Visual object imagery and autobiographical memory: Object Imagers are better at remembering their personal past

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Abstract

In the present study we examined whether higher levels of object imagery, a stable characteristic that reflects the ability and preference in generating pictorial mental images of objects, facilitate involuntary and voluntary retrieval of autobiographical memories (ABMs). Individuals with high (High-OI) and low (Low-OI) levels of object imagery were asked to perform an involuntary and a voluntary ABM task in the laboratory. Results showed that High-OI participants generated more involuntary and voluntary ABMs than Low-OI, with faster retrieval times. High-OI also reported more detailed memories compared to Low-OI and retrieved memories as visual images. Theoretical implications of these findings for research on voluntary and involuntary autobiographical memories are discussed.

Keywords: mental imagery, visual object imagery, autobiographical memory, involuntary memories

Introduction

Converging evidence coming from cognitive psychology and neuroscience research has demonstrated that visual imagery is not a unified and undifferentiated construct, and two separate subsystems, object and spatial imagery, have been reported, at both functional (Farah, Hammond, Levine, & Calvanio, 1988; Kosslyn, 1994; Logie, 2003) and neural levels (e.g., Kosslyn, Ganis, & Thompson, 2001; Mazard, Tzouio-Mazoyer, Crivello, Mazoyer, & Mellet, 2004). In the present study we focused on visual object imagery (which refers to mental representations of the visual appearance of objects, patterns and scenes, in terms of their shape, colour information, brightness, texture and size) and examined whether and how individual differences in object imagery, a stable characteristic that reflects the *ability* and *preference* in generating pictorial mental images of objects, affects voluntary and involuntary retrieval from autobiographical memory (ABM).

The idea that visual imagery contributes to *voluntary* retrieval from ABM and to specific phenomenological aspects of the retrieved memories (e.g. vividness, specificity, relieving) has received strong empirical support from behavioural and neuroscientific (neuropsychological and neuroimaging) studies, which are reviewed first. Conversely, the results of studies on individual differences in visual imagery and voluntary ABMs, reviewed next, are not so clear-cut and straightforward. One of the reasons for these "weak" results might be the way individual differences have been conceived and measured, that is as the very limited and specific ability to generate vivid visual images on demand. In this study we considered individual differences in visual imagery in terms of a broader visual cognitive style (visual object imagery). Finally, so far no study has systematically examined the role of visual imagery in the involuntary retrieval of ABMs (reviewed in the last paragraph). The present study was planned to overcome these limits and shed light on the relationship between ABMs and visual imagery, using an individual differences approach. In the following, we briefly review the relevant literature on these aspects.

Visual imagery and voluntary autobiographical memory

Autobiographical memory (ABM) refers to memory of personal past and "it is of fundamental significance for the self, for emotions, and for the experience of personhood, that is for the experience of enduring as an individual, in a culture, over time" (Conway & Pleydell-Peirce, 2000, p.261).

Most scholars agree that autobiographical memory is a complex cognitive function that involves and requires many other functionally and neurally distinct but interacting processes, of which visual imagery represents a very important component (e.g., the multiple-systems model, Rubin, 2005, 2006; Brewer, 1988; Conway, 1988).

Behavioural studies have consistently reported that almost all voluntary ABMs are accompanied by visual imagery (Brewer, 1986; Rubin, 2005, 2006) and neuroimaging studies have shown that regions involved in visuospatial processing and visual imagery, including occipital regions, are engaged in the retrieval of ABMs (see for a meta-analysis, Svoboda, McKinnon, & Levine, 2006). Studies on the phenomenology of ABMs have also revealed that visual imagery contributes to several phenomenological properties of autobiographical memory, such as vivid remembering (e.g., Brewer, 1986; Greenberg & Rubin, 2003), memory specificity (e.g., Dewhurst & Conway, 1994; Williams, Healy & Ellis, 1999) and the recollective experience during retrieval (e.g., Brewer, 1988; Greenberg & Rubin, 2003; Rubin, Schrauf, & Greenberg, 2003). People are more likely to believe their personal memories when they are accompanied by clear and vivid visual images (e.g., Rubin et al., 2003; Greenberg & Knowlton, 2014) although evidence has been reported that visual imagery may also easily induce false autobiographical beliefs and memories (e.g., Hyman & Pentland, 1996; Mazzoni & Memon, 2003).

According to the hierarchical model developed by Conway and Pleydell-Pearce (2000), voluntary retrieval of ABMs occurs following a top-down direction, which starts from the very top abstract level, such as life time period information, down to general events, to end up with the memory for the specific event. This generative process is effortful and time-consuming, usually taking up to 10/12 sec (e.g., Daaselar, Rice, Greenberg, Cabeza, LaBar, & Rubin, 2008; Rubin, 1998) and always more than 5 sec (see, e.g., Conway, 1990). Compared to this process, direct retrieval of event-specific knowledge is considered to occur only rarely, although recent findings suggested that it might be more common (>50%) than expected (Uzer, Lee & Brown, 2012).

According to the results of several studies, the generation of mental images, especially visual images, would facilitate the intentional retrieval search through the hierarchical structure of ABM (Conway & Fthenaki, 2000; Dewhurst & Conway, 1994; Greenberg & Rubin, 2003; Ogden, 1993; Rasmussen & Berntsen, 2014; Rubin & Schulkind, 1997; Williams et al., 1999). In the voluntary retrieval of ABMs, the detailed sensory-perceptual information and the context-rich themes provided by visual images would enhance access to knowledge-base structures and help the rapid generation of multiple intermediate descriptions that act as powerful indexes in the search for specific-event memories.

Empirical support to this claim comes from experimental studies on the effects of the imageability of the cue on the retrieval of ABMs (Mortensen, Berntsen & Bohn, 2014; Rasmussen & Berntsen, 2014;Williams et al., 1999) and from neuropsychological studies on patients with brain damage to areas known to support visual imagery (Conway & Fthenaki, 2000; Ogden, 1993; see also Rubin & Greenberg, 1998).

For example, in an experimental study on the effects of cue imageability on the voluntary retrieval of ABMs, Williams et al. (1999) reported a clear advantage of high (6.70 sec) *vs.* low-imageable (11.27 sec) cues, in speeding the retrieval processes with a specific contribution of visual imagery, compared to other kinds of imagery, in predicting the number of specific memories, as well as their retrieval times

Lesion studies reported retrograde amnesia in association with relatively isolated damage to the striate and extrastriate cortices (Conway & Fthenaki, 2000; Ogden, 1993; see also Rubin & Greenberg, 1998). In particular, Conway and Fthenaki (2000) noted that patients with impaired visual imagery abilities due to occipital lobes damage could also exhibit retrograde amnesia of specific events, with a specific difficulty in processing the visual aspects of the memories. The same patients, however, did not show impaired memory for lifetime periods or general event knowledge.

