Out of one's mind: A study of involuntary semantic memories

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A B S T R A C T

The study of memories that pop into one's mind without any conscious attempt to retrieve them began only recently. While there are some studies on involuntary autobiographical memories (e.g., Berntsen, 1996; 1998) research on involuntary semantic memories or mind-popping is virtually non existent. The latter is defined as an involuntary conscious occurrence of brief items of one's network of semantic knowledge. The recall of these items (e.g., a word, a name, a tune) is not accompanied by additional contextual information and/or involvement of self – a standard feature of involuntary autobiographical memories. The paper reports several diary and questionnaire studies which looked into the nature and frequency of occurrence of these memories. The data show that people do experience involuntary semantic memories which tend to occur without any apparent cues while being engaged in relatively automatic activities. Possible mechanisms of involuntary semantic memories are discussed (e.g., very long-term priming), and the results of the study provide information on the possible duration of the priming effects in everyday life. Related theoretical and methodological issues and future avenues of research in this neglected area are outlined.

KEY WORDS: Involuntary memories, mind-popping, autobiographical memory, semantic memory, very long-term priming, implicit memory.

Out of one's mind: A study of involuntary semantic memories

Most laboratory studies of memory investigate processes which deliberately retrieve or identify information acquired in the past. However, much of our everyday remembering consists of information coming to mind involuntarily, i.e., without any conscious attempts to retrieve anything (Mandler, 1986; Winograd, 1993). This type of retrieval has been noted as far back as by Ebbinghaus (1885/1964) who, among other forms of memory, delineated memories which occur "with apparent spontaneity and without any act of will", and are "brought about through the instrumentality of other, immediately present mental images" (p. 2). Mandler (1989) claimed that "deliberate retrieval of information seems to be the exception rather than the rule" (p. 103). Thus, "we interrupt our stream of thought with ideas that suddenly 'come to mind', we are frequently 'reminded' of one or another occurrence in the past, and often we are aware of *memories whose apparent irrelevance to the requirements of the moment surprises us*" (p. 291, Mandler, 1986; our italics).

Involuntary memories vary greatly in their character and conditions under which they occur (see Mandler, 1994). For example, the phenomenon of incubation, or a sudden recovery from the tip-of-the-tongue (TOT) state, or the realization that one had intended to do something at this particular moment (i.e., prospective remembering) – all refer to involuntary retrieval of certain memories and contents. Although the act of retrieval per se is non deliberate and usually sudden, in all those cases it is preceded by repeated attempts to solve a problem (incubation), by a memory block (TOT state) or by a conscious decision to do something in future (prospective remembering). The so called flashbacks (i.e., the painful images of traumatic events) that characterize the Post Traumatic Stress Disorder, on the other hand, are preceded by attempts not to remember a certain stressful episode (Bekerian, & Dritschel, 1992). Similarly, unwanted or intrusive memories and thoughts may

keep coming to mind despite attempts to suppress them (see Brewin, 1998; Brewin, Christodoulides, & Hutchinson, 1996; Wegner, 1994).

There is, however, a class of involuntary memories that are not preceded by any deliberate attempts to recall or forget, when, for example, one suddenly remembers some specific episode(s) from one's past. This phenomenon has variously been called passive memories (Roberts, McGinnis, & Bladt, 1994; Spence, 1988), involuntary remembering (Winograd, 1993), remindings (Shank, 1982), mind popping (Mandler, 1994), 'thoughts that come unbidden' (Linton, 1986), and involuntary autobiographical memories (Berntsen, 1996; 1998). The latter term seems to be most appropriate as such memories (both specific and generic) almost always refer to experiences from one's own personal past.

Despite the variety of reference to their occurrence, the study of involuntary autobiographical memories is in its infancy. While interest in involuntary (mainly repetitive) memories has been longstanding among clinical psychologists (for a discussion, see Berntsen, 1996), there is only a handful of studies on adult non clinical populations. This paucity of research is partly due to the difficulty of inducing involuntary memories in the laboratory. Therefore all these studies use the diary and questionnaire methods of enquiry (but see Horowitz, 1975). As Winograd (1993) has noted "the diary method seems all that is available to us. One observes them [involuntary memories] on the wing" (p. 57).

Despite some discrepancies in the obtained results, the diary studies conducted by Berntsen (1996; 1998) and Roberts et al. (1994) have produced converging findings. First, involuntary autobiographical memories seem to be quite common in people's everyday life. As many as 85% of undergraduates indicated that they were familiar with the phenomenon and that they experienced it at least a few times a week (Berntsen, 1996; see also Brewin et al., 1996). Second, involuntary

autobiographical memories tend to occur when people are alone (Roberts et al., 1994; Salaman, 1982) and/or engaged in relatively routine and automatic activities which do not require full concentration on the task at hand (Berntsen, 1998). Finally, these memories are almost invariably triggered by easily identifiable and mostly external visual or auditory cues which refer to some central feature(s) of the involuntary memory (see Berntsen, 1996; 1998; Roberts et al., 1994). The examples from the Roberts et al. (1994) diary study involve, for example, remembering embarrassment at age 13 to wear open toed sandals which was triggered by "looking at this older lady's open toed sandals", or remembering the summer of 1969 and playing in Seattle in a green wading pool which was triggered by the sight of "the green fluorescent color of one's highlighter pen".

However, in everyday life many people have been reporting their surprise at having involuntary memories which are seemingly unrelated to their current activities and thoughts, and for which it is difficult at best to find any identifiable triggers. In addition, these memories do not seem to refer to autobiographical episodes. Rather, they are single words and images that are devoid of personal meaning and thus could be classified as <u>involuntary semantic memories</u>. To our knowledge, these involuntary semantic memories have not been subject of any investigation.

Interestingly, there are some descriptions of the phenomenon in creative literature (see Shalamov, 1994; p. 289-290) and in autobiographies. Nabokov (1966) described it in the following way: "Just before falling asleep, I often become aware of a kind of one-sided conversation going on in an adjacent section of my mind, quite independently from the actual trend of my thoughts. It is a neutral, detached, anonymous voice, which I catch saying words of no importance to me whatever – an English or a Russian sentence..., and so trivial that I hardly dare give samples..." (p. 33).

Although such words and phrases do occur during altered states of consciousness (such as falling asleep or waking up), these states are by no means a necessary condition for their occurrence. Indeed, most involuntary semantic memories in the form of words, phrases or images tend to occur in waking hours while being engaged in daily activities. Moreover, the identification of cues that might trigger these memories is usually very difficult. This is in sharp contrast with the findings on involuntary autobiographical memories and is indicative of some differences that may exist between the latter and involuntary semantic memories.

One interesting and important question that arises in relation to involuntary semantic memories is that if the identification of cues is so difficult then what is the mechanism that brings them about? One possibility is that the cues do occur and trigger involuntary semantic memories but a person is unaware of their existence. This could happen either because they remain outside one's focus of attention (Merikle, & Joordens, 1997) or because they are not subjectively registered while being above the objective threshold of detection (Cheesman, & Merikle, 1986). Indeed, there is a substantial body of evidence showing that many environmental stimuli which remain outside awareness are nevertheless exerting powerful effects on cognitive and social behavior (e.g., Bargh, & Chartrand 1999; Bornstein, & Pittman, 1992).

On the other hand, there is a possibility that during normal and efficient cognitive functioning some aspect of the semantic network is accidentally activated and becomes the object of conscious representation. In other words, these memories could be an erroneous by-product of otherwise efficient and adaptive cognitive processing.

Finally, this ostensibly accidental occurrence of a certain word(s) or an image may be primed by previous encounter(s) with this word (repetition priming), by

a word that is semantically or associatively related to it (semantic and associative priming) or by a phonologically related event or experience. In the course of one's daily activities the activation levels of certain words and concepts may not dissipate immediately after one has encountered them but, instead, remain fairly stable for some time (perhaps minutes and even hours). Additional processes of activation/integration as well as spreading activation could produce many candidates for the "popping" experience, some of which are then primed and become conscious as a function of the various semantic and phonological priming processes. If this (priming) hypothesis is correct then it should be possible to identify a previous occasion when this word or its associate was encountered or experienced in the recent past. This possibility was pointed out by Stern (1938) when he described the phenomenon of perseveration (i.e., a repetitive and involuntary occurrence of certain words/tunes in one's mind).

We report four studies that investigated the nature and the occurrence of these involuntary semantic memories. In Study 1 and 2 the first author (L.K.) kept a diary over an extended period of time (four months in each study). In order to test the generalizability of the findings of these initial diary studies two additional studies were conducted. In Study 3 a short Mind-Popping Questionnaire was administered to a sample of undergraduate students (N = 205) to establish the reality of the phenomenon and the frequency of its occurrence in the larger population. In Study 4, the phenomenon of involuntary semantic memories was directly compared to that of involuntary autobiographical memories by asking a different group of undergraduate students (N=50) to keep a diary of these memories for a period of two weeks (one week for each type of memory).

By carefully recording the involuntary semantic memories as soon as they occurred, we are able to investigate their content and frequency of occurrence in

everyday life, their relation to current activities and thoughts, and the existence of possible triggers (either external or internal). Overall, the studies reported in this paper not only define involuntary semantic memories as distinct from the involuntary autobiographical memories but also provide information about some possible underlying mechanisms.

STUDY 1

METHOD

Participant. The participant was the first author (L.K., aged 35 at the time of the study) who kept a diary over a period of 19 weeks (starting on 20 June, and ending on 30 October). The first four weeks were spent at home, the rest coincided with taking up a new position.

Procedure. L.K. recorded the involuntary memories as soon as possible after their occurrence. There were no restrictions on the time of day, day of week or the number of memories recorded on each day, and a record was kept of all memories that occurred throughout the waking hours of every day.

The following characteristics of each involuntary memory were recorded: the content of memory per se, the place and the time of day, current activities and thoughts, and the presence of identifiable cues, if any. In line with a priming hypothesis an attempt was also made to establish when was the last time L.K. had encountered the contents of the involuntary memory. Since the object of the present study was to explore involuntary semantic memories only, no attempt was made to record involuntary autobiographical memories.

STUDY 2

METHOD

<u>Participant.</u> Two years after Study 1, L.K. kept a diary for 18 weeks (starting from 1 October, and ending on 31 January). During this period L.K. worked at the University except for the Christmas Holidays which were spent at home.

<u>Procedure</u>. Procedure was the same as in Study 1.

R E S U L T S   A N D   D I S C U S S I O N

A total of 126 memories were recorded throughout a period of nineteen weeks of Study 1 and 302 memories throughout a period of eighteen weeks of Study 2. In both studies, the recorded memories easily fell into three distinct categories: known words, unknown words and visual images (see Table 1). There were also few occasions when L.K. spontaneously started to hum a melody. This type of involuntary remembering appears to be frequently experienced by undergraduates in our subsequent studies (Study 3 and 4). However, since there were only four such occasions they were not included in the main data set.

Insert Table 1 here

Almost all known words that popped to L.K.'s mind were English words despite the fact that L.K. is not a native English speaker. Thus, in only 8% (5 words out of 47) and 4% (10 words out of 229) of cases in Study 1 and 2 respectively did she experience the words in her native languages (Georgian and Russian). Accordingly, the unknown words that popped to her mind were either words once studied in English whose meaning was forgotten or were those that she had apparently encountered previously but had not checked for their meaning. Interestingly, none of the recorded unknown words turned out to be non-words after the appropriate checks were made in the dictionary. On a couple of occasions L.K. could not initially find the

word in the dictionary (e.g., gibbering or divulge) but it turned out that this was due to the incorrect spelling (jibbering and devulge).

A typical case of involuntary memory recorded in the diaries would involve L.K. being engaged in some everyday activity (e.g., cooking, washing, typing, etc.), having some thoughts which were mostly unrelated to the task at hand, and then suddenly a word(s) or an image would pop into her mind which would surprise her with apparent irrelevance to both current activities and thoughts (for examples, see Appendix 1).

Initially, the results of Study 1 and Study 2 were analyzed separately. However, with few exceptions all the analyses revealed very similar results. Therefore we will present the data collapsed across the two studies but will point out any interesting differences.

(a) Contents. A total of 428 cases were recorded in both diary studies: 276 known words (64%), 72 unknown words (17%) and 80 images (19%). However, there was a reliable difference between the two studies in terms of the distribution of involuntary memories into the categories of known words, unknown words and images ($\chi^2 = 57.66$, df=2, $p < .001$). Table 1 shows that while the actual numbers of unknown words and images practically did not change across the two studies, the number of known words was almost five times greater in Study 2 than in Study 1 (229 and 47, respectively).

The vast majority of recorded images (63 out of a total of 81) referred to well known places (streets, buildings, motorways, etc.). There were 15 images of persons and only 2 images of an object. As to the known and unknown words, they differed reliably in the prevailing type of contents ($\chi^2 = 92.88$, df=2, $p < .001$). Thus, the majority of known words were the names of people and places whereas the majority of unknown words were common nouns, adjectives and verbs (see Table 2).

Insert Table 2 here

These images and words occurred without any accompanying contextual information referring to a past episode. Moreover, L.K. had no personal or self involvement in these memories which is a typical feature of involuntary (and voluntary) autobiographical memories (Roberts et al., 1994; see also Brewer, 1986; Nigro, & Neisser, 1983). It was therefore reasonable to assume that these memories represented involuntary semantic memories.

(b) Frequency. There was a large variability in the frequency with which these involuntary semantic memories occurred each week (see Table 3).

