From mind-pops to hallucinations?

A study of involuntary semantic memories in schizophrenia

Ia Elua[1], Keith R. Laws, and Lia Kvavilashvili*

University of Hertfordshire, College Lane, Hatfield, Herts, AL10 9AB, UK

Corresponding author:

Lia Kvavilashvili

School of Psychology

University of Hertfordshire

College Lane

Hatfield, Herts, AL10 9AB

United Kingdom

Tel. +44 (0) 1707 285121

Fax +44 (0) 1707 285073

Email: L.Kvavilashvili@herts.ac.uk

[1] Ia Elua is presently at the Jewish Board of Family and Children's Services (JBFCS), Outpatient Mental Health Clinic, 2020 Coney Island Avenue, Brooklyn, New York 11223.

Abstract

Involuntary semantic memories or mind-pops consist of isolated fragments of one's semantic knowledge (e.g., a word or a sentence, proper name, image or a melody) that come to mind unexpectedly, without any deliberate attempt to recall them. They can be experienced as alien and uncontrollable, and may share some phenomenological similarities with hallucinations. The aim of the present study was to investigate the nature and frequency of mind-pops in people with schizophrenia (*N*=37), as well as clinically depressed (*N*=31) and non-clinical controls (*N*=31). Results showed that schizophrenia patients reported experiencing mind-pops more frequently than both depressed and non-clinical controls. Schizophrenia patients also reported a wider range of different types of mind-pops than non-clinical controls. The depressed group did not differ from non-clinical controls in the frequency and range of mind-pops, indicating that mind-pops are not characteristic of clinical populations in general, but may be particularly prevalent in patients with schizophrenia. The possible implications of this finding to current models of auditory verbal hallucinations are discussed and the need for future research in this area is emphasized.

Key words: involuntary memory, semantic memory, cognitive intrusions, depression.

1. Introduction

‘‘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, not even addressed to me, and so trivial that I hardly dare give samples...’’ (p. 33, Nabokov, 1966)

In this passage, Nabokov appears to be referring to a phenomenon which several decades later was defined by Kvavilashvili (1997) as involuntary semantic memories or mind-pops. They come to mind unexpectedly, without any deliberate attempt to recall them, and consist of isolated fragments of one’s semantic knowledge, rather than meaningful episodes from one’s personal past (Kvavilashvili and Mandler, 2004). Although sometimes people do experience these mind-pops during altered states of consciousness (i.e., when falling asleep or waking up), majority occur during waking hours. A typical example would involve a person carrying out an everyday activity (e.g., brushing teeth) and thinking about some unrelated matters (e.g., what to buy for a dinner party), when suddenly a word or a saying (‘jingle bell’, ‘all is well that ends well’), someone’s name (Niccollo Machiavelli), an image (of Twin Towers), or a familiar tune (American National Anthem) pops into mind and amazes the person with its irrelevance to a current situation (*cf.* Mandler, 1986). Although mind-pops are predominantly one-off occurrences, occasionally, they may come to mind repeatedly (especially the musical mind-pops) and be difficult to get rid of. Recurring melodies and songs have been recently studied under a variety of names such as “earworms”, “stuck song syndrome”

(Beaman and Williams, 2010; Williamson et al., in press), or involuntary musical imagery (Liikkanen, in press).

In terms of their content, these verbal, visual and musical mind-pops are different from several other involuntary phenomena described in the literature. For example, ordinary involuntary autobiographical memories, as well as repetitive intrusive memories of negative events, both involve sudden remembering of particular episodes from one's past, such as remembering a trip to Georgia when seeing a holiday advert or remembering being mugged when hearing steps behind in the dark, respectively (Berntsen, 1996; 2009; Brewin et al., 2010; Schlagman and Kvavilashvili, 2008). In contrast, mind-pops refer to fragments of semantic or autobiographical knowledge without accompanying contextual details characteristic of episodic memories (i.e., the *what*, *where*, and *when* aspects of the remembered event). Mind-pops are also different from intrusive thoughts, reported in clinical and non-clinical populations, which consist of sudden and often repetitive thoughts or images about violent or otherwise unpleasant acts, for example, thoughts about hitting someone, having sex in a public place or being poisoned (Clark and Purdon, 1995). Moreover, while intrusive thoughts are highly repetitive, most mind-pops are one-off occurrences. It is therefore reasonable to assume that mind-pops may constitute a distinct class of decontextualized involuntary cognitions that merit closer examination.