Altogether, these results suggest that intact visual imagery is crucial in voluntary retrieval of ABMs and that the ability to generate visual images is necessary for the transformation of generic personal knowledge into specific personal memories.

Individual differences in visual imagery

If it is true that visual imagery plays a key role in the voluntary retrieval of ABMs, one might expect that individual differences in visual imagery should be also related to differences in ABMs. However, and somehow surprisingly, only a few studies addressed this issue, and they focused almost exclusively on the phenomenological aspects of ABMs, with contradictory results.

In one of the first studies, D'Argembeau and van der Linden (2006) found that higher levels of vividness of visual imagery predicted richness of sensory details in memory, as well as clarity of representation of temporal information. However, no significant associations with any other relevant phenomenological properties of ABMs were found (such as the experience of reliving, the intensity of the emotion experienced at retrieval, the personal importance of memory). In a very recent study, Greenberg and Knowlton (2014) found no significant association between individual differences in vividness of visual mental images and several phenomenological properties of ABMs, including the experience of reliving and the amount of sensory details in memory. However, in the same study the researchers found that a higher *tendency* and *preference* for use of visual imagery was associated with a stronger sense of reliving, suggesting that different dimensions of visual imagery might relate to autobiographical memory in different ways, and that differences in the *preference of use* of visual imagery may be more relevant than differences in the *ability* to generate vivid visual images.

Contrary to these predictions, in a second study the direct comparison between Visualizers (those who *tend* and *prefer* to use visual imagery to perform cognitive task) and Verbalizers (those who *tend* and *prefer* to use linguistic strategies instead) showed no significant difference, as both groups had rich ABMs that came with visual imagery and did not differ in their ratings of reliving. According to the authors, various reasons might be advanced to explain this unexpected result. First, it might be that visual imagery is so important that all participants use it when they are recalling ABMs, even if they do not use in other tasks (as happens with Verbalizers). Second, and more important for our study, these findings “may hint that visualizer-verbalizer distinction needs to be refined” (Greenberg & Knowlton, 2014, p.929).

To this regard, in the last two decades several studies have shown that visual imagery is not a unified and undifferentiated construct and that Visualizers are not a homogenous group of individuals, as it was considered in the Greenberg and Knowlton study. Converging empirical evidence demonstrates the existence of two distinct visual imagery subsystems that encode and process visual information in different ways: an object imagery system processes the visual appearance of objects and scenes in terms of their shape, colour information and texture, while a spatial imagery system processes information on object location, spatial relations between parts of the object, object’s movement, and spatial transformations of different elements of the object (Farahet al., 1988; Kosslyn, 1994; Kosslyn et al., 2001; Mazard et al., 2004). Recent studies indicated that this dissociation is also reflected in individual differences in visual imagery (Kozhevnikov, Hegarty, |& Mayer, 2002; Kozhevnikov, Kosslyn, & Shepard, 2005; Vannucci & Mazzoni, 2009; Vannucci, Mazzoni, Chiorri & Cioli, 2008).

Individuals with high levels of object imagery (High-OI) tend and prefer to use imagery to construct vivid high-resolution images of individual objects and scenes and they are facilitated in generating colourful pictorial mental images. They also frequently experience spontaneous visual images and enjoy visual pictorial representations (e.g., paintings) in their daily life. Compared to individuals with low levels of object imagery (Low-OI), High-OI reported a better performance on object imagery tasks, as recognizing degraded pictures of objects (Kozhevnikov et al., 2005; Vannucci et al., 2008). Conversely, they showed a below average performance on visuo-spatial ability tasks, which required performing mental spatial transformations (e.g., three dimensional mental rotation, imagined paper folding; Blazhenkova & Kozhevnikov, 2010; Kozhevnikov et al., 2005).

According to some recent studies, High-OI do not only have a different kind of imagery, but they also differ in other dimensions of cognitive functioning (e.g. perception, creativity, problem solving) and personality (e.g. fantasy proneness). For example, they encode and process both mental images and visual stimuli in a more global and holistic way compared to Low-OI (Vannucci et al., 2008), they show high levels of artistic creativity (Kozhevnikov, Kozhevnikov, Chen, & Blazhenkova, 2013), and a very good academic performance in the field of visual arts (Blazhenkova & Kozhevnikov, 2009, 2010).

In summary, object imagery represents a broader construct than imagery vividness and a stable individual characteristic referring to the abilities/preferences and frequency of use of a specific type of visual imagery. In light of the findings of experimental and phenomenological studies on visual imagery and voluntary retrieval of ABMs reviewed above, one might argue that individual differences in this specific visual cognitive style might affect the processes involved in memory retrieval, and shape the qualities of the memories retrieved. However, to the best of our knowledge no previous study investigated the association between this dimension of visual cognitive style and autobiographical memory.

Involuntary retrieval of ABMs

Another aspect that has been neglected in the research on visual imagery and ABM concerns involuntary ABMs, namely spontaneously arising memories of personal events that come to mind with no deliberate attempt directed at their retrieval (Berntsen, 2009; Mace, 2007).

However, consistent evidence has been reported that most people frequently experience involuntary ABMs in their daily life, especially when they are engaged in undemanding activities that require little attention and concentration (e.g., during relaxation and routine activities) (Berntsen & Hall, 2004; Kvavilashvili & Mandler, 2004). In the large majority of cases (80% or more) this kind of memory is elicited by easily identifiable external cues (e.g., objects, actions, people) (e.g., Berntsen, 1996; Berntsen & Hall, 2004).

Involuntary retrieval of memories is currently conceived as due to a match between elements of the cue and central features or themes of the memory representation of past events (e.g., Ball, Mace, & Corona, 2007; Berntsen, 2009, 2010; Berntsen & Hall, 2004). This occurs through the spreading of activation in an associative network, from the representation of the cue to related concepts in the autobiographical memory system. In the literature, the hypothesis of a direct access to memory representations has been advanced for involuntary ABMs (Berntsen, 1998; Conway, 2005; Uzer et al., 2012). However, as Schlagman and Kvavilashvili (2008) proposed, the presence of a relevant proportion of involuntary memories classified as general (approx. 30% in Schlagman & Kvavilashvili,

2008) seems to suggest that they are retrieved from the same autobiographical memory knowledge base as voluntary memories, following the same top-down (and probably re-constructive) pathway. In this case, though, the spreading of activation is not intentionally initiated but triggered automatically by the cue.