Insert Table 3 here

In Study 1, on average, there were 6.63 memories per week (range 0 to 25) and .95 memories per day (range 0 to 13). In Study 2 there were 16.77 memories per week (range 7 to 37) and 2.45 per day (range 0 to 11). This greater frequency of involuntary memories in Study 2 was due to the large number of known words. Nevertheless, these figures compare well with those of the Roberts et al. (1994) diary study of involuntary autobiographical memories in which the participants reported to have, on average, 6.51 memories during the one week period of the study (SD = 4.08; range 1 to 25), and indicate that involuntary memories (whether autobiographical or semantic) are not single, one-off events but occur, if not regularly, then at least quite frequently in people's everyday lives (see also Berntsen, 1996).

One possibility underlying this enhanced occurrence of known words in Study 2 is that known words occurred with approximately equal frequency in both

studies but that L.K. became more proficient in detecting them. However, if this were the case then in each study there should have been a gradual increase in the number or recorded memories as the time went by. The data in Table 3 show that, if anything, there was an opposite trend: number of recorded memories was higher in the first few weeks of both studies. Thus, the Spearman rank order correlation between the order of weeks and the number of memories recorded was r= -.44, p<.06 and r= -.52, p<.05 in Study 1 and 2, respectively. Therefore, an alternative and perhaps more plausible suggestion is that the frequency of known words genuinely increased in Study 2 due to some personal factors. The role of personality variables in experiencing involuntary semantic memories needs to be investigated in the future.

(c) Places. Seventy-four percent of all recorded memories (N = 317) occurred at home (129 in the kitchen, 68 in the bathroom, 44 in the lounge, 73 in the bedrooms and 3 in the hall). Only 15% occurred at work and 11% in the street or on campus. However, there was a reliable difference between images and words in this respect (χ^2 = 34.19, df=4, p < .001)). Thus, most known and unknown words occurred at home whereas as many as 34% of images (as opposed to 12% and 8% in case of known and unknown words, respectively) occurred at work (see Table 4).

Insert Table 4 here

Moreover, in line with the findings of Roberts et al. (1994), as many as 95% of recorded memories (407 out of 428) occurred either while L.K. was alone (359 cases) or not in direct communication with others (48 cases) like, for example, sitting on a bus or walking in a street (see also Salaman, 1982; Spence, 1988).

(d) Thoughts. Since the majority of memories occurred during an execution of automatic activities (see below), the concurrent thoughts did not necessarily reflect

the current activities but instead concentrated on a variety of fairly mundane past, current or future concerns. When she started to keep the diary L.K. noticed the difficulty with which these thoughts were retrieved even after few seconds of having them (see also Brewer, 1988). In order to avoid the forgetting of these thoughts (which predominantly were in L.K.'s native language), the very first thing that L.K. did after having an involuntary memory was to virtually 'freeze' on the spot and mentally establish the contents of the preceding thoughts. Only after this was done would L.K. start recording a case with all other relevant details in her diary. As a result it was possible to trace most of the train of thoughts preceding the involuntary memories. The immediately preceding thoughts could not be retrieved on 4% of occasions (N = 19) and on 5% of occasions (N = 22) L.K. did not think she had any particular thoughts prior to the occurrence of an involuntary memory.

(e) Activities. The activities in which L.K. was engaged when these involuntary memories occurred can be divided into fairly routine and almost automatic actions that do not require much attentional resources and those which do require such resources. A major difference between automatic and controlled actions is that in the latter the attention is concentrated on the task at hand so that there is no discrepancy between one's current actions and thoughts whereas in the former the attention is less concentrated (i.e., diffused, to use Berntsen's, 1998 terminology) and, as a result, there is a discrepancy between one's actions and concurrent thoughts. For example, when washing hands and, at the same time, thinking of visiting a friend in the evening (cf. Norman, & Shallice, 1986; Reason, 1984).

One important finding that emerged from the data is that 82% of the recorded memories (N = 352) occurred during the execution of automatic actions (e.g., brushing one's teeth, getting dressed, ironing, walking in a street, etc.). Only18% of memories (N = 76) occurred during such controlled actions as entering

data into a computer, making calculations, typing, reading, etc., i.e., when L.K.

concentrated on the task at hand. There was a highly significant difference between

known and unknown words and images in this respect (χ^2 = 142.60, df=2, p < .0001).

Table 5 shows that only 7% of known and 8% of unknown words but as many as 64%

images occurred during the controlled actions.

Insert Table 5 here

The attentional demands of automatic actions may vary so that at certain

critical decision points a person needs to switch from diffuse to concentrated attention

in order to carry out the task successfully. For example, when kneading dough for pizza

and thinking about tomorrow's seminar attention is diffuse whereas when one considers

adding more water to the dough the attention becomes concentrated (cf. Cohen, 1996;

Ellis, & Nimmo-Smith, 1993). Similarly, one may be engaged in controlled activity

(e.g., listening to a talk) but at the same time thinking about completely irrelevant

matters (cf. Berntsen, 1998).

In order to take this finer grained distinction into account each recorded case

was also analyzed for the type of thought (task related/task unrelated). If the

concurrent thought was instrumental for carrying out the next step in the task, even if

the activity as a whole was fairly automatic, then the case was classified as involving

concentrated attention. On the other hand, if the concurrent thought was not related to

the task at hand, even if the task was supposedly controlled, then the case was

classified as involving diffuse attention.

This classification does not broadly change the results presented above as

there were only 21% of cases when attention was concentrated during automatic

activities (N = 88) and 2% of cases when attention was diffuse while being engaged

in controlled actions (N = 9). Table 6 shows that the majority of cases (60%) occurred when attention was diffuse in comparison to the cases when it was concentrated (only 40% of cases). [1]

Insert Table 6 here

These percentages are almost identical to those reported by Berntsen (1998) in her diary study of <u>involuntary autobiographical memories</u>. The participants' (who were young students) attention was found to be diffuse in two thirds (67%) and concentrated in one third (33%) of the cases. It appears that involuntary memories (whether semantic or autobiographical) may occur in everyday life under broadly similar conditions (in terms of attentional demands and/or type of activity).

<u>(f) Cues.</u> A significant aspect of involuntary semantic memories is the absence of easily identifiable cues in one's immediate environment, ongoing activities and concurrent thoughts. Indeed, on the majority of occasions L.K.'s first reaction (and that of others, see Study 3) was being surprised by the irrelevance of the involuntary memory to the current situation. Rather than being directly perceived, the existence of cues was often inferred indirectly on the basis of partial phonological similarity between the cue and memory (sometimes involving only one overlapping letter) or some (often quite remote) associations between the two. For example, hearing someone saying "He will be here" could have triggered the name "Helena", thinking about Vicky could have triggered a name of the place "Twickenham". Thinking "whether I need to put salt into boiling water" could have triggered the surname "Pinker" because the word "salt" could have activated the words "pinch of salt" which could have then triggered Pinker on the bases of phonological similarity (for other examples see Appendix 2). As one can see from these examples the

associations are truly remote and far fetched. However, even after adopting such a lenient criterion for establishing the existence of a cue, overall we were able to identify possible triggers for only 20% of cases (N=87) out of a total of 428 (see Table 7). [2]

Insert Table 7 here

This is in sharp contrast with the results of diary studies of involuntary autobiographical memories. For example, in the study of Berntsen (1996) subjects could identify triggers for their involuntary memories in the vast majority (93%) of the recorded cases (N=700). Moreover, these cues usually referred to central rather than peripheral features of autobiographical memories (74% and 26% of cases, respectively) which perhaps explains why subjects had no difficulties in identifying them (see Berntsen, 1998). Similar results were obtained also by Roberts et al. (1994); cues were identified by subjects in 94% of cases out of a total of 350. Berntsen therefore concludes that involuntary autobiographical memories are not "spontaneous in the sense of being cue-independent, but only in the sense of being unintended" (p. 461; 1996).

According to Berntsen (1998) the majority of involuntary autobiographical memories were triggered by purely external (40%) cues or cues that represented a mixture of external and internal features (34%). Only 26% of memories were triggered by internal thoughts (Berntsen, 1998). In comparison, in the present study, as many as 57% of the cues were internal (see Table 8). Unknown words and images were more likely to be triggered by internal cues whereas known words were equally likely to be triggered by internal and external cues (χ^2 = 6.92, df=1, p < .01).

Insert Table 8 here

We also looked at the contents of the cues and how they were related to the mind-pops that they triggered. As mentioned above, cues (both internal and external) could be categorized as phonologically, semantically or associatively related to the involuntary semantic memories (for examples see Appendix 2). The raw data are presented in Table 9 and there were reliable differences between internal and external cues in this respect (χ^2 = 11.78, df=2, p < .005). The majority of internal cues (72%) were semantically and associatively related to involuntary memories whereas for the majority of external cues (65%) this relation was based on phonological similarity.

Insert Table 9 here

Reliable differences in the type of cue (phonological vs. semantic vs. associative) emerged also for different types of involuntary memories (known vs. unknown words). Table 10 shows that cues for known words were equally likely to be either phonological or semantic/associative (54% and 46%, respectively) whereas the majority of the cues that triggered unknown words were semantic/associative (74%) rather than phonological (26% only) (χ^2 = 7.73, df=2, p < .03).

Insert Table 10 here

The nature of these semantic/associative cues for unknown words merits further consideration. The most surprising feature was that these cues were not immediately apparent to L.K. at the time when an unknown word popped to her mind. However, immediately after writing down a case L.K. would check the meaning of

this unknown word in the dictionary and it was at this stage that she would discover that one of the meaning of the word would be meaningfully related to either her current thoughts or actions at the time of the mind-pop. Nineteen out of 20 semantic and associative cues that were identified for unknown words were of this nature.

Thus, the existence of a semantically/associatively related context (mostly internal in a form of ongoing thoughts) became apparent only after checking the meaning of unknown word in the dictionary. Although at the time of the mind-pop L.K. thought that she did not know the meaning of the word (some words did not even seem familiar) it was apparently available at a nonconscious level and this resulted in the conscious representation of the word in the relevant situation.

Finally, out of 38 phonological cues eleven (29%) were subliminal cues (there was also one subliminal cue in the semantic cue category). At the time of having an involuntary memory, L.K. was almost completely unaware of these cues in her immediate environment. It was only after a very careful examination of her environment that L.K. was able to detect the cue(s) which had apparently triggered the occurrence of a word or an image. Of particular interest is a case of the involuntary semantic memory "Millennium Dome" which occurred immediately after L.K. had been looking in the direction of a shelf with a pack of Sesame Wheat Wafers on it. In order to find a cue for this particular mind pop which surprised L.K. with its apparent irrelevance to a current situation, L.K. carefully examined this pack and discovered the words "Miller's Damsel" written on it in a semi circle. In order to be able to read it L.K. had to turn the pack 90 degrees. Thus, a process of searching for possible external cues for a particular involuntary memory gave us a rare opportunity to observe the effects of subliminal perception in situ (for other examples, see Appendix 3).

(g) Previous encounters/priming. In addition to trying to identify any trigger (either external or internal) for her involuntary memory, L.K. tried also to ascertain whether she had recently thought about or come across the word/image under the question. L.K. had to rely heavily on her incidental memory for many past thoughts and events with the elapsed time being anything between a few seconds to a few months.

The connection between the current involuntary memory and some past event was by no means immediately obvious. The process of establishing such a link was often quite time consuming. For example, when the word 'pickering' popped up L.K. had no idea what this word meant and where or when was it encountered previously. However, the sound of this word made L.K. suspect that it could not be an English noun (confirmed by the absence of this word in the dictionary). The next plausible hypothesis was that it was an English surname. Although L.K. thought that it did not sound like a surname either she still decided to check a list of 86 surnames that she had to read on the previous evening as part of a job related activity. It turned out that one of the names was indeed Pickering.

On some occasions L.K. even resorted to external help from family members and sometimes the connection would appear accidentally much later. For example, while throwing a used bag in a dust bin the word "Acapulco" popped up and since L.K. had no idea what it was and where she might have come across the word she turned to a member of family for help. To her surprise, it was pointed out to her that Acapulco was mentioned on the TV news some 45 minutes ago. On another occasion L.K. could not remember whether she had previously encountered the words "corporal punishment" which popped up unexpectedly. The next day, however, she came across these words when re-reading work related documents. It became then

obvious that she encountered these words five days before having an actual mind-pop (see Appendix 1 for more detailed description of this case).

Despite these difficulties, in as much as 213 cases (49%) out of a total of 428 it was possible to ascertain that L.K. had encountered the contents of involuntary memories in the recent past. The time scale varied from few minutes to two weeks in Study 1 and from few seconds to two months in Study 2. [3] In some cases these previously encountered contents were identical to involuntary memories whereas on other occasions they were related to them either semantically or by some association.

For example, the name 'Portofino' which popped up was encountered two days before when watching the film "Romancing the stone". [4] The words 'Jingle Bell' occurred while walking into the lounge to fetch an item of clothing and were not in any way related to current activities and thoughts. However, half an hour before L.K. had received a leaflet offering a Christmas Catalogue. A casual look at this leaflet was apparently sufficient to spread the activation from "Christmas" node in semantic network to other related nodes such as "Jingle Bell". Moreover, these heightened activation levels were apparently sustained for as long as half an hour (or even two days in case of "Portofino") and eventually resulted in the conscious representation of these words.

As an example of purely associative links between the involuntary memory and previously encountered events consider the following two cases. First, the involuntary memory in a form of an image of an entrance to a Zoo was preceded by thinking (five minutes earlier) about an occasion when L.K. met an acquaintance in front of a TV building. The entrance to the Zoo is in close proximity to the TV building. Thinking about this person standing in front of the TV building apparently activated the representations of other buildings on that street. Moreover, the activation levels of these representations were apparently so high that after a few minutes one of

them suddenly gained access to consciousness. Similarly, the occurrence of a name of an actress 'Cameron Diaz' was preceded by discussing a possibility of seeing a film 'My Best Friend's Wedding' on the previous evening. Although Cameron Diaz has a supporting role in this film her name was never mentioned during this discussion. Nevertheless, talking about the film had apparently activated the names of actors related to this film.