Initial research conducted on mind-popping by Kvavilashvili and Mandler (2004), using single case, diary and questionnaire methods, has resulted in several interesting findings. For example, mind-pops are predominantly experienced in the form of words/phrases, and less frequently as visual images and music. This was shown in a diary

study with 50 undergraduates, where the percentages of recorded verbal, visual and musical mind-pops were 61%, 12% and 27%, respectively (Kvavilashvili and Mandler, 2004, Study 4). Furthermore, mind-pops have consistently been reported to occur when people were alone and engaged in habitual everyday activities, requiring few attentional resources (e.g., resting, having breakfast, or washing up). Most importantly, finding cues in one's environment or thoughts that trigger the mind-pops is extremely difficult. Even when adopting fairly lenient criteria for what constituted a trigger, cues were only detected in approximately 20 to 37% of cases, in contrast to involuntary autobiographical memories, where cues were identified in 80% of cases (Study 4). Finally, in almost 50% of reported mind-pops participants were able to ascertain that the actual or related contents of the mind-pop had recently been encountered in one's environment or internal thoughts. This indicates that the occurrence of a particular mind-pop is not an entirely random event and could be due to a long-term priming mechanism where a single encounter with a particular stimulus or internal thought can cause persistent activation and spreading in semantic network which may then result in sudden conscious experience of this content in a seemingly unrelated context (Kvavilashvili and Mandler, 2004).

One important question that has not been addressed in this new area of research refers to the frequency and prevalence of mind-pops in clinical samples. Mental disorders (e.g., depression, PTSD, OCD) are often characterized by various forms of cognitive intrusions, such as intrusive memories and images of traumatic events, repetitive negative thoughts and compulsions (Brewin et al., 2010). Due to this increased tendency for cognitive intrusions, it is possible that patients also experience mind-pops more frequently than non-clinical populations. In this respect research on patients with

schizophrenia may be particularly relevant, given that their cognitive intrusions in the form of auditory and visual hallucinations appear to have several interesting similarities with mind-pops, both in terms of their automatic nature and their contents. Indeed, non-clinical participants have been reporting having no control over their mind-pops, which appear to come and go as they wish. Due to their unexpected nature, mind-pops can sometimes disrupt the activity that the person is engaged in, and be even perceived as "alien", especially when they are experienced without any obvious triggers, or when they occur in the form of recurring words or melodies (Stern, 1938). All these features are also characteristic of auditory and visual hallucinations (Morrison, 2001; Nayani and David, 1996a). David (2004), for example, has even suggested modifying the DSM-IV (American Psychiatric Association, 1994) definition of hallucinations to include the aspect of uncontrollability.

Another interesting similarity between the two phenomena is that although both mind-pops and hallucinations can occasionally take place during altered states of consciousness, such as moments of falling asleep or waking up (i.e., hypnagogic and hypnopompic hallucinations), both tend to primarily occur during waking hours, when one is alone and/or engaged in undemanding everyday/leisure activities. In addition, finding immediate triggers for both, mind-pops and hallucinations, is often very difficult (Delespaul et al., 2002; Kvavilashvili and Mandler, 2004). Finally, similarities are also present in the varied contents of mind-pops and hallucinations. Thus, hallucinations in schizophrenia occur predominantly in verbal format (i.e., hearing single words, phrases/sentences and conversations), but patients can also experience visual and musical hallucinations (Baba and Hamada, 1999; Nayani and David, 1996b; Saba and Keshavan,

1997; Stephane et al., 2003; Waters et al., 2006). In line with this, mind-pops occur most frequently in the form of single words, names and phrases, but non-clinical participants also report experiencing visual and musical mind-pops (albeit to a lesser degree) (Kvavilashvili and Mandler, 2004, Study 4).

The analysis of these similarities led Elua (2007) to suggest a possibility that mind-pops could be the raw cognitive material from which hallucinations are constructed in schizophrenia. As an initial step in assessing this novel idea it is necessary to examine the nature and frequency of mind-pops in schizophrenia. Therefore, the aim of the present study was to examine whether patients with schizophrenia are experiencing mind-pops more frequently than other clinical populations (e.g., patients with depression) and non-clinical controls. To this aim, we administered a brief Mind-Popping Questionnaire (MPQ; Kvavilashvili and Mandler, 2004), assessing the frequency and different types of experienced mind-pops, to patients with schizophrenia, major depressive disorder (MDD), and non-clinical controls. It was hypothesized that if mind-pops and hallucinations were related phenomena, then the schizophrenia group would report a higher frequency and a larger variety of mind-pops than both depressed and control groups. If however, increased mind-popping was a general characteristic of clinical conditions, then there would be no reliable differences between schizophrenic and depressed participants, and both would score higher than controls. Additionally, mind-popping frequency was examined as a function of presence/absence of hallucinations in schizophrenia patients at the time of participation in the study.