The few studies that directly compared voluntary and involuntary retrieval of ABMs have shown that involuntary ABMs more frequently than voluntary ABMs refer to specific events (Berntsen, 1998; Schlagman & Kvavilashvili, 2008), they are accompanied by more immediate emotional reactions, with greater impact on mood than their voluntary counterparts (e.g., Berntsen & Hall, 2004), and they are also retrieved almost twice as fast as voluntary memories (Schlagman & Kvavilashvili, 2008).

The present study

In the present study we aimed to further investigate the role of visual imagery in the retrieval of ABMs by examining and comparing, for the first time, the association between different levels of visual object imagery and voluntary and involuntary retrieval of ABMs. Differently from the previous studies on individual differences in visual imagery, here we focused on a specific *visual cognitive style*, visual object imagery. Moreover, instead of limiting our investigation to the phenomenological properties of ABMs, we comprehensively assessed the different levels at which visual imagery might affect ABMs, namely number of memories, ease of retrieval (measured in terms of retrieval time), and phenomenological characteristics (e.g. vividness, specificity richness of details, rehearsal, pleasantness, intensity of emotion at retrieval).

Given the centrality of visual imagery in voluntary retrieval of ABMs and given the *tendency* of High-OI to spontaneously generate pictorial visual mental images, we hypothesize that High-OI show facilitated voluntary retrieval of ABMs, in terms of both amount of memories and retrieval times.

The perceptual-like and high-resolution mental images generated by High-OI are also expected to facilitate involuntary retrieval of ABMs: the spontaneous generation of personally-relevant visual mental images, in response to the cue might enhance the match between the cue and the memory representation, making it easier and faster to involuntarily recall personal events.

The analyses of retrieval times, as well as of the proportion of specific *vs.* general ABMs memories, might also contribute to address the still debated issue of the mechanisms (generative *vs.* direct) involved in voluntary and involuntary retrieval and whether and how they are affected by different levels of visual object imagery.

Individual differences in the level of visual object imagery are also expected to affect the phenomenological properties of both voluntary and involuntary ABMs, with High-OI reporting more detailed and more specific ABMs than Low-OI, and recalling memories mainly as visual images (instead of verbal descriptions).

Finally, given the small number of studies that have directly compared voluntary and involuntary ABMs within the same sample of participants, we also aimed to further investigate potential similarities and differences between these two kinds of memories. In line with the results of previous studies, it is predicted that, with respect to voluntary ABMs, involuntary ABMs are retrieved faster, they refer more to specific events, and they are associated with a stronger emotional reaction at retrieval.

Method

Participants

Forty undergraduate students of the University of Florence (26 females; mean age: 24.80 years, *SD* = 3.56 years), all native Italian speakers, volunteered to take part in the experiment. All had normal or corrected-to-normal vision. The sample included 20 High-

OI (13 Female) and 20 Low-OI (13 Female) participants.

Visual object imagery was assessed in a screening phase, in which 344 undergraduate students at the University of Florence completed the Object-Spatial Imagery Questionnaire (OSIQ, Blajenkova, Kozhevnikov & Motes, 2006) and the Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973) in two consecutive distinct sessions (one week interval), and along with other questionnaires unrelated to this study.

On the basis of the classification criteria used in earlier studies with Italian samples for identifying High-OI (see Vannucci et al., 2008), participants who scored above 3.5 in the OSIQ_OI scale and 25 or below in VVIQ were classified as High-OI and participants who scored below 2.5 in the OSIQ_OI and above 40 in VVIQ were classified as Low-OI. High-OI and Low-OI participants were subsequently invited to take part in the present experiment on "concentration and attention".

Materials

<u>Screening phase</u>

In the screening phase in which High-OI and Low-OI were identified, participants completed the Object-Spatial Imagery Questionnaire (OSIQ, Blajenkova et al., 2006; adaptation for the Italian population in Vannucci, Cioli, Chiorri, Grazi, & Kozhevnikov, 2006) and the Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973). The OSIQ was developed to assess individual differences in cognitive style, namely, preference and ability to imagine objects (OSIQ_OI) vs. spatial relations and layouts (OSIQ_SI). OSIQ_OI items measure vividness of mental images, image maintenance, preference for pictorial visual representations, and self-estimated ability to perform tasks requiring object imagery. The mean value the OSIQ_OI items scores is the index of the Object Imagery level, with higher scores indicating higher object imagery (Blajenkova et al., 2006; Vannucci et al., 2006). Previous studies reported good internal consistency, as well as construct, criterion and ecological validity of OSIQ-OI scores (Blajenkova et al., 2006; Vannucci et al., 2006).

The VVIQ is the most frequently used measure of the vividness of visual mental images. It consists of 16 items and participants are asked to rate the vividness of the mental image relative to each item. Ratings range from 1 (image clear and vivid as a perception) to 5 (no image at all). VVIQ item scores summed to provide a total score and lower scores indicate higher vividness.

<u>Experimental session</u>

Involuntary recall. A modified version of the vigilance task developed by Schlagman and Kvavilashvili (2008; see also Kvavilashvili & Schlagman, 2011) and already used in previous studies (Mazzoni, Vannucci, & Batool, 2014; Vannucci, Batool, Pelagatti & Mazzoni, 2014; Vannucci, Pelagatti, Hanczakowski , Mazzoni & Rossi Paccani, 2014) was administered, as a first task of the experimental session.

The task consisted of 200 trials, presented in a continuous fixed order, each remaining on the screen for 3 sec. In each trial a card (approximately 21.5 x 12.5 cm in size) was shown depicting either a pattern of black horizontal (non-target stimuli) or black vertical lines (target stimuli). Target stimuli appeared on 9 trials, presented at fairly long and irregular intervals. Word-phrases (e.g., “relaxing on a beach”, “supportive friend”) in 18-CPI Arial font were shown in the middle of the card on 75 trials.[1] These stimuli were taken from the Italian adaptation of a standardized pool of 800 word-phrases developed by Schlagman and Kvavilashvili (2008) and already successfully used in previous studies on

[1] Compared to Schlagman and Kvavilashvili (2008), we employed a longer presentation time and a reduced number of cues to make the task more effective. A previous study (Vannucci, Pelagatti et al., 2014) had shown that few cues are indeed more effective than many cues in eliciting involuntary ABMs. As for the presentation time, we decided for 3 sec on the bases of pilot data (n = 10), showing that 3 sec were more effective than 1.5 sec.

involuntary memories. In the adaptation, the original 800 word-phrases had been evaluated by 11 independent judges for concreteness and familiarity on a 7-point scale (1 "low" - 7 "high"). In the present study only word-phrases rated as concrete and familiar (rating 5-7) were used. Of these cues, 50 were neutral, 15 positive and 10 negative.

