

Involuntary Retrieval in Episodic Memory

Zixiao Bian^{1,a,*}

¹*Department of Psychology, University of Illinois at Urbana-Champaign, Champaign, IL, USA*

a. zixiaob2@illinois.edu

**corresponding author*

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Abstract: The involuntary retrieval of episodic memory has drawn wide attention and have been researching for decades in the fields of psychology. However, the mechanism of the involuntary retrieval of episodic memory is unclear. This paper mainly focused on the mechanism of involuntary retrieval of episodic memory. After investigating and summarizing the results of past studies done by researchers, we reviewed two theories: triggered mode theory and cognitive control theory. The triggered mode theory is a sophisticated taxonomy that categorized three different subtypes of involuntary memory: chained, direct, and traumatic. The cognitive control theory illustrated the significance of cognitive control and preoccupation of cognitive resource on reducing the occurrence of involuntary retrieval of episodic memory, and the research findings of neuroscience verified the conclusion at present. The triggered mode theory illustrated the involuntary retrieval relies on different levels of classification and the contexts of memory, and the cognitive control theory demonstrated the mechanism of involuntary retrieval under all the contexts and generate notable regulation effects. Thus, the conclusion is valuable when the clinical professionals attempt to develop treatment plans towards patients who are suffering major depressive disorder, obsessive–compulsive disorder, and posttraumatic stress disorder.

1. Introduction

The involuntary retrieval has drawn wide attention and have been researching for decades in the fields of psychology. In a distinguished taxonomy, people's retrieved memories can also be categorized as voluntary memory and involuntary memory. The voluntary memory represents the memory that retrieved by people willingly, whereas the involuntary memory represents the spontaneously retrieved memory and is unintended (Mace, 2007). The declarative memory was then believed contains two varieties: semantic memory and episodic memory (Tulving, 1989). Tulving's theory (1989) suggested the semantic memory is the storage of knowledges such as meanings or facts, and the episodic memory includes people's personal experience. Sharing the traits of memories, either the involuntary memories or the voluntary memories can be classified as involuntary semantic memory, involuntary episodic memory, voluntary semantic memory, and voluntary episodic memory. Among the four diverse memories, the involuntary episodic memory is the one that is most studied, and it refers to the memories of one's personal experiences that strike on one's mind without intentional attempt of

retrieval, on the contrary to the voluntary memories that are retrieved deliberately (Berntsen et al., 2013). Besides involuntary episodic memories there also exist involuntary semantic memories, which refer to the involuntary conscious emergence of items or conceptions in one's semantic knowledge, usually in forms of words and images (Kvavilashvili & Mandler, 2004). Generally, the involuntary memories are more specific, less relevant to personal identity, yet evoke more emotional reaction at the point of retrieval compare to voluntary memories. However, the theory to illustrate the mechanism of the involuntary retrieval of episodic memory is unclear.

2. Literature Background

Early predecessors of memory study described involuntary memory in their literature (Proust, 1956), and Hermann Ebbinghaus first proposed the idea that the retrieval of involuntary memories may occur during the period of retrieval of voluntary memories (Ebbinghaus, 1885/1964). Including Ebbinghaus, past researchers used to focus less on involuntary memories, as they put more efforts on study voluntary and implicit memories, but recently more studies are done and generated many valuable findings in involuntary memories (Berntsen, 2010). Fortunately, decades later, the researchers have discovered profound facts of involuntary memories, people now know involuntary memories, though remain distinguishable, share many commonalities with its voluntary counterparts, and these are universal among people with or without mental disorders, and they categorized the involuntary memories according to the triggered mode. The triggered mode theory suggested involuntary memories can be classified to three subtypes: the involuntary memories that triggered by a voluntary memory; the involuntary memories that triggered by external or internal cues; the involuntary memories that triggered by cues and contain unpleasant factors (Mace, 2007).