The examination of these previous encounters speaks strongly in favor of a priming hypothesis and indicates that in case of involuntary semantic memories one is apparently dealing with two types of long term priming: repetition and semantic or associative priming. It is interesting that there were reliable differences between different types of involuntary memories in this respect. Table 11 shows that words (both known and unknown) were more likely to be preceded by identical primes (i.e., repetition priming) whereas images were more likely to be preceded by associative primes ($\chi^2 = 84.99$, df=4, $p < 001$). Repetition priming was by far the most prevalent as 72% of primes were identical to the involuntary memories whereas semantic and associative primes constituted only 10% and 18% of a total number of primes, respectively.

Insert Table 11 here

We also examined whether the primes were external or internal. A prime was classified as external if it was encountered in the external environment (either heard or seen), and as internal if it occurred internally, i.e., in L.K.'s thoughts only. Table 12 shows that the majority of primes (85%) were encountered in the external environment. However, there was a reliable difference between three different types of primes in this respect ($\chi^2 = 83.31$, df=2, $p < .001$). Thus, the associative primes

were more likely to be internal (59%) whereas the majority of repetition and semantic

primes were external (98% and 75%, respectively).

Insert Table 12 here

(h) <u>Cues and Priming</u>. On the basis of the data in the sections on <u>cues</u> and

<u>previous encounters/priming</u> it was possible to explore the relationship between

detecting a cue and establishing a prime for each particular occurrence of involuntary

semantic memory. In Table 13 the majority of cases did not fall into prime/cue and no

prime/no cue cells which would be the case if detecting a cue enhanced the likelihood

of establishing the existence of a prime and vice versa. If anything there was a very

weak but reliable negative correlation between the two (ϕ = - .11, p < .03). Thus, the

likelihood of detecting a cue was lower if the prime was established than when it was

not established (16% vs. 25%).

Insert Table 13 here

STUDY 3

Studies 1 and 2 produced broadly comparable data. Involuntary semantic

memories in the form of known and unknown words and images occur quite frequently

in everyday life. Some similarities as well as important differences emerged between

involuntary semantic memories recorded in the present study and involuntary

autobiographical memories reported by Berntsen (1996; 1998) and Roberts et al.

(1994). Thus, both types of involuntary memories occur when one is engaged in fairly

automatic everyday activities, i.e., when one's attention is not fully concentrated on the

task at hand. However, they are different in that it is extremely difficult to establish the

existence of a cue for involuntary semantic memory whereas the majority of involuntary autobiographical memories are almost invariably triggered by easily detectable cues. In addition, the involuntary semantic memories seem to be brought about by the mechanism of spreading activation which makes memory traces available and some type of "active", long-term priming in situ which makes these traces then consciously accessible.

Although interesting findings were obtained in Study 1 and 2, they were based entirely on the data of one participant, and the pattern of results could be idiosyncratic to L.K. In Study 3 we therefore examined the prevalence and the nature of this phenomenon in the general population by administering a "Mind Popping Questionnaire" (MPQ) to a large sample of university undergraduates.

METHOD

Material. The four item scale Mind Popping Questionnaire (MPQ) was developed to assess the nature and the frequency of occurrence of involuntary semantic memories. [5] The questionnaire begins with a short description of the phenomenon and how it differs from involuntary autobiographical memories. In addition to some background information such as age, sex, etc., the participants have to answer the following four questions. In Question 1, participants indicate whether they have ever experienced this particular type of mind popping. In Question 2, they rate the frequency with which this phenomenon occurs on an eight point scale where 1= only a few times in my entire life; 2= once or twice a year; 3= once or twice per 6 months; 4= once or twice a month; 5= once or twice a week; 6= three or four times a week; 7= once or twice a day, and 8= three or more times a day. In Question 3, participants are asked to indicate those involuntary semantic memories (referred to as mind pops) which they think they have experienced at least once in their life. Participants can choose as many options as

they want out of possible nine (see Table 14). Finally, participants are asked to give one or two examples of involuntary semantic memories they have experienced.

Procedure. The questionnaire was distributed to participants at the end of their psychology lecture. The smallest class consisted of 20 students and the largest of 53 students. The experimenter first described the phenomenon of involuntary semantic memories and said that the aim of this questionnaire was to explore its prevalence and nature in an undergraduate population. She then asked the participants to read the introduction to the MPQ and then answered all the questions.

Participants. MPQ was distributed to a total of 211 students and was completed by 205 students. More than half of the participants were first and second year psychology students (56%), the rest were humanities (18%) and physiotherapy (26%) students. The mean age of participants was 22.74 (SD = 7.26). There were 165 females and 36 males. Four subjects did not indicate their gender.

RESULTS AND DISCUSSION

Out of 205 participants who completed the questionnaire only 33 students (16%) responded that they had never had involuntary semantic memories. For those 84% of subjects (172 out of 205) who were familiar with this phenomenon, the mean rating for its frequency of occurrence on 8-point rating scale was 5.35 (SD = 1.65) This mean corresponds to experiencing between1-2 or 3-4 mind-pops per week. Moreover, as many as 119 participants (69%) chose point 5 (i.e., once or twice a week) and above on this scale which indicates that involuntary semantic memories occurred quite frequently in this sample of undergraduates.

Furthermore, the results also showed that participants on average experienced 4.26 (SD = 1.87) different types of involuntary semantic memories (see Table 14), and that there was a reliable positive correlation between the latter and the frequency with which these memories were experienced (r = .30, p < .001; N = 171).

Insert Table 14 here

Table 14 shows that known words, proper names and images were experienced by subjects more frequently than phrases/sentences, and words in foreign language. This is broadly in line with the findings from the diary studies. However, Table 14 also shows that by far the most frequently experienced involuntary memory was a familiar tune popping to one's mind. Indeed, 80% of participants chose this option and it was also the most frequently described example given in response to Question 4. This finding was rather unexpected given that in Study 1 and 2 melodies were recorded on only few occasions. If one accepts the priming hypothesis and the fact that undergraduates are exposed to popular music to much greater extent than an academic then this discrepancy is perhaps unsurprising. Alternatively, an occasion when one starts to sing a tune for no apparent reason is probably much more noticeable than a single word or an image.

Illuminating qualitative data was obtained through participants' responses to Question 4. Although answering this question was optional, as many as 99 participants (56%) chose to provide some example(s) of mind-popping as they had experienced it in their everyday life. For these 99 subjects, the majority (75%) provided examples of involuntary semantic memories. [6] Participants provided both general and specific examples of mind pops that they had experienced (see Section A of Appendix 4)

These examples seem to capture the phenomenology of involuntary semantic memories very well. First, some subjects commented on the momentary and fleeting nature of these memories saying that they "tend to go as quickly as they come". Second, subjects commented on the absence of cues and the fact that these

memories may occur at inappropriate times (e.g., lectures, exams) (see section B of Appendix 4).

Participants provided descriptive examples, either general or specific, of types of involuntary semantic memories they had experienced together with the activities they had been engaged in when these memories popped up. The inspection of these descriptions shows once again the difficulties related to the detection of cues for involuntary semantic memories, and also that people are involved in fairly mundane everyday activities like cleaning, driving or studying and that their attention is not usually actively concentrated on a task at hand.

Finally, some participants commented on the fact that the contents of their memories had been encountered previously (see section C of Appendix 4). Moreover, the contents had been encountered either directly (repetition priming) or indirectly (i.e., semantic priming; see example 6 in section C of Appendix 4).

In summary, the results of Study 3 indicate that the involuntary semantic memories do occur for the majority of students in a relatively large sample of undergraduates, and that they occur quite frequently in their everyday life. The examples provided by subjects are broadly in line with the results obtained in Study 1 and 2 in terms of the triggers and the activities involved and speak in favor of the priming hypothesis.

STUDY 4

The results of Study 3 were encouraging as they showed that involuntary semantic memories or mind-popping is a real phenomenon experienced by young adult population. However, the results are based on participants' retrospective self-reports that could have been subject to various biases and demand characteristics (Morris, 1984). Moreover, although participants were given oral and written instructions about a distinction between the involuntary semantic and involuntary autobiographical

memories it may be that some participants did not distinguish between the two. Indeed, 11% of those participants who chose to answer the optional Question 4 provided examples of involuntary autobiographical memories instead of mind pops.

The purpose of Study 4 was therefore to compare the prevalence and the nature of involuntary semantic memories to that of involuntary autobiographical memories within one sample of participants by asking a group of young undergraduates to keep a diary of these memories for a period of two weeks (one week for each type of memory). When making comparisons between these two types of memories the primary interest was in three factors: (1) The content of memories; (2) The type of activity one is involved in when the memory occurs as measured by self-reported levels of concentration/attention, and (3) The existence/absence of triggers. In addition, the present design offered a unique opportunity to examine the correlation between the number of involuntary semantic and autobiographical memories experienced by the same participants. If a reliable positive correlation existed between the two, one could conclude that these two types of memories have similar underlying mechanisms.

METHOD

In this study we used a structured diary method adapted from Berntsen (1996;1998). However, instead of having a small number of participants who experience mind-popping fairly frequently (selected on the basis of their scores on the MPQ), and asking them to keep a diary for prolonged time periods we chose an opposite strategy that involved asking a large group of psychology undergraduates to keep diaries of involuntary semantic and involuntary autobiographical memories (independent of their scores on the MPQ) for one week for each type of memory. In addition, participants were asked to record all involuntary memories that occurred throughout the week rather than only the first two memories for each day of the study

(see Berntsen, 1996). In this way, we expected to obtain more realistic picture of the nature and particularly the frequency of occurrence of these memories in a general population.

<u>Material</u>. Two different diary booklets were prepared, one for involuntary semantic and one for involuntary autobiographical memories. Both booklets contained 32 pages one for each recorded memory. Each page contained a questionnaire that the participants had to fill in whenever they experienced an involuntary memory. Diaries of involuntary semantic memory contained 10 questions and diaries for involuntary autobiographical memories contained 11 questions.

The first 9 questions were the same for both diaries. Participants had to indicate the time and date of memory occurrence. If they could not record the memory within ten minutes then they also had to write down the time and date when the memory was actually recorded. The third question asked the participants to describe the contents of their memory (i.e., what was actually remembered). The fourth question asked participants to specify the thoughts they had immediately before the memory. The fifth question asked participants to indicate what they were doing at the time when the memory occurred. After this participants had to indicate their level of concentration on a 5 point rating scale where 1=not at all and 5=fully concentrating. Question 6 asked participants to indicate the place they were when the memory occurred. Next, participants had to indicate whether their memory was triggered by (a) something in their environment, (b) in their thoughts or (c) there was no trigger. If participants circled option (a) or (b) then they were asked to describe the trigger (question 9). In order to assess the priming hypothesis the final question 10 in the diaries of involuntary semantic memory asked the participants to indicate whether the contents of their mind-pop had been encountered/experienced in recent past. If the participants circled 'yes' option then they had to specify <u>when</u> and <u>where</u> had they

encountered these contents. In the diary booklets of involuntary autobiographical memory questions 10 and 11 were irrelevant to the aims of the present study and will not be discussed further.

Procedure. At the end of the second lecture the lecturer (L.K.) explained to the students the distinction between involuntary autobiographical and involuntary semantic memory and asked them to complete the Mind-Popping Questionnaire (MPQ). When the questionnaire was completed the students were informed that as part of their coursework they had to keep a diary of involuntary semantic and involuntary autobiographical memories over the period of exactly two weeks (one week for each memory type). The diaries were then distributed randomly so that half of the participants received a diary of involuntary semantic memory and the other half a diary of involuntary autobiographical memory. The participants were then asked to read carefully the detailed written instructions on the inside of the cover sheet of the diary.

These instructions explained to the participants how to fill in the diary (i.e., answer each of the 10 or 11 questions on their respective diary pages). The participants were asked to carry the diary with them (in their bags or pockets) and record each memory immediately after its occurrence. If, for some reason, they could not write down the memory (e.g., when driving, being in the lecture, etc.) then they had to record the memory as soon as the opportunity arose afterwards. However, if the participant had already forgotten some crucial details of memory by the time such opportunity arose, instead of filling in the questionnaire, they were asked to acknowledge its occurrence by putting a tick on the inner cover sheet of the diary. In addition, participants were also given an option not to record those memories that were too personal and instead to acknowledge their existence by a tick and the word 'personal' next to it.

When participants had read the instructions they were given the opportunity to ask questions about the study. After answering a few minor questions, the experimenter explained that if throughout the week they did not experience any memories that would not in any way affect their marks on the coursework. Participation in this study was not compulsory but it was explained to the students that it would be mutually beneficial. First, by taking part in this study the students could assist in establishing the existence of a new phenomenon. Second, it would enhance their awareness of issues discussed in the first two lectures, and would thus be potentially helpful for their exams.

After exactly seven days, at the end of the next lecture, the diaries were collected and participants received the second diary. Those who in week 1 of the study recorded involuntary semantic memories had to record involuntary autobiographical memories in week 2 and vice versa.

<u>Participants</u> were 58 final year psychology students taking a course on memory. However, one participant withdrew from the study after few days, six participants did not return their diaries at the end of week 2 and one participant's second diary went missing. The remaining 50 participants (39 females and 11 males) completed both diaries. Their age ranged from 19 to 46 (M=22.90, SD=6.11). Twenty four participants recorded involuntary semantic memories and 26 recorded involuntary autobiographical memories in week 1.