Voluntary recall. A total of 18 new word-phrases (15 neutral, 3 positive and 0 negative) were selected from the general pool. These were not shown in the involuntary recall task and were randomly presented in the voluntary recall task. These cue word-phrases were shown in 18-CPI Arial font in the middle of cards taken from the non-target stimuli in the vigilance task (depicting black horizontal lines). The word-phrases used in the voluntary task did not differ in familiarity, concreteness and valence from the ones used in the involuntary task. Each cue trial lasted 60 seconds (as in Schlagman & Kvavilashvili, 2008).

Memory characteristics questionnaire. At the end of each recall tasks (either involuntary or voluntary) participants recorded details of each memory on a questionnaire, adapted from the one used by Schlagman and Kvavilashvili (2008) and modified for the present study. In particular, participants wrote a detailed description of the memory, and rated its vividness (1 = very vague, almost no image at all; 7 = very vivid, almost like normal vision), the richness of its details (1 = very few; 7 = many), how often the memory had been thought of/rehearsed before (1 = never; 5 = many times), how pleasant or unpleasant the memory event was (1 = very unpleasant; 3 = neutral; 5 = very pleasant), the intensity of the emotional response associated with remembering of the event (1 = no intense at all; 5 = very intense). They were also asked whether the remembered event was general or specific,[2] whether it came to their mind in words or images and they had to indicate the period of

[2] Participants received instructions on how to identify a general and a specific memory. As in previous studies on IAMs (see Bentsen, 1996, 1998, Bentsen & Hall, 2004), participants were told that a remembered situation could take two forms, specific and general.
A specific memory refers to a single episode/event that could be allocated a specific time and place in the past and that had lasted less than a day. Examples were provided (e.g. "yesterday when you went

their life in which the event occurred (childhood-remote memories, adolescence, adulthood).

Procedure

In the screening phase, participants were administered the paper-and-pencil instruments in two consecutive mass testing session (one week interval).

In the experimental session, participants were tested individually. All participants performed first the involuntary memory task and then, after two hours, the voluntary memory task, in order to reduce the risk that participants tried to voluntarily recall memories also during the vigilance task, being aware of our interest in memory (for a similar task order, see also Schlagman & Kvavilashvili, 2008).

After completing the informed consent form, in the involuntary recall task participants were told that they would take part in a study examining concentration using a vigilance task. In this task they would be asked to detect target stimuli (vertical lines) among a large number of non-target stimuli (horizontal lines), by saying ‘‘yes’’ out loud each time they detected a target stimulus. They were told that short sentences would also appear on the screen, but they were irrelevant, and thus could be ignored, as participants were in the 'line detection' group, not in the 'word detection' group (this was a cover story, the word-detection group did not exist). Participants were also informed that the task was quite monotonous and they could find themselves thinking about other things (thoughts, plans about

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shopping in the x store" or "that particular day when your dog ran away when you took it for a walk").

A general memory refers to a generalized representation that summarizes the properties of many similar events (e.g. "going shopping in the x store" or "walking in the woods".). General memories might refer to either extended events that lasted for a longer period of time (e.g., a holiday on the mountains) or repeated events (e.g., using the bus to go to work; going to the beach every summer during childhood). All participants were able to provide correct examples of specific and general memories.

the future, past experiences, etc.), which was normal. They were told that if any mental content (mental contents could refer to thoughts, intentions, plans for the future, past experiences, etc.) crossed their mind during the task, they should click the mouse to interrupt the presentation and write a short sentence describing their mental content. They were informed that this initial brief description of the mental content should be sufficient to remind them of that specific mental content at a later point in time. They were also asked to specify whether the content came from their thoughts, from the external environment or from a word-phrase shown on the screen (if so, they should specify which one).

After all stimuli had been presented and all mental contents recorded, participants were informed about the nature of involuntary memories, saw their short sentences and categorized them as involuntary memories or non-memory contents (here more generically referred to as 'thoughts'). After the categorization task, they were asked to complete for each of the involuntary memories the two-page questionnaire on memory characteristics. Clicking the mouse stopped the time, which was recorded by the computer. The task lasted approximately 60 to 90 min.

In the voluntary recall task, participants were called back in the same location after two hours, and asked to perform a voluntary recall task. The were told to deliberately retrieve a past memory associated with each word presented on the screen. They were informed that each word-phrase would remain on the screen for 60 sec. and that they should try to recall a past memory as quickly as possible within that time. As in Schlagman and Kvavilashvili (2008) it was clarified that memories could be general or specific, recent or remote. Participants were instructed to click the mouse as soon as the memory came to their mind. If participants were unable to recall a past memory within 60 sec., the computer automatically moved onto the next trial. Once all trials had been presented, the participants completed the memory characteristics questionnaire for each reported memory. The voluntary recall task lasted approximately 30 min.

Results

Number of ABMs and non-memory contents ("thoughts").

For the involuntary recall participants were asked to report all task-unrelated mental contents that came into their mind[3]. The mean values and standard deviations of the total number of mental contents (which included IAMs and "thoughts") are reported in Table 1, as well as mean values and standard deviations of the number of voluntary ABMs..

[Table 1]

Independent samples t-tests were performed to compare involuntary ABMs, thoughts, and voluntary ABMs between High-OI and Low-OI groups. The Benjamini and Hochberg (1995)'s step-up false discovery rate-controlling procedure was used to adjust the p-values for multiple comparisons.

As shown in Table 1, the mean number of task-unrelated mental contents (voluntary and involuntary memories and involuntary thoughts together) was significantly higher in the High-OI group than in the Low-OI group, $t(38) = 3.91$, adjusted-$p = .001$, $d = 1.27$. The High-OI group reported a significantly higher number of involuntary ABMs, $t\ (38) = 3.87$, adjusted-$p = .001$, $d = 1.26$, and thoughts, $t\ (38) = 3.16$, adjusted-$p = .001$, $d = 1.03$, than Low-OI.