Many researches have done using behavioral or cognitive psychology methods (Berntsen & Hall, 2004; Berntsen et al., 2013) and neuroscience methods (Hall, N.M., 2008; Hall, S.A., 2014) to study the mechanism of involuntary episodic memory, as well as dedicate to predict the occurrence of involuntary episodic memories under laboratorial control. Such studies revealed the inextricable connection between involuntary memory and cognitive control which refers to the ability of people maintain pursuing the current goal. Some researchers also indicate the variation of the frequency of involuntary retrievals as participants' age varies (Rubin, D.C. & Berntsen 2009). Several clinical researches also have impacted the field of study of involuntary memory. Since we have already known the correlation of involuntary memories and posttraumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD), and major depression disorder (MDD) do exist, meanwhile researchers found the treatment that include trainings to enhance patients' cognitive control would alleviate the patients' symptoms of such mental disorders (Shou et al., 2017; Schweizer et al., 2017). Researchers using cognitive and neuroscience methods also noticed there may have the existence of cognitive control activity in voluntary memories' retrieval and the absence of "control" in involuntary memories' retrieval (Hall, N.M. 2008, Hall, S.A. 2014).

Little is known whether the triggered mode theory and cognitive control theory support or against the statement mentioned above. Thus, this paper is determined to discuss the mechanism and the prerequisite conditions of the occurrence of involuntary memories, that is, the reason of involuntary memories, especially episodic memories, spring to people's mind without intention or volition: whether the involuntary memories are resultant of conditions of triggered modes or caused by the wane of cognitive control.

3. Theories That Explain the Mechanism of Involuntary Retrieval

3.1. Triggered Mode Theories

Prior empirical studies have been done to identify the mechanism of the retrieval of involuntary memory, that is, why and how people remember the memories with no intention of retrieve. The original assumption made by Ebbinghaus (1885, 1964) described involuntary memories might be retrieved during the retrieval of voluntary memories, and the process was called chaining. Yet recent studies proved Ebbinghaus's theory is not the comprehensive explanation of the mechanism of involuntary retrieval by discovering different types of involuntary retrievals (Linton, 1986; Berntsen, 2013), though the existence of the evidence that support Ebbinghaus's theory has also been discovered (Mace, 2005, 2006). These involuntary memories are distinguishable in terms of the triggered mode, that is, how did the memories be retrieved to people's mind. The researchers believed the involuntary memories could be categorized regarding the triggered mode after ongoing studies. On one hand, the direct involuntary memory happened when an isolated cue in people's environment triggered one's involuntary memory of the past (Berntsen, 1996, 1998), as the researchers stated the direct involuntary memories had the highest frequency of occurrence in daily life, and the public usually referred to this type of involuntary memory when they discuss. On the other hand, the chained involuntary memory was less familiar and had the least discussion rate. Chained involuntary memories was triggered by another voluntary memory or involuntary memory, coming into people's mind subsequently after other memories (Mace, 2005, 2006). The last category of involuntary memory was associated with the appearance of traumatic memory (Salaman, 1972). Since traumatic memories were either episodic or autobiographical, people experience repeated occurrence of traumatic memories and this feature was classified as a central feature of posttraumatic stress disorder.

Mace (2008) suggested the chaining type of involuntary retrieval of memories was functional to voluntary remembering, and he proposed examples of past studies focusing on tasks of autobiographical memory, which was considered a combination of involuntary episodic memories and involuntary semantic memories. Mace (2008) concluded, as the results of the experiment tended to indicate, when people were trying to retrieve a specific memory (e.g. visit Buckingham Palace) from a general period of life episode voluntarily (e.g. a trip to Britain), the chaining involuntary retrieval process will sometimes generate relative specific memories (e.g. an afternoon tea at a square of London) of the general period of life episode, and he believed the chaining process might help subjects by providing more complete information for the remembering task. The function of chained involuntary retrieved memories is quite similar to modern intelligent search engine applied by many internet explorers. When users search a specific concept from a general category intentionally, for example, searching the dolphin which belongs to marine mammals, the search engine may give advice for users and display "you may also interest in the beluga whale (which also belongs to marine mammals)". However, despite the triggered mode theory explained the nuances between three subtypes of involuntary memories finer details, the theory did not demonstrate the mechanism from behavioral, cognitive, and neuroscientific level.