RESULTS AND DISCUSSION

A total of 90 involuntary semantic memories and 205 involuntary autobiographical memories were recorded. In addition, there were 7 ticks to denote those memories that occurred but were not recorded (6 for autobiographical and 1 for semantic memories) and 18 ticks to denote personal autobiographical memories that participants did not want to disclose. Initially, each memory description was

examined to determine whether it actually was the type of memory that participants were requested to record. All 205 memories recorded in autobiographical memory diaries were actually autobiographical memories. Out of 90 memories recorded in semantic memory diaries 16 memories were not semantic memories. [7] Therefore, the analyses were carried on the basis of the remaining 74 mind-pops and 205 involuntary autobiographical memories.

(a) Order effects. The mean number of recorded memories as a function of order (involuntary semantic memories first vs. involuntary autobiographical memories first) and memory type (involuntary semantic memories vs. involuntary autobiographical memories) are presented in Table 15. In order to examine if there were any order effects these means were entered into a 2 (order) x 2 (memory type) mixed ANOVA with the repeated measures on the last factor.

Insert Table 15 here

The results showed a main effect of memory type (F(1,48) =8.66, p<.01). Overall, more involuntary autobiographical memories were recorded by participants than involuntary semantic memories (M=4.01 and M=1.47, respectively). Unexpectedly, there was also the main effect of order (F(1,48) =4.79, p<.05). Those who recorded involuntary autobiographical memories first produced overall more memories than those who recorded involuntary semantic memories first (M=3.98 and M=1.50, respectively). More important, however, was a reliable order by memory type interaction (F(1,48)=6.05, p< .02).

A test of simple main effects revealed that the effect of order was present only for involuntary autobiographical memories (F(1,48)=5.54, p<.05) and not for semantic memories (F<1). Thus, while the number of involuntary semantic memories

did not reliably differ in week 1 and week 2 of the study (M=1.29 and M=1.65, respectively), significantly more autobiographical memories were recorded in week 1 than in week 2 (M=6.31 and M=1.71, respectively). It appears that having to record involuntary mind-pops in week 1 somehow affects the number of involuntary autobiographical memories in week 2. However, without additional data it is hard to say whether this effect reflects a decrease in the actual number of autobiographical memories in week 2 or the participants' ability/willingness to detect/record autobiographical memories.

Closer inspection of the data revealed that there were 3 cases with extreme values. These were participants who recorded 48, 18 and 13 involuntary autobiographical memories, respectively. Interestingly, all these participants happened to be in a group that recorded autobiographical memories in week 1. In order to eliminate the possibility that the obtained interaction was due to the existence of 3 extreme cases in week 1 data we re-run the 2 x 2 mixed ANOVA with the data of these 3 participants removed. However, although the mean number of involuntary autobiographical memories decreased the pattern of results was the same as before.

(b) Correlation between involuntary semantic and autobiographical memories. Since each participant collected both types of memories it was possible to address the issue about the relationship between involuntary semantic and autobiographical memories. The Pearson's product moment correlation was positive and reasonably large ($r(49)=.57$, $p<.001$). However, the examination of the scatterplot revealed that this high correlation was entirely due to 2 outliers with 48 and 18 involuntary autobiographical memories who also happened to have the highest number of mind-pops (i.e., seven each). When their data was excluded correlation became non significant ($r(47)=.08$, $p>.05$).

(c) Direct comparisons between two types of memories. In this section the involuntary semantic and autobiographical memories will be compared with respect to memory content, type of ongoing activities and presence of triggers. In these comparisons each memory will be treated as an individual case independent of another. Since the number of involuntary semantic memories was relatively low and there were no outliers with extreme values, all recorded involuntary semantic memories were used in the analyses. In contrast, in case of involuntary autobiographical memories if the three participants with extreme number of recorded memories (48, 18 and 13, respectively) were included this could potentially produce biased results. In order to avoid such potential biases we included into the analyses only the first nine memories of these three participants. This was done because in the remaining pool of 47 participants (after excluding the 3 extreme cases) the maximum number of recorded memories was 9 (one participant). Therefore the analyses on involuntary autobiographical memories was conducted on a total of 153 involuntary autobiographical memories instead of 205 memories.

1. The content of memories. Each recorded memory was examined for its content. In line with previous studies conducted by Berntsen (1996; 1998) and Roberts et al. (1994) each involuntary autobiographical memory was described by participants with one or more sentences and invariably referred to some events and experiences from one's personal past (for examples see section A of Appendix 5). In contrast, the mind pops were described by participants with one or few words and invariably referred to some fragments of general knowledge rather than personal experiences from the past. They easily fell into one of the three categories: Words in their native language (including single words, phrases, proper names), images, and melodies (for examples see section B of Appendix 5). All words were words whose meaning was known to the participant. There was only one case of a word in foreign language but the

participant did not indicate whether its meaning was known to her (so it was counted as known word). Out of 74 mind pops 45 (61%) were words, 9 (12%) were images and 20 (27%) were melodies. This relatively high number melodies is in line with the results of questionnaire Study 3 in which very high proportion of participants admitted experiencing melodies as mind-pops.

2. Levels of concentration on ongoing activity. When each memory was experienced participants had to record the activity they were engaged in at the time and had to rate on a five-point scale how much they were concentrating on this activity. Ratings 1 and 2 on this scale indicated low levels of concentration, rating 3 - medium level of concentration and ratings 4 and 5 - high levels of concentration. The activities people were engaged in at the time of involuntary memories varied greatly and ranged between fairly automatic ones requiring low levels of concentration such as lying in bed, walking, having a shower and those requiring more attention and concentration such as reading, writing up lecture notes, having a conversation or a discussion, etc. The frequency of memories as a function of the level of concentration and memory type are presented in Table 16. The results of statistical analysis showed that there was no significant difference between the involuntary semantic and autobiographical memories with respect to the type of concentration rating (χ^2 = 3.66, df=2, p=.16). Table 16 shows that both types of memories were predominantly experienced by participants during low to medium levels of concentration.

Insert Table 16 here

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3. Presence of triggers. For each recorded memory participants indicated whether the memory was triggered or not triggered by something either in one's environment or in one's own thoughts. The percentage of memories as the function of triggers and

memory type is presented in Table 17. For involuntary autobiographical memories triggers were detected in as many as 80% of cases. This is in line with findings from previous diary studies of Berntsen (1996) and Roberts et al. (1994) in which triggers were detected for 93% and 94% of recorded memories. In contrast, triggers for involuntary semantic memories were reported in only 37% of cases. Although this percentage is slightly higher than the one established in Study 1 and 2 (i.e., 20%) it is nevertheless significantly lower than the one for involuntary autobiographical memories ($\chi^2 = 28.22$, df=1, p<.001).

Insert Table 17 here

(d) Priming hypothesis. For each recorded involuntary semantic memory participants also had to indicate whether they encountered the content of the memory (i.e., saw, heard, thought of, etc.) in the recent past. This information was necessary to assess the priming hypothesis outlined in the introduction. In 31 cases out of 74 (42%) participants indicated that the memory content had been encountered previously (ranging from few minutes to 2-3 weeks ago). This percentage is not different from the one (49%) obtained in Study 1 and 2 (χ^2=1.57, df=1, p>.05).

(e) Metamemory for mind-popping frequency. As pointed out in the method section participants were asked to fill in the Mind-Popping Questionnaire (MPQ) before they started to keep a diary. Overall, the questionnaire results replicate those obtained in Study 3 both in terms of percentage of participants who admitted experiencing mind-pops (82% vs. 84% in Study 3) as well as the types of mind-pops experienced (see Table 14). However, since all participants were asked to keep a diary of involuntary semantic memories (irrespective their responses on MPQ) it was possible to examine participants' metamemory awareness of the occurrence of mind-

pops in their everyday life. Thus, the participants who claimed to have never experienced mind-popping (responded with 'no' to Question 1) or very infrequently (ratings 1 to 3 on the 8-point rating scale of frequency for Question 2) should not have in principle experienced/recorded any mind-pops throughout the one week period. On the other hand, those who chose rating 4 (corresponding to a statement 'once or twice a month) had only a 50% of chance to experience one mind-pop during this week. Finally, those who chose rating 5 and above on the scale should have experienced at least one (if not more) involuntary semantic memory.

However, as one can see from Table 18, participants do not seem to have insight in the frequency of their involuntary semantic memories as there were no reliable differences between these four groups of participants in terms of actual frequency with which they experienced none versus at least one mind-pop throughout the week (χ^2=1.14, df=3, p>.05). Indeed, as many as 62% and 50% of those participants who initially thought they either never experienced mind popping or very infrequently did actually record at least one mind-pop (range 1-7). In contrast, as many as 33% of those participants who thought they experienced at least one or two mind-pops per week did not actually record a single mind-pop. This lack of insight is also reflected by the non existence of any reliable positive correlation between participants' frequency ratings in questionnaire and the actual number of mind-pops experienced during the diary study (r(45)=.09, p >.05). These findings underscore the advantages of diary studies over retrospective questionnaire studies in this field of research. Second, they also indicate that some people who do experience involuntary semantic memories may not be paying attention to them and thus assume that they never experience them.

Insert Table 18 here

In conclusion, Study 4 produced interesting results that are important for several reasons. First, the results replicate the findings from our first three studies on involuntary semantic memories as well as the findings of Berntsen (1996) and Roberts et al. (1994) on involuntary autobiographical memories (e.g., prevalence of triggers and being engaged in relatively automatic activities at the time of the memory occurrence). Second, the existence of mind-pops may be more prevalent than revealed by the MPQ data. Most important, however, the results show that involuntary semantic memories are distinct from involuntary autobiographical memories. Thus, they are far less likely to be triggered by easily detectable triggers. They may be occurring less frequently (at least on the basis of the data from the first week of the study) and, finally, there appears to be no positive relationship between the number of experienced involuntary semantic and autobiographical memories.

GENERAL DISCUSSION

We will start with the findings that emerged from our diary and questionnaire studies. This will be followed by a discussion of possible underlying mechanisms for involuntary semantic memories. We will also address other related issues (definitional, methodological, etc.) that arise from the results of the present investigation and possible avenues for future research.

(a) Empirical findings. We have demonstrated the existence of a type of involuntary memory in everyday life which can be provisionally termed as involuntary semantic memories. There are several important differences between the latter and the involuntary autobiographical memories.

First, substantial differences exist at a purely phenomenological level. Thus, involuntary autobiographical memories always refer to a particular incident in one's past (either specific or generic) experienced in a specific time period and/or place.

They have a narrative structure in that subjects' descriptions of these memories always consist of one or two sentences describing what happened in the past, and they usually involve the subject as a participant. In contrast, involuntary semantic memories do not have any of these characteristics. They consist of single words and images (and melodies in Study 3 and 4) without any reference to past experiences at a certain time and location, and mostly represent knowledge about the world around us. This includes not only purely semantic knowledge (e.g., a noun or the name of a Prime Minister) but also autobiographical facts such as a name of one's former schoolteacher or a particular non-word used by one's children when they were small (see Conway, 1987, for drawing a distinction between autobiographical facts and autobiographical memories). As long as no additional personal/contextual information is recalled with these words/images we will classify all these cases as involuntary semantic memories. [8]

Second, a crucial difference between the two types of involuntary memories is the lack of easily detectable triggers in the case of involuntary semantic memories. Even after accepting a relatively lenient criterion for a cue (i.e., a remote association or phonological similarity based on just a couple of letters) it was possible to identify the cues in only 20% of cases in Studies 1 and 2. Although the participants in Study 4 were able to detect cues in 37% of cases this is still in sharp contrast to involuntary autobiographical memories for which cues were identified in 80% of cases (or in 93% and 94% of cases in the Berntsen (1996) and Roberts et al. (1994) studies, respectively).

Third, although big individual differences appear to exist in the frequency with which one experiences both involuntary semantic and involuntary autobiographical memories the results of Study 4 show that the latter are apparently experienced more frequently than the former. Thus, the mean number of recorded

involuntary autobiographical memories in week 1 of Study 4 was 6.31 (SD=9.40, range 0-48) which is in line with the results of Roberts et al. (1994) study where participants had on average 6.51 (SD=4.08, range 1-25) involuntary autobiographical memories in one week. In contrast, participants of Study 4 recorded on average only 1.29 mind-pops (SD=1.43, range 0-7) in week 1. Despite this variability it was not the case that those who experienced more involuntary autobiographical memories would also experience more involuntary semantic memories. There was no statistically reliable correlation between the two (when the two outlier cases were excluded). Taken together all these findings indicate that involuntary semantic memories are distinct from involuntary autobiographical memories and that they may have different underlying mechanisms.

Despite the aforementioned differences between involuntary semantic and autobiographical memories there is also one important commonality. Thus, both involuntary semantic and autobiographical memories tend to occur when one is alone (or not in direct contact with others) and engaged in relatively automatic and habitual everyday activities such as cleaning, cooking, driving, walking, studying, etc. The characteristic feature of the majority of these activities is that one's attention does not need to be concentrated on monitoring and controlling the ongoing activity due to the automatic activation of pre-programmed action schemas (Norman, & Shallice, 1986; Reason, 1984). Instead, one's mind is free to wander from one thought to another that is unrelated to the current activity. When one is engaged in such a routine and habitual everyday activity, one's attention is in a diffused rather than concentrated mode (Berntsen, 1998).

In Study 1 and 2, 60% of involuntary semantic memories occurred when one's attention was diffuse rather than concentrated. A similar percentage (67%) was also obtained for involuntary autobiographical memories by Berntsen (1998). The

most convincing evidence in this respect was obtained in Study 4 where participants indicated the existence of low to medium levels of concentration in 81% and 75% of cases for involuntary semantic and involuntary autobiographical memories, respectively.