A similar pattern was obtained when analyses were limited to involuntary ABMs and thoughts triggered by the word-phrase cues: High-OI reported a higher number of involuntary ABMs triggered by the cues compared to Low-OI, $t\ (38) = 3.59$, adjusted-$p = .001$, $d = 1.16$, and a higher number of thoughts, $t\ (38) = 2.82$, adjusted-$p = .001$, $d = 0.91$ (Table 1).

[3] Classification of mental contents as memories or other mental contents (thoughts) was done relatively easily and quickly.

As for involuntary ABMs, we also compared in the two groups the mean proportion of memories that were reported to have a trigger. Triggers could be a cue, a thought or an environmental stimulus. t-tests for independent samples did not reveal any significant difference between High-OI and Low-OI in the mean proportion of IAMs triggered either by cues (.88±.16 vs .79±.35), $t(36) = 1.03$, $p = .308$, $d = 0.35$, or by thoughts (.10±.15 vs .20±.34), $t(36) = -1.11$, $p = .273$, $d = -0.37$.

In the voluntary recall task, the High-OI group reported a significantly higher number of ABMs than the Low-OI group, t (38) = 3.28, adjusted-p = .003, d = 1.06 (Table 1). The discrepancy in the number of ABMs between High-OI and Low-OI in the involuntary condition did not substantially differ from that in the voluntary condition, as the 95% confidence intervals of the two effect sizes overlapped (0.58-1.94 and 0.40-1.72, respectively).

Retrieval times

For those involuntary ABMs that participants reported as being triggered by cues presented on the screen, we could calculate retrieval times (RTs, as in Schlagman & Kvavilashvili, 2008). RTs were computed as the time from the present (clicked on) trial, back to the trial that presented the word-phrase cue that was reported by the participant to have triggered the involuntary memory. For example, if a participant clicked on Trial 23 and the RT for that trial was 0.55 sec., and the word that triggered the memory was two trials back, then 6.00 sec. would be added (i.e., 3 sec. per trial), to make a retrieval time of 6.55 sec. For the voluntary recall task, RTs were calculated from the onset of the stimulus (the cue phrase) to the time the participants pressed a key indicating they retrieved a memory. For each participant we computed the median RT for involuntary and voluntary ABMs. Means and standard deviations of median RTs for involuntary and voluntary ABMs, as well as for thoughts in High-OI and Low-OI, are shown in Table 2.

[Table 2]

A 2 x 2 mixed model ANOVA, with Group (High-OI and Low-OI) and Memory type (voluntary *vs.* involuntary) as independent variables was carried out on the RTs of all memories. This analysis revealed a significant main effect of Memory type, as RTs for involuntary ABMs were significantly faster than RTs of voluntary ABMs, F (1,32) = 12.10, adjusted-p = .001, η^2 = .17, and a significant main effect of Group, as RTs were almost twice as fast in High-OI than in Low-OI, F(1,32) = 4.33, adjusted-p = .046, η^2 = .06. The interaction between Group and Memory type was not significant (Table 2).

The same 2 x 2 mixed model ANOVA was separately carried out on RTs of specific and general memories. In either case only the main effect of Group was significant: RTs were faster in High-OI than in Low-OI both for specific memories, F (1,25) = 18.40, adjusted-p = .001, η^2 = .26, and general memories, F (1,18) = 13.31, adjusted-p = .002, η^2 = .32. The main effect of Memory type and the interaction were not significant (Table 2).

No significant difference was found between High-OI and Low-OI on the RTs of thoughts (M= 3.920 sec, SD = 1.83 vs M= 4.54, SD= 1.40) ,t (31) = - 1,03, p = .310, d = 0.37.

Characteristics of ABMs

Mean values and standard deviations of the various phenomenological characteristics for involuntary and voluntary ABMs in High-OI and Low-OI are shown in Table 2. Results are organized by characteristic.

For the phenomenological characteristics of memories, several 2 x 2 mixed model ANOVAs, with Group (High-OI and Low-OI) and Memory type (voluntary *vs.* involuntary) as independent variables, were carried out. A step-up false discovery rate-controlling procedure (Benjamini & Hochberg, 1995) was used to control the inflation of Type I error due to multiple comparisons.

The mixed model ANOVA conducted on the mean rating of vividness showed that High-OI reported more vivid memories compared to Low-OI, F (1, 36) = 6.21, p = .025, η^2 = .12. Moreover, involuntary ABMs were more vivid compared to voluntary ABMs, F (1, 36) = 28.51, p < .001, η^2 = .16, and the two-way interaction was significant, F (1, 36) = 11.21, p = .006, η^2 = .07: High-OI reported more vivid voluntary ABMs compared to Low-OI, while no significant differences were found for involuntary ABMs.

High-OI also reported more detailed ABMs compared with Low-OI, F (1, 36) = 30.18, p < .001, η^2 = .39. Involuntary ABMs were more detailed than voluntary memories, F (1, 36) = 5.86, p = .027, η^2 = .04.

Significant differences between High-OI and Low-OI were also found in the proportion of ABMs recalled as mental images, F (1, 36) = 12.38, p = .005, η^2 = .17. High-OI reported a significantly higher proportion compared to Low-OI. No other effects were significant.

As for the period of life in which the event occurred, High-OI reported a higher proportion of childhood/remote memories compared to Low-OI, F (1, 36) = 5.69, p = .028, η^2 = .09. A higher proportion of remote childhood memories was reported in voluntary ABMs compared to the involuntary counterpart, F (1, 36) = 8.97, p = .011, η^2 = .09. The two-way interaction was also significant: High-OI reported a higher proportion of remote involuntary ABMs, compared to Low-OI, F (1, 36) = 6.26, p = .025, η^2 = .06, but no significant differences between the two groups were found for voluntary memories.

No significant differences between High-OI and Low-OI were found in the intensity of the emotional reaction experienced during the retrieval, but involuntary ABMs were associated with a more intense emotional reaction during retrieval compared to voluntary ABMs, F (1, 34) = 9.70, p = .010, η^2 = .08. Similarly, no significant differences were found between the two groups in the frequency of rehearsal of memories and in the proportion of specific memories, but involuntary ABMs were more rehearsed than voluntary ABMs, F (1, 36) = 19.57, $p < .001$, $\eta^2 = .10$, and there was a significantly higher proportion of specific memories, F (1, 36) = 6.77, $p = .024$, $\eta^2 = .04$.

