown that progressive hippocampal atrophy can be detected many years before the diagnosis of dementia and in the asymptomatic stage of the disease (Fox, Warrington, Freeborough, et al., 1996; Fox, Warrington, Stevens, et al., 1996; Ridha et al., 2006; Schott et al., 2003). Interestingly, however, the types of VSTM binding deficit that have so far been reported in AD patients' e both sporadic cases and FAD have been confined to tasks that probe colour-shape or colourecolour bindings (Parra et al., 2009, 2010, 2011). Such tasks are often considered to probe conjunctive binding: the ability to form a single representation of an item with multiple elements, with veridical retrieval depending crucially upon the ability to access the unitary, integrated representation (see Moses & Ryan, 2006). By contrast, retrieval of multi-feature items that can be performed by remembering individual parts separately (e.g., identity and location) is considered to depend upon relational binding (Hannula et al., 2015). Whether the distinction between relational and conjunctive binding is a useful one is open to debate, but several studies have shown that conjunctive binding can be preserved in patients with hippocampal lesions (e.g., Baddeley, Allen, & Vargha-Khadem, 2010; Mayes et al., 2007; Parra et al., 2015).

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