These findings are in line with the results of several other studies that have investigated involuntary retrieval or "popping up" experiences in such diverse areas of enquiry as daydreaming, task unrelated images and thoughts (TUITs) and prospective memory (i.e., remembering to perform intended actions at an appropriate time in the future). In a naturalistic study of prospective memory (Ellis, & Nimmo-Smith, 1993) participants were more likely to report having involuntary recollections (i.e., rehearsals) of the to-be-performed intentions when they were not concentrating on the task at hand (see also Sellen, Louie, Harris, & Wilkins, 1997). On the other hand, Giambra (1995) found that the occurrence of TUITs during an ongoing laboratory vigilance task decreased as the frequency of the to-be-detected targets increased. Thus, being in a relaxed state of mind and/or being engaged in activities that are not attentionally demanding is generally a prerequisite of a "popping up" experience whether it is a daydream, prospective memory task, sudden solution of the problem after one has abandoned attempts to solve it (as in case of incubation) or involuntary autobiographical and semantic memories (cf. Mandler, 1994, pp. 9-13).

Taken together, these findings are important as they raise interesting issues about our current understanding of automaticity in relation to the involuntary retrieval processes. The varied phenomena listed above appear to satisfy most of the requirements of automaticity (i.e., they involve fast and effortless processes which are not under our conscious control) except that they do suffer from interference in dual task situations (Hasher, & Zacks, 1979; Posner, & Snyder, 1975; Shiffrin, & Schneider, 1977). Indeed, in a series of experiments Marsh and Hicks (1998)

selectively manipulated the cognitive load (high vs. low) of ongoing tasks which tapped different components of working memory system. They found that performance on a prospective memory task embedded into these ongoing tasks was impaired in high load condition for those tasks that tapped central executive component of working memory (for similar findings in a study on TUITs or stimulus independent thought see Teasdale, Dritschel, Taylor, Proctor, Lloyd, Nimmo-Smith, & Baddeley, 1995).

There are two possible ways in which one can solve this apparent paradox from the standpoint of the limited resources account of automaticity. One is to conclude, as did Marsh and Hicks (1998), that involuntary retrieval in prospective memory, despite being perceived as a spontaneous and automatic process, nevertheless requires a certain amount of conscious executive processing and, as a result, can not be regarded as an entirely automatic process (see Teasdale et al., 1995 for drawing similar conclusions in the case of stimulus independent thoughts). The second possibility is that certain automatic processes can still take up some of the available attentional resources. This position is based on the findings which have established a dual task interference for such seemingly automatic processes as the Stroop task (e.g., Kahneman, & Triesman, 1984) or an automatic detection of a target (e.g., Hoffman, Nelson, & Houck, 1983). Kihlstrom (1999) has argued that "There is no a priori reason… why an automatic process should consume no attentional resources" (see also, McNally, 1995).

However, it is also possible to account for these findings without necessarily adopting the limited resources account of automaticity (see e.g., Logan, 1991). Thus, the likelihood of processing (and noticing) task irrelevant stimuli that may act as potential triggers for involuntary memories (whether autobiographical or semantic) could be higher when one is engaged in automatic than in controlled activities.

Another related possibility is that when one is not concentrating on the task at hand the processing of task irrelevant or even task relevant information elicits strong and fast spreading of activation of semantic representations. The occurrence of such associative spreading is less likely when one is actively concentrating on limited number of incoming stimuli as is the case in controlled activities (Mandler, 1994). If anything, the activation of task irrelevant representations is actively inhibited. If, as will be shown below, the occurrence of involuntary semantic memories is partly due to the existence of such associative spreading in response to incoming stimuli then it is understandable why involuntary semantic memories are more likely to occur when one is engaged in automatic activities.

In summary, although involuntary semantic and autobiographical memories are similar in that they both require that one's attentional resources are not fully deployed by the task one is currently engaged the vast majority of involuntary autobiographical memories are triggered by easily identifiable cues whereas involuntary semantic memories seem to be, at least subjectively, cue independent.

Although the identification of cues for these memories was difficult, the occurrence of involuntary semantic memories is by no means entirely as accidental as it may be experienced. On 30% and 58% of occasions in Study 1 and Study 2, respectively, it was possible to ascertain with fair amount of certainty that L.K. had encountered the events related to involuntary memories in the recent past (the time interval varied from few seconds to as long as two months). Moreover, recent encounters with the contents of involuntary memories was recorded in 42% of cases in Study 4 and was also pointed out by some of the undergraduates who took part in Study 3 (see Appendix 4). Taken together, these findings speak in favor of the priming hypothesis.

The occurrence of involuntary semantic memories in everyday life is indicative of priming in a novel, apparently spontaneous, and often long-term mode. Priming and implicit memory, when studied in the laboratory, refer to a change in one's ability to identify or produce an item as a result of specific prior encounters either with the item itself (repetition priming) or a related item (semantic and associative priming) (see Schacter, 1987; Tulving & Schacter, 1990). In most of the laboratory experiments of repetition and semantic priming, processes of activation/integration and spreading activation (Anderson, 1983; Collins, & Loftus, 1975; Mandler, 1989) are inferred from subjects' performance in tasks which either require the processing of the targets (e.g., perceptual identification, lexical decisions, naming, etc) or their production (word stem or fragment completion, category exemplar production, etc.). The fact that these target words are usually processed more quickly or produced at a higher rate than control words allows one to assume that the targets have been activated by the primes (Graf, & Mandler, 1984; Meyer, & Schvaneveldt, 1971; Rajaram, & Roediger, 1993).

In contrast, many of the cases in the present study are indicative of a special form of very long-term repetition and semantic priming. Unlike the laboratory studies in which priming is assessed by the processing of the targets that occur in the context of an ongoing task (e.g., perceptual identification, lexical decision, word fragment or word stem completion), in involuntary semantic memories the activation levels of primes are such that they can result in the unexpected conscious representation of the primed concept while being engaged in activities which do not involve the processing/production of the target words (i.e., the contents of the involuntary semantic memories). This is a major difference between involuntary semantic memories and implicit memory tasks. In the latter, involuntary retrieval occurs in the

context of an ongoing task performance, in the former it usually occurs in the context of ongoing activity but in the absence of target that is being processed.

The existence of this particular form of priming extends the range of priming phenomena. First, it indicates that automatic and unconscious processes of activation and spreading activation underlying priming and implicit memory, studied under specially designed laboratory conditions, do operate also outside the laboratory in people's everyday life (see also Foss, 1982 for discussing the ecological function of priming in natural language comprehension). This conclusion is probably not surprising but it is important in the light of recurrent debates about the ecological validity and generalizability of laboratory research in the past decade (Banaji, & Crowder, 1989; see also January issue of American Psychologist, 1991; June issue of Behavioral and Brain Sciences, 1996).

Second, our results provide new insights on the possible duration of priming effects. Thus, the effects of repetition priming studied in the laboratory, particularly with tasks that require the production of target stimuli, are usually short lived and do not last longer than few hours (e.g., Graf & Mandler, 1984; Squire, Shimamura, & Graf, 1985) or few days (e.g., Sloman, Hayman, Ohta, Law, & Tulving, 1988; Tulving, Schacter, & Stark, 1982; but see Tulving, Hayman, & Macdonald, 1991). [9] As to the effects of semantic priming, they can be dramatically reduced or even eliminated when a single word or a delay of few seconds is inserted between the prime and the target (as an exception see Becker, Moscovitch, Behrmann, & Joordens, 1997 who managed to obtain semantic facilitation for as many as 8 intervening items). In contrast, the results of the present study show that a single exposure to a word(s) encountered in everyday life can produce activation of several weeks (if not months) which may eventually result in the conscious occurrence of this word or semantically/associatively related word(s).

Finally, our results also demonstrate the nature of semantic priming in everyday life as well as the richness of semantic networks and their relation to the network of autobiographical facts (cf. Vallée-Tourangeau, Anthony, & Austin, 1998). Specifically, when the spreading of activation in a semantic network is studied in laboratory, the prime/target pairs that are used are almost always the abstract names of categories and category exemplars (e.g., Bird-Robin) or names of associatively related concepts (e.g., Doctor-Nurse) (see e.g., Neely, 1976). Our results show that this type of activation does occur in the course of everyday life. For example, the activation of semantically related concepts in response to reading the word "Christmas" so that later on one of the activated concepts like "Jingle Bell" pops into mind. However, the results are also consistent with general notions of semantic networks of representations that consist of all the factual knowledge that is acquired throughout one's life. For example, talking or thinking about a film such as "My Best Friend's Wedding" may activate subconsciously lots of related information such as the names of actors, locations where it was shot, etc., and as a result, one of these names can gain access to consciousness next morning at a seemingly inappropriate moment. Moreover, our results show that similar processes of activation are operating in one's network of autobiographical knowledge or facts. For example, a mere encounter of a colleague in a staff room in the morning, without having any interaction with him, can apparently activate a vast amount of autobiographical knowledge one has about this person so that later on in the afternoon one specific expression used only by this colleague (e.g., holy moly) pops into one's mind.

These findings generate hypotheses for future investigations of the nature and the time course of semantic priming with more naturalistic material and/or the possible relationship between one's networks of semantic and autobiographical knowledge. For example, one can assume that a single encounter (either external or

internal) with a certain item activates not only semantically related words and concepts but also a plethora of autobiographical facts related to that item. Therefore, when a subject in a typical priming experiment is shown a word 'mother' priming effects should be obtained not only for semantically related target words such as 'father' or 'daughter' but also for a variety of autobiographical facts related to subject's own mother (e.g., her first name, occupation, favorite food, etc.). Of particular interest would be to compare the magnitude of priming for the semantic associates to the prime word (i.e., 'mother') and the autobiographical facts associated with that prime. Recent research in autobiographical memory (e.g., Conway, 1987; Conway, & Bekerian, 1987) shows that it should be possible to design such experiments.

(b) <u>Theoretical mechanisms</u>. Involuntary semantic memories apparently occur as a result of spreading activation in the representational network of semantic and autobiographical knowledge. Moreover, a single encounter with an item can apparently elicit persistent and long-lasting activation(s). A question that needs to be addressed concerns the reasons for the occurrence of a particular involuntary memory at a particular time and place, especially in the absence of easily detectable external or internal triggers. We believe that a dual process theory can provide some answers to this question.

Dual process theory (DPT) dates to experiments in the 1970s that showed the interaction of familiarity and retrieval processes in recognition and recall. It was suggested by Atkinson and extended and developed by Mandler and their associates (Atkinson, Herrmann, & Westcourt, 1974; Mandler, 1979; 1980; 1991). In Mandler's terms DPT postulates two processes that operate on mental representations - activation/integration and elaboration (<u>cf</u>. Bower, 1996).

Activation/integration is an automatic process that occurs whenever the representation of an event is processed. The presentation of information (objects, people, events, etc.) activates relevant existing knowledge units (schemas), and boosts the level of activation of all the constituent features of the event. Integration occurs automatically as the previously established connections or relations among the features lead to further activation of the "connected" features of the item and thus "integrate" the specific event that is activated. Some of the consequences of such activation are the phenomenal experience of increased familiarity and perceptual fluency.

In contrast, elaboration is the process whereby mental contents are related to one another. It is most evident in the establishment of new organizations that make possible subsequent retrieval, and successful "search" processes. The concept has been variously used in the past, and it is generally relevant to many of the phenomena we find in deliberate memory, such as recall, partially in recognition, and in many kind of organization of target material.

Elaboration is presumably a conscious process that activates previously established relationships among mental structures and allows new relations to be formed, enhancing both activation and retrievability at the same time. In other words, activation can occur without elaboration or consciousness but any elaboration accesses the representation of the event and necessarily produces activation. The class of phenomena usually called "implicit" is a function of activation, whereas "explicit" processes require elaborated structures.

In relation to involuntary semantic memories DPT assumes that a large number of different perceptual and conceptual nodes are activated in the course of daily experience without, however, any of that activation being conscious or deliberate. Given that priming can produce activation over reasonably long periods

(see Roediger & McDermott, 1993), we thus wander through the world with a spreading web of activation going on in our representational mind.

The majority of these activations will not be accessed and will possibly decay. The functional importance of these activations is that they can be potentially accessed in response to current task requirements such as recognizing a friend, remembering someone's name or finding a solution to a problem (cf. Bower, 1996; Anderson, 1983). For example, Judson, Cofer, and Gelfand (1956) found that subjects were more likely to find a solution to Maier's two-string problem if they encountered the key words to the solution (i.e., string, pendulum and swing) earlier on in the session in an unrelated list learning task (for similar results see Higgins, & Chaires, 1980 who used very different tasks and materials). Also, numerous studies on implicit memory have shown that subjects will fill in word fragments or complete word stems with previously encountered words.

In case of mind-popping (i.e., involuntary semantic memories) we assume that some partially relevant (integratable) cue in the environment (or in one's thoughts) accesses some previously activated representation or fragment of a representation. The integrative process activates a complete unit which then reaches conscious realization. For example, hearing someone saying "very long" may act as a phonological trigger boosting the activation level of the name "Versace" encountered a day before on TV. Or thinking about baking German cookies for Christmas could act as an associative cue and enhance the activation levels of a character from a German fairy tale "Rapuntsel" mentioned a couple of days ago by a friend during a lunch break. As a result of these processes the names "Versace" and "Rapuntsel" pop into one's mind. [10]

A remaining question of interest is why cues or primes are so difficult to identify. In Study 1 and 2, for example, cues were identified in only 20% of cases and

in as much as 38% of cases neither cues nor primes were identified (see Table 13). The difficulty may be better understood when we examine some specific cases.