Discussion

The major aim of the present study was to systematically investigate the association between a specific visual imagery style, namely visual object imagery, and the voluntary and involuntary retrieval of ABMs. We also aimed to further investigate similiarities and differences between voluntary and involuntary ABMs.

Overall our results show that people who, as a cognitive style, tend to use visual object imagery in their life (i.e., High-OI individuals) are facilitated in remembering their personal past, showing an advantage for both voluntary and involuntary ABMs. High-OI remembered more personal memories and with shorter retrieval times compared to Low-OI. Moreover, and consistent with their visual style, High-OI produced more detailed memories (higher amount of perceptual/sensory details), which were mainly recalled as visual images, and they retrieved more remote/childhood involuntary ABMs compared to Low-OI.

Theoretical implications for voluntary retrieval

The advantage shown by High-OI in voluntary recall of ABMs is consistent with the results of previous behavioural and neuroimaging studies on healthy subjects and neuropsychology patients, showing that voluntary retrieval of ABMs relies heavily on the visual modality (e.g., Conway, 1988, 1990; Daselaar et al., 2008; Svoboda et al., 2006) and that visual imagery contributes to several aspects of ABM, including their recollective quality (Greenberg & Rubin, 2003; Rubin, 2005, 2006), their vividness (e.g., D'Argembeaus & van der Linden, 2006), as well as the easiness (retrieval times) of retrieval (Rasmussen & Berntsen, 2014; Williams et al., 1999). Finding that high object imagery helps (both in terms of number and speed) voluntary retrieval of autobiographical memories supports the claim (e.g., Williams et al., 1999) that the creation of mental images facilitates retrieval of ABMs via increasing the ease and speed of search through the hierarchical structure of ABM (Conway & Pleydell-Pearce, 2000). The presence of a substantial percentage of general memories in both groups is consistent with the idea that voluntary ABMs are retrieved by both High-OI and Low-OI following a top-down hierarchy.

Moreover, we found that the advantage of High-OI in terms of number of memories and speed of retrieval was not limited to "specific" memories, but also extended to "general" memories. This confirm that using visual images speeds access at all levels of the hierarchical structure of ABM, not just at the level of event-specific knowledge. While our data provide empirical support for a generative/hierarchical retrieval process, a closer look at retrieval times for specific memories, which were very short, seems to suggest that the advantage in High-OI could also be due to direct retrieval (e.g., Barsalou, 1988; Conway, 1990; Haque & Conway, 2001). For voluntary specific memories (the majority of memories) High-OI reported an average median retrieval time of 3.28 sec., consistent with the use of direct retrieval. In this case the cue would directly activate event specific knowledge and the access might proceed bottom-up rather than top-down within the ABM hierarchical structure. For specific memories Low-OI participants reported an average median retrieval time of 5.09 sec. and 14% of them reported a median retrieval time under 3 sec. This pattern of results becomes even clearer when we calculate for each participant the proportion of memories recalled within 2/2.5 sec., which for High-OI is 36%, whereas in Low-OI is 11%, with 69% of participants reporting no memories with retrieval time under 2.5 sec.

These findings for High-OI suggest that the generation of detailed and perceptual-like mental images in response to experimenter-provided cues might not only speed up the process of searching for a memory along the top-down hierarchy, but it may also stimulate a different, fast and automatic, direct access to the concrete sensory-perceptual fragments of information represented in the memory of a specific event.

Although direct retrieval has been so far considered to occur more rarely than generative retrieval (Barsalou, 1988; Conway, 1990; Haque & Conway, 2001), according to the results of a more recent study by Uzer et al. (2012) direct retrieval might be indeed more common (> 50%) than previously reported, with participants being more likely to use direct retrieval when they are cued with objects than when they are cued with emotions, in line with the hypothesis that event memories are more likely to be indexed by concrete information than by abstract concepts such as feelings (see also, Conway & Bekerian, 1987; Fitzgerald, 1980). Uzer et al. (2012) reasonably suggested that averaging retrieval times could hide the frequency with which direct retrieval occurs, and thus makes it impossible to examine the use of both retrieval processes (direct and generative) in the same participant.

In the case of High-OI, the cue might trigger a detailed, concrete mental image, that in turn, might favour the direct activation of event-specific information, thus bypassing the need to search through the hierarchical structure of autobiographical memory.

In some previous studies, high-imageable cue words facilitated access to more specific memories, compared to low-imageable cue words (e.g., Rasmussen & Berntsen, 2014; Williams et al., 1999). Williams et al. (1999) showed that the visual imageability of the cue-word was a significant predictor of specificity of voluntary ABMs. In our study we did not find any significant differences between High-OI and Low-OI in the proportion of specific memories, either in the voluntary or involuntary recall tasks. On the one hand, the in-consistency in the results might depend on the different measures of specificity used in the studies (we asked participants to classify their memories as "specific" or "general", instead of using a scale of specificity). On the other hand, it might be that High-OI and Low-OI do not differ in the probability to recall specific memories but more globally in how easily they access their ABMs and in the mechanism used to access them (as suggested by the different patterns in the retrieval times). It should be also considered that different aspects of visual imagery might relate to autobiographical memory in different ways, so that visual imageability of the cues and object imagery as an individual trait might relate differently to ABM retrieval.

Theoretical implications for involuntary retrieval

In the present study we found an advantage of High-OI also in involuntary retrieval of ABMs, namely for those memories that come to mind spontaneously without any conscious or deliberate attempt to retrieve them (for a review, Berntsen, 2009, 2010). In involuntary recall tasks, High-OI were able to produce more involuntary ABMs compared to low-OI, and their retrieval times were almost twice as fast as those of Low-OI.

According to the current models on involuntary retrieval, a memory is reactivated through a spreading of activation occurring automatically, without conscious awareness and in response to some accidental cues, with external cues (e.g., objects, actions, people) being more effective than internal experiences (e.g., thoughts and emotion). In particular, it is suggested that involuntary memories are triggered when a sufficient match occurs between elements of the cue and central features or themes of the memories (e.g., Ball et al., 2007; Berntsen, 2009, 2010; Berntsen & Hall, 2004).