3.2. Cognitive Control Theories

3.2.1. Behavioral and Cognitive Mechanisms

Other researchers discovered different types of involuntary memories. The direct involuntary memory mentioned by Berntsen (1996) was recently studied using a more advanced cognitively psychological method. Berntsen (2013) mainly focused on the involuntary episodic memories, which were the self-

related memories that jump into people's mind spontaneously. As the researchers stated, it was the first time that the involuntary memories were studied under controlled and manipulated encoding phase. The research creates 4 study trials: unique cue with unique scene, unique cue with repeated scene, repeated cue with unique scene, and repeated cue with repeated scene. After the encoding phase, the participants would complete the retrieval phases according to their assigned groups (involuntary and voluntary). Across the four studies, the researchers had three major findings. First, the retrieval of involuntary memories happened most in response to unique cues than repeated cues. The phenomenon was explained by the concept of cue overload, which meant the ability of the cue to easily distinguish one scene from all else in the memory. Second, the voluntary memories required much more cognitive resource and executive function compared to involuntary memories, and voluntary memories recalled repeated scenes most. And this was in agreement with the naturalistic studies that people tended to recall an over general rather specific memories when they were asked to recall. Third, the participants recalled scenes faster in involuntary condition than voluntary condition, even when the participants of the involuntary group were finishing tasks that required cognitive resources.

Schlagman and Kvavilashvili (2008) did researches of involuntary episodic and autobiographical memories and got the same result and conclusion as Berntsen et al. (2013) did. Schlagman and Kvavilashvili stated the direct involuntary memories can occur as long as the cues exist, even people are not in the "retrieval mode". However, either Schlagman & Kvavilashvili or Berntsen et al.'s study used neutral cues and neutral scenes, such as a picture of trees or a sound of car driving, instead of highly emotional cues. Berntsen et al. (2013) stated that although the laboratorial experiments indicated the involuntary memories associated the most frequently with unique cues and retrieved unique scenes, the involuntary retrieval of memories in the real life tend to occur during the process of people finishing other attention-demanding tasks (i.e. people are at a condition of the lack of enough cognitive resource) and to be triggered more by repeated cues (i.e. more normal and ordinary cues) in an emotional activated condition. A researching result supports the idea of Berntsen et al. (2013). Staugaard and D. Berntsen (2014) studied the effect of cue discriminability (i.e. the uniqueness of the cue for participants) and emotional density of scenes. The researchers found a positive correlation between the discriminability of cues and involuntary retrievals if the retrieval took place immediately or in a short time period after encoding the cues and the scenes; there also existed a positive correlation between the emotional density of scenes and involuntary retrievals if the retrieval took place after 24 hours of encoding. The results had external validity to apply to clinical field.

Additionally, the past studies often used diary documentation method (Berntsen & Rubin, 2002; Mace, 2005) and subjective report method (Berntsen et al., 2013), hence there were a lack of objective measure of occurrence of involuntary retrieval. Thus, the focus of our discussion would be transferred to cognitive function, emotional arousal, and neural basis. Experimenters who studied cognitive function, involuntary memory, and human aging contributed to a relatively more unified idea that could be used to explain the occurrence of involuntary retrieval. Barzykowski and Niedzwienska (2018) conducted a research to test the effect of cognitive load on the occurrence of involuntary memories. The cognitive load was the extent to which the task demand cognitive resource of a person. A task with high cognitive load may require people to allocate more cognitive resource to that task, and the remaining resource that could be used to detect environmental cues or even the occurrence of a retrieved memory would be decreased. However, such cues and memories needed to surpass an awareness threshold to be noticed by people, as suggested by Barzykowski and Staugaard (2018). The researchers found complex results: both the voluntary and the involuntary retrieval of memories occurred less in cognitive load group than in control group; the involuntary retrieval of memories had

much higher proportion of all memories occurred in cognitive load group than in control group. To be more specific, when researchers add cognitive load to participants, the amount of all memories retrieved decreased, and the voluntary retrieval decreased much more than involuntary retrieval did. The results indicated that the involuntary retrieval is, though influenced by cognitive load negatively, more resistant, and automatic. The explanation of such results might be the difference in cognitive resource demanded for involuntary retrieval and voluntary retrieval. Since the voluntary retrieval is an active process, it may require more cognitive resource for each retrieve process, and if the available resource is deficient, such process may not be activated. On the other hand, the involuntary retrieval requires cognitive resource to detect the internal or external cues, and such demand is far less than an active process. Thus, when people were assigned tasks with cognitive loads, the available cognitive resource dropped, yet involuntary retrieval that needed less resource decrease slightly and could still occur while the occurrence of voluntary retrieval decreased dramatically. The theory could be supported by Barzykowski & Niedzwienska (2018), Berntsen et al. (2013), Daniel L. Murman (2015), and Rubin & Berntsen (2009). These studies indicated people's executive cognitive function declines slightly as people age, meaning the cognitive resource available decreases as people grow older. However, some studies suggested the frequency of involuntary and voluntary retrieval did not change significantly between different age groups while others suggested both frequencies dropped in a small degree (Maillet, D. & Schacter, D.L, 2016). But, people in either age group would report involuntary retrieval occurred more often, not in absolute value but in proportion, when they were assigned attention demanding (i.e. cognitive resource preoccupied) tasks.