Consider this example: Passing a fish store may activate some fish names and fish experiences without us being conscious of that (cf. Anderson, 1983; Collins, & Loftus, 1974). [11] Sometime (often much) later, somebody in a conversation mentions a wiring problem which spreads to the representation of "cable". The result is an unusual experience of "Kabeljau" (the German name of cod which one has come across in some recipes in the distant past) popping to mind. Thus, nothing in the immediate or recent environment is responsible as far as one can tell but some combination and spreading of activation did in fact produce the phenomenon, i.e., two activations unrelated in both time and content may produce a mental content that is both unexpected and seems contextually irrelevant (cf. Nelson et al., 1998).

There is ample experimental evidence showing that the processing of a target word automatically activates not only its corresponding representation but also the other words that are semantically related to it. For example, in semantic priming experiments such indirect activations have been assessed by measuring reaction times (in a lexical decision task) to target words which are semantically related to previously presented primes (e.g., Fischler, 1977; Neely, 1976; 1977). In addition, there are several other lines of research which have shown that automatic activation of related information in response to a target word can exert strong effects on performance in such different tasks as free recall and recognition (Mandler, & Rabinowitz, 1981; Roediger, & McDermott, 1995), cued recall (Nelson et al., 1998), implicit memory tasks (McDermott, 1997), reading and text comprehension (Kintsch, 1988; Sharkey, & Mitchell, 1985). For example, McDermott (1997) showed that associative activation of a non presented prime word in a list of semantically related words was sufficient to produce priming on both conceptual (i.e., word association

test) and perceptual implicit memory tests (such as word stem and word fragment completion).

However, the time lag between the presentations of primes and the target items in these studies was relatively short (in the order of minutes) and especially so in case of semantic priming studies (in the order of seconds only). While there are few demonstrations of more long lasting associative priming with time lags of up to 30 minutes (see Yaniv, & Meyer, 1987) the present study shows that such indirect associative activation can last as long as several days (if not weeks).

Although such long-lasting activations of associated concepts do apparently exist in everyday cognitive functioning, our results nevertheless show that the majority of detected primes (72%) were identical (or phonologically similar) to the subsequent mind pops which means that the latter occurred as a result of direct automatic activation of primes per se. Moreover, this activation was apparently sustained much longer (up to two months) than in case of associative primes (up to ten days). One could therefore suggest that the relative difficulty of identifying primes was probably due to L.K.'s inability to retrieve the incidentally encountered primes in the past rather than the existence of very long lasting indirect activations.

On the other hand, the difficulty to detect the cues is more likely to be due to the rapid spreading of (relatively short-lived) activation in semantic networks in response to stimuli in the current environment (whether external or internal). Indeed, as one can see from Tables 9 and 10 as many as 49 detected cues (56%) out of 87 were semantically or associatively related to the contents of involuntary semantic memories. However, the conscious identification of such indirect cues as hearing someone talking about "wiring problems" being a cue to Kabeljau (see above) is both unusual and unlikely and, as a result, the majority of such cues go unnoted.

Another reason for an apparent absence of cues in case of involuntary semantic memories is that some of the cues are subliminal. Thus, in Study 1 and 2 it was possible to identify such cues on only twelve occasions but it is obvious that they may have been in operation much more frequently.

Finally, there is a possibility that mind-pops are elicited by cues which share only a single syllable or letter with the contents of a mind-pop which will also make the detection of the relationship difficult, if not impossible. Some support for this idea comes from our own examples of cues (see section A of Appendix 2), and especially from a recent study of James and Burke (2000) on phonological priming effects on word retrieval after tip-of-the-tongue (TOT) experiences. In that study, participants were more likely to resolve their TOT state by giving a correct answer to a general knowledge question (e.g., the word 'velcro') if they were given to process the words which shared some phonological components with this target word (e.g., <u>ve</u>nerable, p<u>el</u>let, de<u>cr</u>eed, overth<u>ro</u>w, and mistlet<u>oe</u>). Although most of these words shared only parts of one single syllable with the target word (which made it impossible to detect any connections/similarities between them and the target word 'velcro') their processing was more likely to elicit the resolution of the TOT state (i.e., producing the target word 'velcro') than the processing of the phonologically unrelated words. The investigation of the nature of the relationship between the external cues and the elicited memories (phonological vs. semantic) is an important direction for the future research.

In summary, involuntary semantic memories seem to be brought about by the cumulative action of long term residual activation of a prime per se and relatively short term (associative) spreading of activation in response to one's current situation. This is consistent with previous findings that spreading of activation primarily makes underlying representations more accessible (Graf & Mandler, 1984) but that actual

conscious access is produced by the other priming effects (over both short and long term period).

Here is another difference between involuntary semantic and autobiographical memories. In the latter there is no necessity to assume the existence of long-term priming. Some aspect of external stimuli or internal thoughts elicits a spread of activations in the network of semantic and autobiographical nodes and schemas, and due to a perfect match between the cue and a central feature of a certain autobiographical memory, the representation of the latter is automatically activated above the threshold level and a person suddenly remembers a certain episode from the past (see Conway, & Pleydell-Pearce, 2000).

The absence of a long term priming component in case of involuntary autobiographical memories is apparent from the Berntsen's (1996) study who found that the majority of recorded memories (65%) referred to events that happened more than a year ago. In addition, in 45% of cases subjects also indicated that they had never experienced a particular memory before.

(c) <u>Other relevant issues</u>. One interesting aspect was that even a very brief encounter with new events that have been processed only perceptually can be consciously (albeit involuntarily) retrieved at a later point. This is in contrast to countless laboratory findings on levels-of-processing which have shown the detrimental effects of perceptual processing (as opposed to deep semantic processing) on tests of conscious retrieval such as recall and recognition. However, our results show that passing a street or road sign with a name of previously unknown street or area can be sufficient for this name to pop into one's mind later. Similarly, reading someone's name in a newspaper or hearing it on the news can be sufficient for the name to pop up. The same thing can also happen when one encounters a word in foreign language (i.e., unknown word) and s/he does not know its meaning.

When such incidents occurred L.K. was always surprised by the fact that these names had been retained despite such brief encounters. Moreover, in several cases L.K. had no conscious memory (or even a feeling of familiarity) of encountering these new names before. Only after a process of verification from others (usually family members) or by accident would L.K. establish that she had previously encountered the name (e.g., finding out that the name Acapulco was mentioned on news or that the word "el diablo" was encountered while watching a film or that "Frobisher" was a name of a street she may have passed in the morning).

Obviously one may question whether these mind-pops can still be termed (involuntary) semantic memories given that they are primed by a single encounter with a novel stimuli (an unknown name or a word). Although they are not a result of multiple encounters with a relevant item which is a characteristic feature of semantic memories their occurrence was not accompanied with the retrieval of relevant contextual information which is characteristic of episodic memories (Tulving, 1972). If anything, it was necessary to resort to elaborate search strategies to establish the context in which they had been previously encountered. In this sense, such mind-pops can still be referred to as involuntary semantic memories. In addition, these cases were by no means a large category in the pool of recorded memories. In Study 1 and 2 they comprised only 17% of cases out of 428 (see Table 1), and none were recorded in Study 4.

Existence of this relatively small subset of mind-pops is interesting also because they may represent a type of memory that Tulving (1983) referred to as "free radicals". These are memories whose contents have become detached from the original episode "but have not (yet) been attached to the (permanent) semantic-memory system" (p. 117). Tulving describes several interesting cases of these free radicals in patients with amnesia who report experiencing certain ideas going 'through

their mind' (without them knowing why), and which actually represent the contents of previously learned material without the patients having any memories of a previous learning episode. According to Tulving (1983) the evidence of the existence of free radicals in normal memory is completely lacking. However, the results of the present study appear to provide such evidence and show that the idea of free radicals is worth examining in more depth in the future research.

Another related finding was that much more information is preserved in one's long term memory than one is aware of (for a discussion of this issue see Loftus, & Loftus, 1980). This was particularly obvious in case of mind-pops of English words which had been apparently learned previously but L.K. thought that she had forgotten their meaning. Nevertheless, on several occasions the occurrence of such "unknown words" was apparently triggered by current stimuli or primed by preceding events. For example, the word "hurdle" popped up while L.K. was in her office making a hot drink, and thinking how nice and warm it was in the room. L.K. could not remember the exact meaning of this word although she had the vague feeling of familiarity and that it could mean a barrier for jumping. Since she was unsure about it she checked the meaning of this word in the dictionary only to find out that the second entry for this word was "problem or difficulty" and that it had been even underlined by her at some point in the past. The occurrence of this word was surprising because few seconds before L.K. started to make a drink she was experiencing difficulty in remembering a name of a correlation coefficient which she needed for the paper she was working on. Or consider the supposedly unknown word "torrid" that popped into mind while L.K. was thinking about a middle-aged colleague with amusement as she pictured him dancing vigorously on a dance floor at a recent party. These cases are interesting because they indicate that although the meanings of certain words can be completely forgotten, and are not even recognized when they pop up, nevertheless they can be primed or cued by relevant

context which indicates that at subconscious level the meaning is still preserved in one's memory.

These findings are not particularly surprising in the light of several laboratory studies which have shown that there are significant savings in re-learning materials which have been forgotten to the extent that they are not even recognizable let alone retrievable (e.g., Bahrik, & Phelps, 1988; Nelson, 1978). However, in all these studies the long-term retention of knowledge is assessed by implicit measures (such as savings in re-learning) whereas in our study these supposedly forgotten words and names directly pop into one's mind. Much of the information that we think is forgotten is only inaccessible rather than unavailable (cf. Lewis, 1979; Tulving, & Pearlstone, 1969).

(d) Methodological issues and future research. Several methodologically important points have emerged from the present study. First, the results show that despite the momentary and fleeting nature of the phenomenon the relevant data can be obtained by the questionnaire and the diary methods. Second, Study 4 has demonstrated the advantages of using the diary method over the questionnaires. Finally, and perhaps most importantly, Study 1 and 2 have demonstrated the usefulness of a researcher collecting data over a long period of time on himself or herself. Although this method has not been popular with psychologists (for some exceptions see Ebbinghaus, 1985/1964; Larsen, 1992; Linton, 1978; Wagenaar, 1986) our study has shown the benefits of self- observation (and possibly experimentation) for generating interesting ideas and hypothesis which can be then subjected to tests with more participants and/or more controlled methods of enquiry.

However, further and significant progress in this new area of research on involuntary memories will be made when the study of both involuntary semantic and involuntary autobiographical memories can be brought under laboratory control. We

have developed a laboratory method that induces involuntary autobiographical memories in response to incidental cue words encountered by participants in the context of ongoing and relatively undemanding vigilance task (detecting a pattern with vertical lines from the patterns of consisting of horizontal lines) (Kvavilashvili & Schlagman, 2003). We are now developing experimental methods to capture and explore involuntary semantic memories in the laboratory. One possibility is to expose a participant to many words (both in and outside of one's focus of attention) at an encoding stage. These words could serve as possible primes for later involuntary semantic memories which could occur while being engaged in an easy and leisurely paced color discrimination task on a computer screen so that some words can be displayed parafoveally (possible cues). The participants will be asked to relax as much as possible while they are engaged in this easy and monotonic task but if they experience a mind pop they have to report it immediately to the experimenter. By varying the nature of relationship between the primes and possible cues (phonological vs. semantic) it should be possible to investigate some of the aspects of priming mechanisms underlying involuntary semantic memories.

In conclusion, we have described a type of memory called <u>involuntary semantic memories</u> to distinguish them from involuntary autobiographical memories. The results not only shed some light on the nature of these memories and the conditions of their occurrence but also provide some information about possible mechanisms of this interesting but neglected phenomenon.

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FOOTNOTES

[1] As in previous analyses with the type of activity (controlled vs. automatic), there was a highly significant difference between known and unknown words in comparison to images with respect to the prevailing type of attention during the involuntary memory

($\chi^2 = 45.65$, df=2, p < .001). As one can see from Table 5, in comparison to 75% of images, only 34% of known and 24% of unknown words occurred while being in concentrated attention mode.

[2] One can see from Table 6 both known and unknown words were significantly more likely to be triggered by cues than images ($\chi^2 = 26.70$, df=2, p < .001).

[3] It is important to point out that the number of previous encounters/primes was twice as high in Study 2 than in Study 1 (58% and 30%, respectively). This was probably

due to enhanced awareness of the existence of such primes and efficiency with which L.K. was able to trace them after her experience and the results gained in Study 1.

[4] On few occasions these previously encountered contents were only partially identical to the involuntary memory. For example, involuntary memory 'Santa Monica' was preceded by the name 'Mr. Monica' seen in a film two days before whereas the name of the composer 'Poulenc' was preceded by reading 'Consomme de Poulet' on a box of chicken soup 5 minutes before.

[5] The MPQ can be obtained from the first author.

[6] The remaining participants produced involuntary autobiographical memories (11%), tip-of-the-tongue phenomenon (9%) or some other examples (5%).

[7] These memories represented a range of phenomena such as autobiographical memories, daydreams, absentmindedness and prospective memory tasks, etc.

[8] There is, of course, a possibility that some of the involuntary autobiographical memories studied by other researchers were actually involuntary semantic memories. For example, Salaman (1988), when describing her involuntary autobiographical memories, points out that some of them were only the fragments of past experiences such as an aspect of a street or someone's face. Similarly, one could speculate that those generic autobiographical memories recorded in the studies of Roberts et al. (1994) and Berntsen (1996) for which subjects could not detect triggers were actually involuntary semantic memories. In future studies a distinction should be made between involuntary autobiographical and involuntary semantic memories.