2. Material and Methods

2.1. Participants

The initial sample consisted of 103 participants (29 males and 70 females), where 31 were non-clinical controls, 32 – depressed clinical controls, and 40 – schizophrenia patients. Clinical participants were recruited from a Day Treatment Program for chronically mentally ill individuals and an Out-Patient Mental Health Clinic. Non-clinical controls were the support staff and the psychotherapists employed by the same Clinics, who were not familiar with the research in this area, and were blind to the aims and hypothesis of the study.

To ensure that only high functioning clinical patients were included in the study, the entire sample was administered the Mini Mental State Examination (MMSE: Folstein et al., 1975), and instead of a standard cut off point of 24, we used a stricter cut off point of 26 (the lowest score for the non-clinical control group). This resulted in the exclusion of 1 depressed and 3 schizophrenia patients, and the final samples consisted of 37 schizophrenia patients (19 males, 18 females), 31 depressed controls (9 males, 22 females), and 31 non-clinical controls (1 male, 30 females).

The procedure for diagnosing the patients was identical in both Clinics. In particular, at the moment of admission each patient underwent the initial intake assessment conducted by the licensed psychotherapist. The diagnosis was then discussed with a team of clinicians in a disposition conference. The next step involved psychiatric evaluation (including the independent assignment of the diagnosis) conducted by the staff psychiatrist (medical doctor). In addition, diagnosis was reviewed and re-evaluated every three months by treating psychotherapists and psychiatrists, and all patients received annual psychiatric re-evaluations with the purpose of reviewing the assigned diagnosis and recommended treatment plan. Patients were categorized according to DSM-IV

(American Psychiatric Association, 1994) criteria. Out of 37 schizophrenia patients, 23 were diagnosed with Schizophrenia, Paranoid Type, 11 with Schizophrenia Undifferentiated Type, and 3 with Residual Type. All 31 depressed patients had a diagnosis of MDD without psychotic features.

In addition to receiving the already confirmed diagnoses for all of the participants, the first author who is a licensed clinician, conducted independent clinical interviews with each participant, prior to including them in the study. The purpose of these interviews was to confirm the presence of the diagnosis at the moment of participation, as well as to specifically identify the presence/absence of hallucinations in the schizophrenia group. Thus, out of 37 schizophrenia patients, 15 were not experiencing hallucinations or delusions at the time of testing (although all had previously experienced auditory hallucinations). The remaining 22 participants reported experiencing hallucinations at the time of testing (auditory hallucinations in 19 cases and visual hallucinations in 3 cases). All schizophrenia patients were receiving anti-psychotic medications, and all depressed patients (with the exception of two) were on antidepressants.

2.2. Background variables as a function of group

Table 1 presents the mean age, MMSE scores (Folstein et al., 1975), and years of education as a function of group. No reliable differences emerged between the groups in their mean MMSE scores (all p_s>0.10). In terms of age, depressed patients were older than the schizophrenia and control participants (p=0.001 and p=0.018, respectively), who did not differ from each other (p=0.44). On the other hand, control participants had spent significantly more years in education than either schizophrenia or depressed patients (both p_s<0.0001), whose means did not differ from each other (p=0.49).

2.3. Materials and procedure

All participants completed the Mind Popping Questionnaire (MPQ; Kvavilashvili and Mandler, 2004) in an individual session with the researcher (I. E.), who explained the nature of involuntary semantic memories and encouraged participants to ask clarifying questions while they were working on the questionnaire. The MPQ consists of four questions designed to measure the frequency, as well as the type of the content (e.g., whether they are words, phrases, images, sounds, etc.) of involuntary mind-pops. It starts with a short description of the mind-popping phenomenon and explains how it differs from involuntary autobiographical memories. After the description, the first question asks participants to state (Yes/No) whether they have ever experienced the phenomenon themselves. Those participants who respond by 'No' discontinue the questionnaire, and those who answer 'Yes' proceed with the remaining questions. In Question 2 participants rate the frequency of experiencing mind-pops in their everyday lives on an 8-point scale with the following scale points: 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 presented with a list of possible mind-pops (see Table 3 for descriptions of different types of mind-pops), and are asked to indicate those types of mind-pops that they have experienced at least once in their lifetime. The final Question 4 is optional and asks participants to provide examples of mind-pops from their everyday lives.