3.2.2. Neuroscientific Discoveries

Although the neuroscience approach was rarely used in studying involuntary retrieval of episodic memory, the researches that applied such method yield valuable results by giving objective physiological indices that indicating the befall of involuntary retrieval. A study designed to understand the neural basis of involuntary episodic memory utilized the functional magnetic resonance imaging (fMRI) method to complete the measurement (Hall, S.A. et al., 2014), and this study generated both behavioral results and neural results which were in accord with a previous experiment (Hall, N.M. et al, 2007) using positron emission tomography (PET) method. The measurement was consist of three stages: the first stage included simultaneous event-related functional imaging data that detected the neural basis; the second stage was behavioral measure that make sure the involuntary memories were retrieved; the third stage was the opposite of the second that affirm the voluntary memories were not retrieved or only retrieved minimal amount. The research method was adapted from the successful paradigm of Berntsen et al. (2013), and the experimenters modified the retrieve environment to fMRI scanner. The behavioral result pointed out the truth that the retrieval of voluntary memory correlated with higher retrieval effort on a 0 to 7 scale than involuntary memory, which supported the theory that the retrieval of voluntary memories required more cognitive resources than the retrieval of involuntary memory. Hall, S.A. et al. (2014) continued to indicate the difference in neural activities between retrieval of voluntary memory and involuntary memory. The study discovered only two brain regions' activities had significant difference: greater activities of dorsolateral prefrontal cortex (DLPFC) and left auditory cortex (LAC) for voluntary than involuntary groups, and this result suggested that participants in voluntary group proceeded the retrieval under control (Mitchell & Johnson, 2009) to pursue the test goal and existed higher top-down attention to the environmental cues. Additionally, the general function of lateral prefrontal cortex where DLPFC located was to conduct a controlled and strategic cognitive processing (Miller, 2000; Koechlin et al., 2003), and the lack of such activity in retrievals of involuntary memories

suggested the low in demand of resources of prefrontal cortex (PFC), which played indispensable roles in support cognitive control (Widge et al., 2019).

In general, the studies applied neuroscience method provide objective evidence to support the theory of studies applied behavioral and cognitive method. The existence of voluntary memories is not the prerequisite of the occurrence of involuntary episodic memories. Both the occurrence of voluntary memories and involuntary memories would decline as the cognitive resources were preoccupied by attention-demanding tasks. Moreover, the difference between retrieval of voluntary episodic memories and involuntary episodic memories is the activation of certain cerebral cortices that administer cognitive resource and cognitive control, and the retrieval of voluntary memories requires much more cognitive resources and controls than retrieval of its involuntary counterparts.

4. Clinical Application

The studies of involuntary, especially episodic, memories have practicability, because the results can be used to understand the cognitive and neural mechanism and generalize to clinical application. Diary studies done by researchers have shown the prevalence of involuntary memories in the daily life, and they often describe the experiences as one involuntary memory triggered subsequent involuntary memories like a chain (Berntsen, 1996). Moreover, earlier researches of intrusive episodic memories and childhood depression indicated the traumatic memories were highly likely to be involuntary and frequent for females with major depression disorders (Kuyken & Brewin, 1994). The research results of involuntary memories had high values of clinical application, because the following studies demonstrated the association of high level of depressive symptoms and distress following by involuntary memory retrieval. Expectedly, the involuntary episodic memories also played important roles in posttraumatic stress disorder and OCD. The involuntary memories were a distinguished symptom of PTSD participants, and they reported higher amount of occurrence of involuntary memories, especially with negative emotions in their subjective cognition, than the control group during behavioral studies (Hall, S.A. et al., 2018), and participants with OCD prone tended to have intrusive memories of past events, a typical instance of involuntary episodic memory, be less confidence when recalling negative self-engaging situations (Abou-khalil, 2012). Meanwhile, researchers argued that for patients with MDD and PTSD, the cognitive control regions, including DLPFC and inferior frontal gyrus (IFG), presented decreased connectivity with amygdala (Satterthwaite et al., 2016).