[9] It is interesting that very long-term repetition priming effects have been recently reported on tasks such as word naming (Cave, 1997) and face recognition (Bruce, Carson, Burton, & Kelly, 1998) that do not require the production of target items.

[10] It is interesting that a very similar account is put forward by Yaniv and Meyer (1987) for the processes involved in the phenomenon of incubation, i.e., when a

solution to a problem suddenly pops into mind much later, after one has abandoned solving the problem and switched to other unrelated activities. Thus, according to their *memory-sensitization hypothesis* "the initial unsuccessful attempt to solve a problem may partially activate stored, but currently inaccessible, memory traces critical to the problem's solution. Then, during a subsequent intervening period of other endeavors, the activation may sensitize a person to chance encounters with related external stimuli that raise the critical traces above threshold and trigger their integration with other available information"(p. 200).

[11] However, not all researchers agree that such activations are always out of our conscious awareness. For example, Underwood (1965) argued that processing a word is likely to produce its associate into conscious awareness at encoding whereas others have pointed out that such associative and non conscious activations can in principle (but not always) result in conscious representation of the associate (e.g., see McDermott, 1997; Nelson, McKinney, Gee, & Janczura, 1998).

TABLE 1

Number of Involuntary Memories in the Form of Known Words, Unknown Words and Visual Images Recorded in Diary Study 1 and Study 2. Row Percentages in Brackets.

Type of Involuntary Memory

Study	Known Words	Unknown Words	Visual Images	TOTAL
Study 1	47 (37%)	38 (30%)	41 (33%)	126 (100%)
Study 2	229 (76%)	34 (11%)	39 (13%)	302 (100%)
TOTAL	276 (64%)	72 (17%)	80 (19%)	428 (100%)

T A B L E 2

Number of Involuntary Memories (Pooled Across Study 1 and 2) in the Form of Known Words and Unknown Words Categorized as Proper Names of People and Places, Common Words (Nouns, Adjectives and Verbs), and Other (e.g., Brand Names). Row Percentages in Brackets.

S p e c i f i c   C o n t e n t   o f   I n v o l u n t a r y   M e m o r y

	Names of people and places	Nouns, adjectives and verbs	Other	TOTAL Words
Known Words	148 (54%)	52 (19%)	76 (27%)	276 (100%)
Unknown Words	12 (17%)	56 (78%)	4 (5%)	72 (100%)
TOTAL	160 (46%)	108 (31%)	80 (23%)	348 (100%)

T A B L E 3

Number of Involuntary Semantic Memories recorded in Each Week of Study 1 and

Study 2.

	Study 1	Study 2
WEEK 1	25	37
WEEK 2	6	29
WEEK 3	23	34
WEEK 4	3	29
WEEK 5	3	10
WEEK 6	7	7
WEEK 7	0	21
WEEK 8	13	19
WEEK 9	9	7
WEEK 10	5	10
WEEK 11	5	13

WEEK 12	1	9
WEEK 13	9	9
WEEK 14	3	10
WEEK 15	0	22
WEEK 16	4	19
WEEK 17	4	10
WEEK 18	2	7
WEEK19	4	–
TOTAL	126	302

T A B L E 4

Number of Involuntary Memories in the Form of Known Words, Unknown Words
and Visual Images (Pooled Across Study 1 and 2) Which Occurred at Home, in Office
at work and Elsewhere. Row Percentages in Brackets.

	Places Where Involuntary Memories Occurred			
Memory Content	Home	Office	Elsewhere	TOTAL
Known Words	208 (75%)	32 (12%)	36 (13%)	276 (100%)

Unknown Words	56 (78%)	6 (8%)	10 (14%)	72 (100%)
Images	53 (66%)	27 (34%)	0 (0%)	80 (100%)
TOTAL	317 (74%)	65 (15%)	46 (11%)	428 (100%)

TABLE 5

Number of Involuntary Memories in the Form of Known Words, Unknown Words and Visual Images (Pooled Across Study 1 and 2) Which Occurred During Automatic and Controlled Activities. Row Percentages in Brackets.

Type of Activity

Memory Content	Automatic	Controlled	TOTAL
Known Words	257 (93%)	19 (7%)	276 (100%)
Unknown Words	66 (92%)	6 (8%)	72 (100%)
Images	29 (36%)	51 (64%)	80 (100%)
TOTAL	352 (82%)	76 (18%)	428 (100)

T A B L E 6

Number of Involuntary Memories in the Form of Known Words, Unknown Words
and Visual Images (Pooled Across Study 1 and 2) Which Occurred While Being in
Diffuse and Concentrated Processing Mode. Row Percentages in Brackets.

Mode of Processing

Memory Content	Diffuse	Concentrated	TOTAL
Known Words	161 (66%)	82 (34%)	243 (100%)
Unknown Words	51 (76%)	16 (24%)	67 (100%)
Images	21 (27%)	56 (73%)	77 (100%)
TOTAL	233 (60%)	154 (40%)	387 * (100%)

* *Note*. Since it was not possible to classify processing mode as diffuse or
concentrated without knowing the thought at the time of occurrence of the involuntary
memory those 41 cases in which thoughts could not be remembered or were not
identified are omitted from this Table.

TABLE 7

Number of Involuntary Memories in the Form of Known Words, Unknown Words and Visual Images (Pooled Across Study 1 and 2) for Which Cues Were Identified and for Which No Cues Were Identified. Row Percentages in Brackets.

Presence of Cues

Memory Content	Cues	No Cues	TOTAL
Known Words	57 (21%)	219 (79%)	276 (100%)
Unknown Words	27 (37%)	45 (63%)	72 (100%)
Images	3 (4%)	77 (96%)	80 (100%)
TOTAL	87 (20%)	341 (80%)	428 (100%)

T A B L E 8

Number of Involuntary Memories in the Form of Known Words, Unknown Words and Visual Images (Pooled Across Study 1 and 2) for Which Identified Cues Were Either External or Internal. Row Percentages in Brackets.

T y p e of C u e

_____

Memory Content	Internal	External	TOTAL
Known Words	27 (47%)	30 (53%)	57 (100%)
Unknown Words	21 (78%)	6 (22%)	27 (100%)
Images	2 (67%)	1 (33%)	3 * (100%)

TOTAL	50 (57%)	37 (43%)	87 (100%)

* *Note*. Chi-squared calculated from the raw data in this table (see text) is based on the data of only known and unknown words. The number of images was too small (N=3) to be included in this analysis.

T A B L E 9

Number of Internal and External Cues (Pooled Across Study 1 and 2) Which Were Phonologically, Semantically and Associatively Related to Relevant Involuntary Memories. Row Percentages in Brackets.

Relation Between Cue and Involuntary Memory

_____

Type of Cue	Phonological	Semantic	Associative	TOTAL

Internal Cue	14 (28%)	26 (52%)	10 (20%)	50 (100%)
External Cue	24 (65%)	9 (24%)	4 (11%)	37 (100%)
TOTAL	38 (44%)	35 (40%)	14 (16%)	87 (100%)

T A B L E 10

Number of Involuntary Memories in the Form of Known Words, Unknown Words

and Visual Images (Pooled Across Study 1 and 2) Which Were Phonologically,

Semantically and Associatively Related to Their Relevant Cues. Row Percentages in

Brackets.

Relation Between Cue and Involuntary Memory

_____

Memory Content	Phonological	Semantic	Associative	TOTAL
Known Word	31 (54%)	18 (32%)	8 (14%)	57 (100%)
Unknown Word	7 (26%)	17 (63%)	3 (11%)	27 (100%)
Images	0 (0%)	0 (0%)	3 (100%)	3 * (100%)
TOTAL	38 (44%)	35 (40%)	14 (16%)	87 (100%)

* *Note*. Chi-squared calculated from the raw data in this table (see text) is based on

the data of only known and unknown words. The number of images was too small

(N=3) to be included in this analysis.

T A B L E 11

Number of Involuntary Memories in the Form of Known Words, Unknown Words and Visual Images (Pooled Across Study 1 and 2) Which Were Preceded by Phonologically Identical (i.e., Repetition Priming), Semantically and Associatively Related Primes. Row Percentages in Brackets.

Relation Between Prime and Involuntary Memory

_____

Memory Content	Repetition	Semantic	Associative	TOTAL
Known Word	134 (82%)	13 (8%)	17 (10%)	164 (100%)
Unknown Word	14 (70%)	6 (30%)	0 (0%)	20 (100%)
Images	6 (21%)	1 (3%)	22 (76%)	29 (100%)
TOTAL	154 (72%)	20 (10%)	39 (18%)	213 (100%)

T A B L E 12

Number of Internal and External Primes (Pooled Across Study 1 and 2) That Were

Phonologically Identical (i.e., Repetition Priming), or Semantically and Associatively

Related to Their Respective Involuntary Memories. Row Percentages in Brackets.

T y p e of Prime

Relation Between Prime and Involuntary Memory	Internal	External	TOTAL
Repetition	3 (2%)	151 (98%)	154 (100%)
Semantic	5 (25%)	15 (75%)	20 (100%)
Associative	23 (59%)	16 (41%)	39 (100%)
TOTAL	31 (15%)	182 (85%)	213 (100%)

T A B L E 13

Number of Involuntary Semantic Memories (Pooled Across Study 1 and 2) Which

Were or Were not Triggered by Cues or Preceded by Primes. Row Percentages in

Brackets.

E x i s t e n c e o f C u e

Existence of Prime	Cue	No Cue	TOTAL
Prime	34 (16%)	179 (84%)	213 (100%)
No Prime	53 (25%)	162 (75%)	215 (100%)
TOTAL	87 (20%)	341 (80%)	428 (100%)

T A B L E 14

Proportion of Undergraduates in Study 3 and 4 Who Chose Following Response

Options (Listed Below) in Response to Question 4 of Mind-Popping Questionnaire

(MPQ): "Below Are Listed Possible Contents of Involuntary Mind Pops. Please, Put a

Tick Along Those Contents Which You Think You Have Experienced at Least Once

in Your Life. You Can Tick as Many Options as You Feel Appropriate".

	Proportion of Participants in	
Content of Involuntary Memory	Study 3	Study 4
1. A word in your native language	.61	.73
2. A phrase or a sentence in your native language	.48	.42

3. A proper name (of a person, town, street, TV programme, etc.)	.63	.44
4. A word in a foreign language - and you know its meaning	.38	.32
5. A word in a foreign language - and you do not know or have forgotten its meaning	.22	.27
6. A visual image	.66	.68
7. A sound	.34	.32
8. A melody	.80	.73
9. Other (please, specify)	.17	.05

T A B L E 15

Mean Number of Memories as Function of Order and Memory Type

_____

	Type of Involuntary Memories	
Order	Semantic	Autobiographical
Semantic memory first	1.29 (week 1)	1.71 (week 2)
Autobiographical memory first	1.65 (week 2)	6.31 (week 1)

_____

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T A B L E 16. Number of Involuntary Memories as Function of Memory Type

And Concentration Rating (Row Percentages in Brackets)

_____

L e v e l s   o f   c o n c e n t r a t i o n

	LOW	MEDIUM	HIGH	Total
Semantic	36 (49%)	24 (32%)	14 (19%)	74 (100%)
Autobiographical	83 (55%)	31 (20%)	38 (25%)	152* (100%)
Total	119 (53%)	55 (24%)	52 (23%)	226 (100%)

* Note that concentration rating for one involuntary autobiographical memory was

missing, hence 152 memories instead of 153.

T A B L E 17. Number of Involuntary Memories as a Function of Memory Type and Presence/Absence of Triggers (Row Percentages in Brackets).

_____

<p align="center">T r i g g e r   D e t e c t e d   b y   P a r t i c i p a n t</p>

	YES	NO	Total
Semantic	27 (37%)	46 (63%)	73 * (100%)
Autobiographical	122 (80%)	31 (20%)	153 (100%)
Total	149 (66%)	77 (34%)	226 (100%)

_____

* Note that trigger information for one involuntary semantic memory was missing,

   hence 73 memories instead of 74.

T A B L E 18. Number of Participants in Study 4 as a Function of Self-Reported Frequency of Mind-Pops in MPQ and Actual Frequency Displayed in Diary (No Recorded Memories Vs. At Least One Memory) (Row Percentages in Brackets).

	R e c o r d e d M e m o r i e s I n D i a r y S t u d y		
Rated Frequency	A t L e a s t O n e	None	Total
Never	5 (62%)	3 (38%)	8 (100%)
Very infrequently (Ratings 1 to 3)	6 (50%)	6 (50%)	12 (100%)
Infrequently (Rating 4)	9 (69%)	4 (31%)	13 (100%)
Frequently (Ratings 5 to 8)	8 (67%)	4 (33%)	12 (100%)
Total	28 (62%)	17 (38%)	45 (100%)

–

A P P E N D I X 1

Examples of involuntary semantic memories recorded in Study 1 and 2 as a function

of type of memory content: known words, unknown words and visual images.

KNOWN WORDS

TIME: 20 August, Sunday, 8: 25 p.m.
CONTENT: **Helena Rubinstein**
PLACE: Kitchen
ACTIVITY: Washing up.
THOUGHTS: I was thinking whether to go jogging tonight and if we could go by 9 o'clock.
CUES: None
PREVIOUS ENCOUNTER: Yes. Yesterday morning when I was having breakfast I mentioned this name in my conversation with I.K. and he asked who she was.