3. Results

Unless otherwise specified, the alpha level was set at .05 and the effect size was measured by partial eta squared (η_p^2), with small, medium, and large effects defined as 0.01, 0.06, and 0.16, respectively (Cohen, 1977).

3.1. *Familiarity with the phenomenon of mind-popping (Question 1)*

All 37 individuals with schizophrenia reported having experienced mind-popping by answering "yes" to Question 1. By contrast, 6 out of 31 depressed participants (19%) and 5 out of 31 non-clinical control participants (16%) reported to have never experienced mind-pops in their entire lives. These differences between schizophrenia patients and depressed and non-clinical controls were statistically significant, $\chi^2(2, N=99) = 7.55$, $p=0.02$.

3.2. *Frequency of reported mind-pops* (Question 2)

Next, we examined the self-reported frequency of mind-pops on an 8-point scale with options ranging from 1=only a few times in my entire life to 8=three or more times a day. The responses of those 6 depressed and 5 non-clinical control participants who did not experience mind-pops were classed as "0" (i.e., "never"). The one-way ANOVA on mean frequency ratings (Table 2, upper panel) resulted in a significant main effect of group with a large effect size, $F(2,96)=15.28$, $MSE=5.39$, $p<0.0001$, $\eta_p^2=0.24$. Planned comparisons showed that, in line with predictions, schizophrenia patients reported experiencing mind-pops more frequently ($M=6.05$) than both depressed ($M=3.74$) and non-clinical control groups ($M=3.13$) (both $p_s<0.0001$), who did not differ from each other ($p=0.30$). These results did not change when the age and years of education were entered as covariates in the above one-way ANOVA. Importantly, we also repeated the above analyses by excluding those 6 depressed and 5 non-clinical control participants

who denied ever experiencing mind-pops. Although this increased the mean frequency ratings in these groups to 4.64 (*SD*=2.33) and 3.73 (*SD*=1.73), respectively, the results remained the same with schizophrenia participants still scoring significantly higher than the non-clinical controls ($p<.00001$) and the clinically depressed participants ($p=.009$).

Finally, to examine whether increased mind-popping experience was related to having hallucinations at the time of testing, the schizophrenia group was divided into those who reported having hallucinations (*N*=22) and those who had history of hallucinations (*N*=15), but were not reported to have hallucinations at the time of testing. Although the mean frequency rating was nominally higher in the former group (*M*=6.23, *SD*=1.80) than in the latter (*M*=5.80, *SD*=2.40), this difference was not statistically significant ($F<1$).

3.3. Different types of mind-pops reported (Question 3)

Table 3 shows the proportion of participants who reported experiencing each of the different types of mind-pops listed in Question 3. A series of Chi-squared tests did not result in statistically reliable differences between the three groups in terms of whether they reported experiencing (Yes/No) a particular type of mind-pop (the largest $\chi^2=4.68$, $p=0.096$, for a melody). However, when we conducted a one-way ANOVA to examine the number of different types of mind-pops that participants experienced at least once in their lifetime (see Table 2), a significant effect of group emerged $F(2,85)=3.19$, $MSE=4.46$, $p=0.046$, $\eta_p^2=0.07$. Planned comparisons showed that schizophrenia patients experienced significantly larger range of different types of mind-pops than non-clinical controls ($p=0.01$), but did not differ from depressed participants ($p=0.42$), and the latter two groups did not differ from each other ($p=0.13$).

3.4. *Examples of mind-pops (Question 4)*

Although answer to this question was optional, 62% of schizophrenia patients, 48% of depressed patients and 27% of controls provided examples of mind-pops experienced in their everyday lives. This difference between the groups was significant, $\chi^2(2, N=88) = 7.60$, $p=0.02$, and follow up comparisons showed that schizophrenia group was more likely to give an example than the non-clinical control group ($\chi^2(1, N=68) = 7.60$, $p=0.006$), but did not differ from the depressed group ($p=0.28$) who, in turn, did not differ from the non-clinical controls ($p=0.13$). Some of the examples provided by participants are shown in Appendix 1. In all three groups participants described similar contents (e.g., words, phrases, images, and melodies) and conditions in which they experienced mind-pops (i.e., during habitual mundane activities and in the absence of immediate triggers in the environment or one's own thoughts).