As mentioned above as the theory of the mechanism of involuntary episodic retrieval, although the proportion of involuntary memories increased, the amount of reported involuntary memories decreased as cognitive load increased, that is, the available cognitive resource decreased. Thus, by using the theory, patients with PTSD would alleviate the state of such mental disorder by training cognitive control, which preoccupied the cognitive resources and would restrain the available resources for involuntary episodic retrieval to occur. Such clinical treatment idea could be generalized to MDD and OCD.

Clinical researchers indeed discovered evidence to support such treatment idea. Schweizer et al. (2017) demonstrated by completing a computerized working memory task that both improved cognitive control and demand cognitive resources, and the result showed that: the participants reported less PTSD symptoms and had the emotion regulation strategies increased. Moreover, other researchers (Shou et al., 2017) conducted studies using cognitive behavioral therapy (CBT) as treatment, and the CBT was associated with the change of connectivity between amygdala and cognitive control regions. The evidence indicated the effectiveness of CBT in organized the previously dysregulated region connection that caused by MDD and PTSD. The study related to OCD

also showed the effectiveness of CBT treatment (Li. et al., 2018) by indicating the rebuild of connectivity between DLPFC and right orbitofrontal cortex (ROC), and thus inhibited the intrusive thoughts and alleviated the symptoms of participants with PTSD. The clinical researches and applications agreed with the cognitive mechanism of involuntary retrieval and was supported by neuroscientific evidence.

5. Conclusion

The triggered mode theory illustrated the involuntary retrieval of memory at the level of classification and the contexts of memory retrieval, and the cognitive control theory demonstrated the mechanism of involuntary retrieval under all the contexts and generate notable regulation effects. Our theory of the involuntary retrieval of episodic memory was the combination of two theories. The involuntary retrieval of memory could be categorized into three subtypes using triggered mode theory: the direct involuntary retrieval, the chained involuntary retrieval, and traumatic involuntary retrieval. The mechanism of cognitive control theory may apply to all three subtypes. Similar to voluntary retrieval, the involuntary retrieval requires cognitive resources to occur, yet the amount that the latter demand was far less than the former. When people's cognitive resources are preoccupied by attention-demanding tasks, the occurrence of both involuntary memories and voluntary memories decreased. However, the proportion of involuntary retrieval increased as it is less dependent on cognitive resources, compare to its voluntary counterparts which is a more active and cognition-consuming process. Such theory is supported by neuroscientific evidences that the involuntary retrieval is associated with less active regions, for example, DLPFC and LAC which are associated with cognitive resource and cognitive control. The theory mutually vitrified with studies in clinical fields as well. Since patients who have PTSD, MDD, and OCD are all have dysregulation of certain brain regions and cognitive control regions in varying degrees, the treatments of CBT that train the cognitive control could alleviate the symptom of these disorders. Thus, we concluded the occurrence of involuntary retrieval of episodic memories can be categorized using triggered mode, and the retrieval is associated with the lack of employ of cognitive control.

6. Limitation and Future Direction

However, the researches done currently have limitations. The most vital one is to assure the participants reporting the occurrence of involuntary retrievals more accurately, which now is full of indeterminacy. Most of the past researches applied the subjective report method, for example, asked the participants to keep dairy of involuntary memory or asked the participants to mark on notebooks when they retrieved involuntary memories. Such procedure may draw serious results if the participants who have less knowledge of psychology cannot distinguish the involuntary memory from voluntary memory, the data might be contaminated. Additionally, the ecological validity of these laboratorial researches is yet to be proved, even though some of the clinical researches already supported some theories, we may not apply the research results to publics without more reliable studies in the future.

The future studies could be conducted as the following direction: researchers may find more objective physiological indices than merely the inactive of DLPFC and LAC to confirm the occurrence of involuntary retrieval of episodic memories along with the subjective reported method. Such indices might be the blood flow of certain brain region that indicating the activation, or some electrical signals that can be detected using advanced technology. Moreover, the utilization of latest technology, for instance, artificial intelligence and machine learning, would assist the study of

voluntary and involuntary retrieval of memories. Meanwhile, an increase in the clinical field of study that focus on certain mental disorders for instances, MDD, PTSD, and OCD, would promote the overall application and development of psychological treatment. The cooperation of cognitive psychology, neuroscience, and clinical psychology would generate outstanding academic contribution on involuntary retrieval of memory.

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