TIME: 8 October, Wednesday, 2:01 p.m.
CONTENT: **Rummage**
PLACE: Office
ACTIVITY: Editing my paper- inserting spaces between the paragraphs.
THOUGHTS: Did not have any other thoughts than required by my activity
CUES: None
PREVIOUS ENCOUNTER: Yes. Four hours ago when I was trying to find a spelling of the word "Rugamuffin" in the dictionary I came across the word "rummage". I read carefully its meaning and also thought that this was the name of the town in one of the David Lodge's novels

TIME: 12 October, Sunday, 2:13 p.m.
CONTENT: **Portobello Road**
PLACE: Lounge
ACTIVITY: Was standing on the chair and cleaning dust from the wall lamp shade.
THOUGHTS: I was thinking that I had to clean the remaining two lamp shades as well.
CUES: None.
PREVIOUS ENCOUNTER: None that I am aware of.

TIME: 15 October, Wednesday, 6:23 p.m.
CONTENT: **Mindboggling**
PLACE: Kitchen
ACTIVITY: Cooking dinner - stirring the contents of a pan.
THOUGHTS: I was mentally planning tomorrow's dinner. I was thinking whether broccoli and sweet corns would be enough or whether I needed to buy some courgettes as well.
CUES: Yes, was probably triggered by my indecision what to do tomorrow. Definitely, this was not a mindboggling problem but still I was sort of puzzled.
PREVIOUS ENCOUNTER: None that I am aware of.

A P P E N D I X 1 (continued)

UNKNOWN WORDS

TIME: 13 July, Thursday, 3:25 a.m.
CONTENT: **Mural**
PLACE: Bedroom
ACTIVITY: Was getting into bed and realized I had a slight headache.
THOUGHT: I thought whether I would need to take some pills in the morning.
CUES: None.
PREVIOUS ENCOUNTER: None that I am aware of. I have no idea what this word means. I even don't have the feeling I have ever met this word before.

TIME: 25 August, Friday, 10:20 a.m.
CONTENT: **Sagacious**
PLACE: Office
ACTIVITY: Was reading my paper from computer screen on page 8. I was reading the sentence "The most serious error occurred when the subjects read the word 'prefect' without substituting for 'detective' and continued reading the text being unaware of their failure".
THOUGHT: I could not decide what to do with the ending of this sentence.
CUES: None.
PREVIOUS ENCOUNTER: None that I am aware of. The word was very familiar but I could not remember its meaning so had to check in the dictionary.

TIME: 17 November, Monday, 10:45 p.m.
CONTENT: **Corporal punishment**
PLACE: Kitchen
ACTIVITY: Making a sandwich for tomorrow.
THOUGHTS: Thought about what could be a suitable time to eat this sandwich tomorrow morning, whether I could have it at 11 a.m.
CUES: None.
PREVIOUS ENCOUNTER: I initially thought that it meant "capital punishment" but when I checked in the dictionary it said: "Punishment inflicted on the body, especially beating". I have idea where or when I might have come across these words, may be in relation to two British nun who have been accused of killing an Australian nun but I can not be sure.
PREVIOUS ENCOUNTER (additional entry): Today, on 18 November at 8:15 p.m. I was looking through 80 job applications and in one of them I found this word. It was in the title of one of the applicant's dissertation. I read this application last Wednesday evening on 13 November.

TIME: 31 December, Wednesday, 12:45 p.m.
CONTENT: **Cantankerous**
PLACE: In the bus stop.
ACTIVITY: Looking at my watch to see how much time I had spent waiting for a bus, and being rather annoyed.
THOUGHT: I was thinking that I would have been better off if I walked to the supermarket and took a local S4 bus from there.
CUES: Yes. (see below)
PREVIOUS ENCOUNTER: None that I am aware of. Although the word was familiar and I knew that few months ago I learned its meaning I could not remember it. After I checked in the dictionary and found out that it means "bad tempered" I now think that it was definitely triggered by me being very angry and frustrated at wasting so much time in a bust stop.

A P P E N D I X 1 (continued)

VISUAL IMAGES

TIME: 6 October, Friday, 9:50 a.m.
CONTENT: **A view of a road and a small church in Cardiff**
PLACE: Office
ACTIVITY: I was reading K&G's paper and making some marks on the margin. When I finished writing 'see p.3. This is in contradiction with final section' I had a visual image of this place in Cardiff.
THOUGHTS: Did not have any other than those related to writing a comment (see above).
CUES: None
PREVIOUS ENCOUNTER: An hour ago I was thinking about a forthcoming Christmas trip to Cardiff. In particular, I was wondering how much would it cost if I went there by bus.

TIME: 24 June, Saturday, 1: 25 p.m.
CONTENT: **An entrance of Zoo in Tbilisi**
PLACE: Kitchen
ACTIVITY: I in the middle of preparing chicken salad
THOUGHTS: Was thinking that it would be a very tasty chicken salad when it's ready.
CUES: None
PREVIOUS ENCOUNTER: Few minutes ago I was thinking about how I met last time D.D. in front of the TV building in Tbilisi. This building is in close proximity to the Zoo (some 100 meters down the street).

TIME: 5 October, Sunday, 7:30 p.m.
CONTENT: **A face of an actress playing Harriet in the TV version of "Emma".**
PLACE: Lounge
ACTIVITY: Having a dinner with N.K. and watching "Pretender" on TV at the same time. An actress on TV lifted her eyebrow in a very specific way.
THOUGHTS: I started to think whether this movement meant that she was a good actress when this image popped up.
CUES: Yes. This particular movement on the actress's face may have triggered the image of a face of another actress (playing Harriet) because the latter could have also made similar movement although I can not consciously remember it.
PREVIOUS ENCOUNTER None that I am aware of.

TIME: 6 October, Friday, 9.50 a.m.
CONTENT: **An image of an escalator leading to a British Chemist's Shop in the undergroung complex of Iveria Hotel in Tbilisi**
PLACE: Bedroom
ACTIVITY: Typing in accuracy data to run ANOVA on CRL.
THOUGHTS: My mind was totally occupied with the numbers I was entering in.
CUES: None
PREVIOUS ENCOUNTER: None.

A P P E N D I X 2

Examples of involuntary semantic memories and the cues that were likely to have triggered

them. These cues were related to memories semantically and associatively or through (partial)

phonological similarity.

POSSIBLE CUE	ELICITED MEMORY
(a) PHONOLOGICAL	
1. Trying to move a yoghurt pot with letters <u>SUM</u> on it	Mid<u>SUM</u>mer Night's Dream
2. Hearing someone saying YOU in the room next door	Euthanasia
3. Reading a note saying "please do not smoke on this vehicle"	Versace
4. Thinking about Abstract	Aaron
5. Thinking about London Aquarium	Lambourgene

6. Thinking "this is really terrible"   Tempus
7. Hearing cooing of a pigeon   Wolverhampton
   in the distance which could
   vaguely sound like the elicited
   memory

(b) SEMANTIC
1. Picking up pieces of food   Dilapidated
   from the sink hole
2. Thinking what dishes to cook for   Giabata
   the guests next day
3. Hearing the sound of my boots
   when walking down the corridor   Tap dancing
4. Thinking about "It's 1 p.m. and I   Disciplinary action
   have not done any work yet"
5. Hearing a comment made about   Melanie Griffith
   Julia Robetrs

(c) ASSOCIATION
1. Thinking about how fresh   Nicorette
   the food was in a restaurant I
   was at an hour ago (in this restaurant
   a colleague took out and chewed a
   Nicorette tablet).
2. Saw a picture of a grid (crossed lines)   Collinearity
   on a plastic bag. The picture was
   vaguely similar to the figures or drawings
   one could encounter in statistics handbooks
3. Thinking whether to cook German cookies   Rapuntsel
   for Christmas   (name of a character from a
German

                                                      fairy tale)

A P P E N D I X 3

Examples of involuntary semantic memories and their respective cues that were not

immediately perceived by L.K. Note that while the subliminal cues in the first three

examples are phonologically related to the content of elicited memory the relation

between the cue and the memory in the last example is semantic.

CONTENT: **Acapulco**
PLACE: Kitchen
ACTIVITY: Unpacking a parcel I got from my aunt. I took out spice boxes from a plastic bag. I looked at this bag and while noticing that there was something written on it (but without actually reading) threw it in the trash bin.
THOUGHT: Had some spice related thoughts but can not remember what exactly.
CUES: In order to establish a cue for this memory I searched the kitchen and then took out the bag from the bin to check what was written on it. The word written on the bag was
"AK PECETE".

CONTENT: **Poligram Studios**
PLACE: Bedroom
ACTIVITY: Was getting dressed in order to see I.K. off to train station. I cast a rapid glance at I.K.'s luggage and made a mental note that there were three pieces of luggage.
THOUGHT: I was thinking that I needed to put on my jeans.
CUES: None that I was aware of. However when I started to search the room in hope of finding a cue I suddenly noticed the word "Poly" written on I.K.'s metal suitcase.

CONTENT: **Decapitated**
PLACE: Kitchen
ACTIVITY: Doing washing up. I.K. asked whether to throw away an empty jar of tomato sauce. I said "no", so I.K. put it in front of me and left. I started to read the name of a company that produces the sauce and read "Classico" when this word popped up
THOUGHTS: Did not have any additional thoughts while I was reading "Classico"
CUES: None that I am aware of.
CUES (additional entry): After 15-20 minutes I resumed washing up and while doing so I looked at the jar again. I suddenly discovered that underneath the word "Classico" with much smaller pring was written "Di Capri". It is interesting that the word "Decapitated" popped up while I was reading "Classico" and I was not even aware that there was something written underneath it.

CONTENT: **Itchy and Scrathcy** (the names of characters from The Simpsons cartoon)
PLACE: Bathroom
ACTIVITY: I went into the bathroom and was just standing there, while at the same time
THOUGHT: I was thinking that I had to take out the laundry from the washing machine.
CUES: Only when these names popped up and I started to wonder why did they occur did I realize that while I was standing there I was also automatically scratching my waist at the back.

A P P E N D I X 4

Examples of involuntary semantic memories provided by subjects in response to

Question 4 of the Mind-Popping Questionnaire:

A. Descriptive examples of types of involuntary memories and activities in which one

is involved when these memories pop up.

a. General Examples

1. I could be carrying out an everyday activity - e.g., driving/attending lecture - and visual images appear in my head - possibly of people I know/places I've been (with no relevance to what's going on in reality. I could be doing the housework and certain melodies I hadn't heard for a while pop into my head (no apparent triggers involved).

2. Sometimes, when I am washing up or cleaning my teeth or something I think about a

   person that I have not seen for a while when this person has no connection to what I was thinking about.

3. An old pop song phrase will suddenly appear, or a word, or a name of someone and will linger very annoyingly for an hour or two - but probably only if my mind is not otherwise occupied, i.e., whilst doing housework or driving.

4. Could be doing housework and the theme tune from a TV programme suddenly pops

   into mind.

5. Sitting in lectures/working/typing an essay, suddenly remember a theme tune to programme, tune from song or a quote from book/film.

6. I believe small mind pops happen to me very frequently - may be once an hour or more, _provided_ my mind is _not_ actively engaged in a task (cognitive task).

b. Specific Examples

7. Last Sunday I was doing something but I can't remember what it was and all of nowhere into my head I think "Chicken fajita's" which is odd because I've never eaten them and I'm vegetarian.

8. When running/jogging suddenly thought of the Homer Simpson (from the cartoon).

9. Working on project, name of my dog I lost 3 years ago pops into my head.

10. Lying on my bed, doing my homework - and an old pop song sprang to mind. Watching TV - and name of an old friend springs to my mind.

B. Examples which refer to the absence of cues in involuntary semantic memories

1. I have frequently experienced, when concentrating on something, a word or phrase will come into my head and I'll think "What on earth made me think of that?".

2. Mostly melodies - always leave me wandering where they come from.

3. Songs coming into my head at strange times that don't relate to what I'm thinking about and I haven't heard for a while.

4. Tunes at the most inappropriate times - e.g., lectures and exams.

5. Is this (i.e., mind-popping) so different from free-association? - other than there is no cue or prompt of course. Or at least, there is no obvious cue...!

C. Examples which refer to previous encounters with the contents of involuntary

   semantic memories

1. After a period of revision the next day the names of things pop into my head.

2. The most common thing that 'pops' into my head is a tune or song words, as I listen
   to a lot of music.

3. Previous things said or done during the day popping back into my mind for no apparent reason.

5. Last night - trying to get to sleep I thought 'SAVALOY' because someone had asked
   me about savaloys earlier that day.

6. I suddenly recalled a name - an unusual name - whilst cleaning. For a day or so I
   could not recognize the name, then I recollected it was that of a marine archaeologist
   I'd heard about some 4 or 5 years before. The only possible reason I could think of
   for this memory was a diving magazine I'd been lent a week or so before, though
   there was no mention of this name in it.

A P P E N D I X   5

A. Examples of Involuntary Autobiographical Memories Recorded in Study 4:

"My first day at high school and meeting new people"

"A night out at the font when someone taking photos for the web site asked to take a photo of myself and a few friends. However, the batteries were dead."

"Recall of watching 'The matrix' whilst eating dinner at home"

"Remembered cutting my two fingers when I was small, with the edge of a can when playing with water in the sink"

B. Examples of Involuntary Semantic Memories Recorded in Study 4:

WORDS
Hairband, Kimono, Marbles, Panda Accolade, Rowan Atkinson, Kylie, an Oxford Dictionary, tongue piercing, an Audi TT

IMAGES
Image of butterfly; Image of Latin teacher; Visual image of my old bedroom last year; Image of old college friend; Visual image of the Millennium Bridge in London

MELODIES
Spontaneously whistling the American National Anthem
"You Know You're Right"- A song by Nirvana

The Neighbours theme tune