In terms of the mechanism, the advantage shown by High-OI might be due to the perceptual-like properties of the visual images spontaneously generated by High-OI in response to cues, that might facilitate the matching between cues and memories. The notion of transfer-appropriate processing (e.g., Roediger, 1990) would also help in predicting that concrete and pictorial mental images generated by High-OI in response to cues should be more effective at activating episodic memories, providing a greater overlap with the processing of episodes at encoding.

An alternative hypothesis, which however can coexist with the previous one, is that High-OI might automatically generate mental representations which, besides being rich in sensory/perceptual details, are also highly flexible and refer to personal experiences. Mental images can be similar to mental representations of personal events (see also Conway, 2005). People can create their own personal mental images of the word phrase "a glass of wine," by adding elements that are personally relevant. Personally-enriched representations would increase the likelihood of a match with existing personal memories (for a discussion, see Mazzoni et al., 2014).

An alternative potential explanation of the advantage is that High OI participants search is faster because of a faster automatic spread of activation in the semantic network and hierarchical autobiographical knowledge network (Conway & Pleydell-Perce, 2000) than in the Low-OI group. Their greater speed of retrieval and the presence of approximately 25/30% of memories classified as general as opposed to specific support this explanation. However, the very short retrieval times reported for the specific memories by High-OI suggests that the faster access might be due to direct retrieval processes, which are also likely to be frequently used in this group.

The shorter retrieval times reported by High-OI in both voluntary and involuntary recall task might be also due to High-OI being in general faster in processing information. Faster general information processing would then produce faster access to all memories. While this might in principle be the case, and speed certainly represents a crucial element in previous explanations of facilitated access to mental contents, our data seem to suggest that higher speed of processing is not the only factor at play. The procedure used in the involuntary task allowed us to collect response times not only for memories but also for other types of mental contents (intentions, considerations, generic thoughts, etc.) that were triggered by the cues. Response times for these mental contents were not significantly different between High-OI and Low-OI, suggesting that the advantage of High-OI is limited to access to memories, rather than access or production of mental contents in general. It seems then that the main variable is the creation of high quality visual mental images, which enhances speed of access specifically to memory representations.

Comparison between voluntary and involuntary ABMs

An additional aim of the present study was to further examine the similarities and differences between voluntary and involuntary ABMs, by comparing their retrieval processes (e.g. retrieval times) and their memory characteristics.

In line with the results of previous studies, we found markedly shorter retrieval times for involuntary as compared to voluntary ABMs (Kvavilashvili & Schlagman, 2011; Schlagman & Kvavilashvili, 2008). Significant differences were also found in the phenomenology of memories, with involuntary ABMs being more detailed, vivid, specific, more frequently rehearsed and associated with a more intense emotional reaction at retrieval.

The predominance of specific memories in involuntary recall confirms the results of several diary as well as experimental studies (Berntsen, 1998; Berntsen & Hall, 2004; Schlagman & Kvavilashvili, 2008). The stronger intensity of the emotional reaction associated with involuntary compared to voluntary retrieval is also consistent with the data reported in previous diary studies, showing that involuntary memories are accompanied by more immediate emotional reactions and have more impact on mood than their voluntary counterparts (Berntsen & Hall, 2004; Rubin, Boals & Berntsen, 2008).

Future developments

This is the first study examining the association between visual object imagery, measured as a cognitive style, and voluntary and involuntary recall of ABMs. In the present study we cued autobiographical memory using concrete word-phrases, which have been found to be more effective in triggering ABMs compared to abstract ones (e.g., Rasmussen & Berntsen, 2014; Williams et al., 1999). Future studies might confirm the role of visual imagery by assessing whether the advantage shown by High-OI was selective for concrete cues, or it can also be observed in abstract cues, which are characterized by a lower imagery potential. Future research should also examine whether the advantage reported by High-OI in involuntary ABMs generated during a visual vigilance task is also obtained using a verbal task, like the continuous word association task (CWAT) developed by Ball (2007) for eliciting involuntary memories in the laboratory.

Recent work (Anderson, Dewhurst, & Nash, 2012; Rasmussen & Berntsen, 2014) has shown a facilitatory effect of visual imagery not only on the retrieval of ABMs but also on the construction of future events (e.g. participants were asked not only to retrieve past specific events, but also to imagine future ones), although the effect was stronger for past relative to future events. In our study, High-OI reported a higher amount of non-memory contents (called thoughts) in the vigilance task, compared to Low-OI. Since this category of mental contents was very heterogeneous, as it included fantasies, plans for the future, concerns, etc., it was difficult to make a meaningful comparison with involuntary autobiographical memories. Future studies should systematically verify whether the advantage reported by High-OI in accessing their personal past does also extend to the construction of future events and assess the level (s) at which the effect occur (e.g. amount of future events, retrieval times, phenomenological characteristics of the events).

Blazhenkova and Kozhevnikov (2010) also reported evidence of a relationship between visual object imagery and emotion. In their work, many visual artists reported that their visual object images had strong emotional components, being emotionally driven, generated by emotional experiences or oriented to convey emotions. While in the present study we did not find significant differences between High-OI and Low-OI in the level of intensity of the emotional reaction associated with memory retrieval, at least in part these findings might be due to the fact that most of our word-phrase cues were neutral. Using an equal number of neutral and emotional cues, both negative and positive word-phrases, can help to systematically address this issue.

Other results reported in the present study deserve future attention and investigation. The retrieval times reported by High-OI in both recall tasks seem to suggest that one of the differences between High-OI and Low-OI might be a facilitated direct retrieval to event-specific representations. Given the relevance of these results for understanding not only the way High-OI and Low-OI retrieve memories, but also the frequency of use of direct retrieval, direct retrieval should be more systematically examined, possibly including different and converging methods to assess and differentiate generative and direct retrieval (see for example Uzer et al, 2012).

Finally, in our study we focused on ordinary, daily-life voluntary and involuntary ABMs. Future studies might extend the investigation to unpleasant and unwanted intrusive memories/images for negative or adverse material. The results of the few studies that investigated the association between individual differences in mental imagery and intrusive memories, generally suggest that some dimensions of mental imagery (e.g. vividness of mental images, in Morina, Leibold & Ehring, 2013; preference for visual processing compared to verbal processing in Krans, Näring, Speckens, & Becker, 2011) might contribute to the development of intrusive memories following exposure to traumatic events, making some individuals at a higher risk for post-stressor intrusive memories. However, as recently discussed by Kvavilashvili (2014), "although ordinary involuntary autobiographical memories and intrusive memories are similar in terms of their spontaneous nature they are different in a number of ways" (p. 102), and they refer to distinct phenomena, making any generalization of results from involuntary ABMs to intrusive memories rather problematic.