4. Discussion

The aim of the present study was to assess the novel hypothesis that schizophrenia patients would report experiencing involuntary semantic memories or mind-pops more frequently than clinical (depressed) and non-clinical controls. This prediction was based on the analysis of certain similarities between various forms of mind-pops and auditory, visual and musical hallucinations, which led Elua (2007) to propose a possible link between mind-pops in general population and hallucinatory experiences in schizophrenia. Increased frequency of involuntary semantic memories in schizophrenia can also be predicted from research showing increased or disorganized activation of semantic network in patients with schizophrenia and formal thought disorder, especially when using an indirect priming paradigm (see Pomarol-Clotet et al., 2008). Therefore, if events encountered in everyday life elicit stronger activation and/or wider spread of activation of

related concepts in the semantic network of schizophrenia patients (*cf.* Beck and Rector, 2003), it is likely that these patients will experience involuntary semantic memories more frequently than non-clinical controls or clinically depressed participants.

Results of the present study fully supported the main hypothesis. First, reliable group differences were established in terms of whether participants reported being familiar with the phenomenon of mind-popping. Consistent with the results of studies on student and non-student samples (Kvavilashvili and Mandler, 2004; Kvavilashvili et al., 2009), 19% of depressed (*N*=6) and 16% of non-clinical control participants (*N*=5) reported to have never experienced the phenomenon of mind-popping. By contrast, all schizophrenia patients reported having mind-pops. Second, and most important, schizophrenia patients reported experiencing mind-pops more frequently than clinically depressed and non-clinical control groups, and having a wider range of different types of mind-pops than non-clinical controls. No significant differences emerged between the non-clinical controls and depressed participants in terms of the above variables, suggesting that increased mind-popping is not characteristic of clinical populations *per se*, but is certainly more of a common phenomenon reported by people with schizophrenia.

Nonetheless, the proportions of participants who reported experiencing any of the nine possible types of mind pops did not result in significant group differences (see Table 3). Thus, 57 to 60% of schizophrenia patients reported experiencing verbal mind-pops like words, phrases in native language and proper names, with even larger percentages reporting visual images (65%) and melodies (81%), which are comparable to proportions reported by depressed and non-clinical controls. Overall, the absence of group effects

may indicate that the phenomenology of mind-pops in schizophrenia patients is similar to that in non-clinical participants, and that the main difference between the groups is in the increased frequency of the mind-pops experienced by these patients. It is also intriguing that the increased frequency of mind-pops occurred both in patients who were experiencing hallucinations at the moment of the testing and in patients who had previously experienced hallucinations although not at the time of participation. Although this finding should be treated with caution (as we classified patients according to clinical interviews rather than any specific measures of hallucinations), it suggests that mind-popping may not be linked to experiencing hallucinations at the time of investigation, and as such could be a trait rather than a state phenomenon in people with schizophrenia. In this respect, it would be interesting to compare hallucinating schizophrenia patients with those who have no previous history of hallucinations, to assess the link between mind-popping and hallucinations more directly.

One question that arises from this study concerns whether schizophrenia patients simply overestimated the frequency of mind-pops because they could not adequately distinguish them from hallucinations. If they were unclear about the difference between the two phenomena, then the hallucinating patients would have provided the higher frequency ratings than the non-hallucinating ones, but this was not the case. Additionally, the majority of examples provided by schizophrenia patients demonstrate that they understood the difference and did not confuse the two. Nevertheless, one possibility in future research might be to study mind-pops in people with schizophrenia using a diary method which may permit more naturalistic on line assessment of mind-popping in schizophrenia.

Despite these potential limitations, we propose that our results have potentially interesting implications for cognitive models of auditory verbal hallucinations. Although there is some consensus amongst researchers that hallucinations are internal mental events that are misattributed to external sources, disagreement about the nature of these mental processes still exists (Jones, 2010). Various theorists have characterized them as inner speech (Allen, et al., 2007; Bentall, et al., 1991; Frith, 1996; Frith & Dolan, 1997), intrusive thoughts (Morrison, 2001), or episodic memories that lack contextual information (Hemsley, 2005; Waters et al., 2006). However, research comparing inner speech and hallucinations shows that there may not be considerable overlap in their phenomenological properties (e.g., Hoffman et al. 2008; Langdon et al., 2009), whereas research on intrusive thoughts in schizophrenia has been somewhat vague about the precise contents of such thoughts (e.g., Jones and Ferneyhough, 2009; Moritz and Larøi, 2008; McCarthy-Jones et al., 2011; but see Morrisson and Baker, 2000).

In contrast, a memory based model of Waters et al. (2006) suggests that auditory hallucinations may consist of fragments of episodic memories which lack accompanying contextual information. For example, the patient may have an auditory hallucination of hearing a comment made by a person who abused them in childhood without remembering at the time any other details of the context in which this comment was made. Although approximately 10% to 20% of hallucinations may link to memories of such traumatic experiences (see Jones, 2010), the contents of other hallucinations may involve more mundane fragments such as someone's name mentioned on TV, a phrase overheard in a café, environmental noises (e.g., laughter), and music (Beck and Rector, 2003). However, such fragments without contextual details can be described more

accurately as semantic, rather than episodic/autobiographical memories, and they seem to be similar to the contents of involuntary semantic memories or mind-pops examined in the present study.

One problem faced by inner speech models (as well as those based on intrusive thoughts) is that they cannot fully explain the varied phenomenology of hallucinations occurring in the form of verbal material (e.g., words, sentences, verbal orders or comments), environmental sounds (laughing, knocking), music, or images in case of visual hallucinations (Badcock, 2010; Jones, 2010). Consequently, it has been proposed that different mechanisms may underlie these various forms of hallucinations. For example, Jones (2010) has suggested that while more complex auditory verbal hallucinations (in the form of running commentary or conversations) can be explained by cognitive mechanisms (e.g., inner speech), the seemingly random contents in the form of environmental sounds and music or images can be "more parsimoniously accounted for by a bottom-up ictal-based neurological model" (p.586). However, given that these different forms of hallucinations can co-occur in the same person, it is possible that there is one common cognitive mechanism that cuts across these different domains (*cf.* Moritz and Larøi, 2008).

The results of the present study suggest that involuntary semantic memories and their underlying cognitive processes can be one such common mechanism behind the various manifestations of hallucinations in schizophrenia. This novel idea opens up several interesting avenues for future research. For example, it is unclear whether the content of mind-pops is more negative and distressing in patients with schizophrenia than in clinical and non-clinical controls, and whether schizophrenia patients are more likely

to actively suppress and/or control the occurrence of their mind-pops (*cf*. Jones & Fernyhough, 2006). If that is the case, then these processes can be responsible for transforming ordinary mind-pops into hallucinations (see Morrison, 2001). Alternatively, it is possible that the mind-pops in schizophrenia are not more negative than in non-clinical population, but that the patients interpret them differently, i.e., as more alien and threatening (e.g., they may assume something strange is happening to them, and/or that they are "going mad", etc.) (Beck and Rector, 2003; Morrison, 1998; 2001; Morrison et al., 1995). Another interesting question is to examine whether hallucinations are brought about by the same long-term priming mechanism that seems to underlie the occurrence of mind-pops in everyday life (Kvavilashvili and Mandler, 2004). If this is the case, then the contents of hallucinations may be primed by having encountered them in identical or similar form in one's environment or thoughts in recent past (see Beck and Rector, 2003 for examples of such priming of hallucinations in their patients with schizophrenia).

In conclusion, this is a first attempt to demonstrate the increased frequency of involuntary semantic memories in patients with schizophrenia, suggesting a possible intriguing link between mind-pops and hallucinations. It is therefore possible that ordinary mind-pops, experienced as benign phenomena by non-clinical individuals, will take the exaggerated and abnormal form of auditory (and other types of) hallucinations in patients with schizophrenia. Future research should investigate in more detail the stages and various cognitive and non-cognitive processes that may enable this transformation.

References

Allen, P., Aleman, A., McGuire, P. K, 2007. Inner speech models of auditory verbal hallucinations: Evidence from behavioural and neuroimaging studies. International Review of Psychiatry 19, 409-417.

American Psychiatric Association, 1994. Diagnostic and statistical manual of mental disorders, fourth edition (DSM-IV). American Psychiatric Association, Washington, DC.