Conclusions

In summary, the results of this study represent an important contribution in understanding the role played by visual imagery in both voluntary and involuntary retrieval of ABMs. In particular, the present findings provide for the first time clear evidence that pre-existing individual differences in visual object imagery style might strongly affect the processes involved not only in voluntary but also in involuntary retrieval of ABMs, and shape the qualities of the memory retrieved. The results also suggest that high object imagers might use direct retrieval more often, a result that deserves further investigation.

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Table 1

Means, standard deviations, results of significance tests and effect sizes of the comparison of High Object Imagers (High-OI, n=20) and Low Object Imagers (Low-OI, n=20) on the number of mental contents, involuntary and voluntary autobiographical memories (ABMs), non-memory contents (thoughts) and proportion of memories and thoughts triggered by a specific stimulus.

Variable	High-OI		Low-OI		t	df	p_{BH}	d
	M	SD	M	SD				
Vigilance task								
Number of task-unrelated mental contents	22.35	14.11	8.35	6.67	3.91	38	. 001	1.27
Number of total involuntary ABMs	10.65	7.79	3.40	2.42	3.87	38	.001	1.26
Number of involuntary ABMs triggered by the cue	9.70	7.96	2.85	2.43	3.59	38	.001	1.16
Number of total thoughts	11.70	7.64	4.95	5.31	3.16	38	.004	1.03
Number of thoughts triggered by the cue	7.50	6.36	2.75	3.68	2.82	38	.008	0.91
Voluntary recall task								
Number of ABMs	16.20	2.44	12.25	4.64	3.28	38	.002	1.06

Note: M=mean: SD=standard deviation; df=degrees of freedom; p_{BH}=p-value adjusted for multiple comparisons following the Benjamini and Hochberg (1995)'s step-up false discovery rate-controlling procedure; t and df = t-value and degrees of freedom, respectively, from the independent sample t-test; d=Cohen's effect size for independent-sample mean comparisons; [a] and [b] families of comparisons for which the adjusted p_{BH} has been computed.

Table 2

Means and standard deviations of scores in median retrieval times (RTs) and phenomenological characteristics of voluntary and involuntary autobiographical memories in High-OI and Low-OI and results from the Group (High-OI vs Low-OI) by Memory type (Voluntary vs Involuntary) factorial ANOVA.

Variable	High-OI		Low-OI		Group effect				Memory type effect				Group-by-Memory type Interaction			
	M	SD	M	SD	F	df	p_{BH}	η^2	F	df	p_{BH}	η^2	F	df	p_{BH}	η^2
All memories RTs					12.10	1,32	.001[a]	.17	4.33	1,32	.046 [a]	.06	0.92	1,32	.345[a]	<.01
Inv-ABMs	3,332.85	1,216.03	6,067.96	4,560.79												
Vol-ABMs	4,390.80	2,190.98	8,930.80	6,860.83												
Specific memories RTs																
Inv-ABMs	3,218.34	1,205.58	7,736.05	5,595,99	18.40	1,25	.001[a]	.26	2.05	1,25	.165[a]	.04	2.28	1,25	.144[a]	.05
Vol-ABMs	3,280.94	1,469.87	5,430,27	1,996.62												
General memories RTs																
Inv-ABMs	4,052.29	2,856.97	10,346.33	5,404.45	13.31	1,18	.002[a]	.32	2.27	1,18	.149[a]	.04	0.63	1,18	.437[a]	.01
Vol-ABMs	3,256.29	1,384.04	7,773.83	6,894.22												
Phenomenological characteristics																
Vividness[b]					6.21	1,36	.025	.12	28.51	1,36	<.001	.16	11.21	1,36	.006	.07
Inv-ABMs	5.75	0.79	5.59	0.78												
Vol-ABMs	5.48	0.90	4.37	1.07												
Details[b]					30.18	1,36	<.001	.39	5.86	1,36	.027	.04	0.50	1,36	.329	<.01
Inv-ABMs	5.61	0.70	4.54	0.60												
Vol-ABMs	5.40	0.88	4.15	0.80												
Reharsal[c]					1.40	1,36	.178	.03	19.57	1,36	<.001	.10	0.48	1,36	.329	<.01
Inv-ABMs	2.91	0.52	3.06	0.86												
Vol-ABMs	2.41	0.69	2.70	0.50												
Pleasant memory[c]					1.85	1,36	.154	.03	0.01	1,36	.499	<.01	1.52	1,36	.178	.02

Inv-ABMs	3.55	0.49	3.87	0.68												
Vol-ABMs	3.70	0.49	3.74	0.43												
Emotional Intensity[c]					4.00	1,34	.054	.08	9.70	1,34	.010	.08	0.01	1,34	.499	<.01
Inv-ABMs	3.71	0.54	3.39	0.56												
Vol-ABMs	3.39	0.69	3.04	0.57												
Specificity[d]					0.14	1,36	.452	<.01	6.77	1,36	.024	.04	2.35	1,36	.126	.02
Inv-ABMs	68.42	18.85	76.84	27.36												
Vol-ABMs	64.34	20.71	61.06	28.13												
In shape of images[e]					12.38	1,36	.005	.17	1.90	1,36	.154	.02	1.41	1,36	.178	.02
Inv-ABMs	93.21	13.29	72.54	31.16												
Vol-ABMs	93.91	6.57	82.06	13.86												
Childhood memories[f]					5.69	1,36	.028	.09	8.97	1,36	.011	.09	6.26	1,36	.025	.06
Inv-ABMs	17.45	20.91	0.93	3.93												
Vol-ABMs	18.95	13.13	17.62	15.36												

Note: ABM=autobiographical memory; OI=object imagery; M=mean: SD=standard deviation; df=degrees of freedom; p_{BH}=p-value adjusted for multiple comparisons following the Benjamini and Hochberg (1995)'s step-up false discovery rate-controlling procedure; η^2=effect size; Inv=involuntary; Vol=voluntary; [a] not included in the adjustment for multiple comparisons; [b] Ratings were made on 7-point scales; [c] Ratings were made on 5-point scales; [d] Memories were rated as specific or general. Means represent mean percentage of specific memories averaged across participants; [e] Memories were rated as remembered in shape of images or words. Means represent mean percentage of memories retrieved in shape of images averaged across participants; [f] Means represent mean percentage of memories referring to childhood/remote events.