Baba, A., Hamada, H., 1999. Musical hallucinations in schizophrenia. Psychopathology 32, 242-251.

Badcock, J. C., 2010. The cognitive neuropsychology of auditory hallucinations: A parallel auditory pathways framework. Schizophrenia Bulletin 36, 576-584.

Beaman, C. P., Williams, T. I., 2010. Earworms ('stuck song syndrome'): Towards a natural history of intrusive thoughts. British Journal of Psychology 101, 637-653.

Beck, A. T, Rector, N. A, 2003. A cognitive model of hallucinations. Cognitive Therapy and Research 27, 19-52.

Bentall, R. P., Kaney, S., Dewey, M. E., 1991. Paranoia and social reasoning: An attribution theory analysis. British Journal of Clinical Psychology 30, 13-23.

Berntsen, D., 1996. Involuntary autobiographical memories. Applied Cognitive Psychology 10, 455-460.

Berntsen, D., 2009. Involuntary autobiographical memories: An introduction to the unbidden past. Cambridge University Press, Cambridge.

Brewin, C. R., Gregory, J. D., Lipton, M., Burgess, N., 2010. Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. Psychological Review 117, 210-232.

Clark, D. A., Purdon, C. L., 1995. The assessment of unwanted intrusive thoughts: A review and critique of the literature. Behaviour Research and Therapy 33, 967-976.

Cohen, J., 1977. Statistical power analysis for the behavioral sciences. Academic Press, New York:

David, A. S., 2004. The cognitive neuropsychiatry of auditory verbal hallucinations: An overview. Cognitive Neuropsychiatry 9, 107-123.

Delespaul, P., de Vries, M., van Os, J., 2002. Determinants of occurrence and recovery from hallucinations in daily life. Social Psychiatry and Psychiatric Epidemiology 37, 97-104.

Elua, I., 2007. Involuntary semantic memories and thought suppression in patients with schizophrenia. Unpublished Doctoral Thesis, University of Hertfordshire.

Folstein, M. F., Folstein, S. E., McHugh, P. R., 1975. "Mini-Mental State": a practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research 12, 189-198.

Frith, C., 1996. The role of prefrontal cortex in self-consciousness. The case of auditory hallucinations. Philosophical Transactions of the Royal Society of London. Series B, 351, 1505-1512.

Frith, C., Dolan, R. J., 1997. Brain mechanisms associated with top-down processes in perception. Philosophical Transactions of the Royal Society of London. Series B, 352, 1221-1230.

Hemsley, D., 2005. The schizophrenic experience: Taken out of context? Schizophrenia Bulletin 31, 43-53.

Hoffman, R. E., Varanko, M., Gilmore, J., Mishara, A. L., 2008. Experiential features used by patients with schizophrenia to differentiate 'voices' from ordinary verbal thought. Psychological Medicine 38, 1167-1176.

Jones, S. R., 2010. Do we need multiple models of auditory verbal hallucinations? Examining the phenomenological fit of cognitive and neurological models. Schizophrenia Bulletin 36, 566-575.

Jones, S. R., Fernyhough, C., 2006. The roles of thought suppression and metacognitive beliefs in proneness to auditory verbal hallucinations in a non-clinical sample. Personality and Individual Differences 41, 1421-1432.

Jones, S. R., Fernyhough, C., 2009. Rumination, reflection, intrusive thoughts, and hallucination-proneness: Towards a new model. Behaviour Research and Therapy 47, 54-59.

Kvavilashvili, L., 1997, September. A diary study of involuntary semantic memories: A delineation of the phenomenon. Paper presented at British Psychological Society Cognitive Section Annual Conference, University of Bristol, Bristol, UK.

Kvavilashvili, L., Mandler, G., 2004. Out of one's mind: A study of involuntary semantic memories. Cognitive Psychology 48, 47-94.

Kvavilashvili, L., Schlagman, S., Erskine, J. A. K., Kliegel, M., 2009, September. Do things pop into mind when you are old? Effects of age on involuntary cognitions. Paper presented at the British Psychological Society Cognitive Section Conference, University of Hertfordshire, Hatfield, UK.

Langdon, R., Jones, S. R., Connaughton, E., Ferneyhough, C., 2009. The phenomenology of inner speech: comparison of schizophrenia patients with auditory verbal hallucinations and healthy controls. Psychological Medicine 39, 655-663.

Liikkanen, L. A., in press. Musical activities predispose to involuntary musical imagery. Psychology of Music.

Mandler, G., 1986. Reminding, recalling, recognizing: Different memories? In: Klix, F., Hagendorf, F. (Eds.), Human Memory and Cognitive Capabilities. Elsevier Science Publishers, Amsterdam, pp. 289-297.

McCarthy-Jones, S., Barnes, L. J., Hill, G. E., Marwood, L., Moseley, P., Fernyhough, C., 2011. When words and pictures come alive: Relating the modality of intrusive thoughts to modalities of hypnagogic/hypnopompic hallucinations. Personality and Individual Differences 51, 787-790.

Moritz, S., Larøi, F., 2008. Differences and similarities in the sensory and cognitive signatures of voice-hearing, intrusions and thoughts. Schizophrenia Research 102, 96-17.

Morrison, A. P., 1998. A cognitive analysis of the maintenance of auditory hallucinations: Are voices to schizophrenia what bodily sensations are to panic? Behavioural and Cognitive Psychotherapy 26, 289-302.

Morrison, P., 2001. The interpretation of intrusions in psychosis: An integrative cognitive approach to hallucinations and delusions. Behavioural and Cognitive Psychotherapy 29, 257-276.

Morrison, A. P., Baker, C. A., 2000. Intrusive thoughts and auditory hallucinations: a comparative study of intrusions in psychosis. Behaviour Research and Therapy 38, 1097-1106.

Morrison, A. P., Haddock, G., Tarrier, N., 1995. Intrusive thoughts and auditory hallucinations: A comparative study of intrusions in psychosis. Behavioral and Cognitive Psychotherapy 23, 265-280.

Nabokov, V., 1966. Speak, memory: An autobiography revisited. Weidenfeld and Nicolson, London:

Nayani, T. H., David, A. S., 1996a. The neuropsychology and neurophenomenology of auditory hallucinations. In: Pantelis, C., Nelson, H. E., Barnes, T. R. E. (Eds.), Schizophrenia: A Neuropsychological Perspective. Wiley, New York, pp. 345-372.

Nayani, T. H., David, A. S., 1996b. The auditory hallucination: A phenomenological survey. Psychological Medicine 26, 177-189.

Pomarol-Clotet, E., Oh, T. M. S. S., Laws, K. R., McKenna, P. J., 2008. Semantic priming in schizophrenia: systematic review and meta-analysis. The British Journal of Psychiatry 192, 92-97.

Saba, P. R., Keshavan, M. S., 1997. Musical hallucinations and musical imagery: Prevalence and phenomenology in schizophrenic inpatients. Psychopathology 30, 185-190.

Schlagman, S., Kvavilashvili, L., 2008. Involuntary autobiographical memories in and outside the laboratory: How different are they from voluntary autobiographical memories? Memory and Cognition 36, 920-932.

Stephane, M., Thuras, P., Nasrallah, H., Georgopoulos, P., 2003. The internal structure of the phenomenology of auditory verbal hallucinations. Schizophrenia Research 61, 185-193.

Stern, W., 1938. General psychology. The Macmillan Company, New York:

Waters, F. A. V., Badcock, J. C., Michie, P. T., Maybery, M. T., 2006. Auditory hallucinations in schizophrenia: Intrusive thoughts and forgotten memories. Cognitive Neuropsychiatry 11, 65-83.

Williamson, V.J., Jilka, S. R., Fry, J., Finkel, S., Müllensiefen, D., Stuart, L., in press. How do "earworms" start? Classifying the everyday circumstances of involuntary musical imagery. Psychology of Music.

Table 1

Mean Age, MMSE Scores, and Mean Number of Years in Education as a Function of Group (Schizophrenia vs. Depressed vs. Non-Clinical Control).

	Schizophrenia (N=37)	Depressed (N=31)	Non-Clinical Controls (N=31)		
Variables				F(2, 96)	p-value
Age					
Mean	43.41[a]	51.90[b]	45.42 [a]	5.75	0.004
SD	(10.36)	(11.39)	(10.02)		
Range	21-62	24-63	24-61		
MMSE					
Mean	28.32	28.84	28.77	1.70	0.19
SD	(1.45)	(1.16)	(1.12)		
Range	26-30	26-30	26-30		
Education					
Mean	13.46[a]	13.97[a]	17.55[b]	17.59	0.000
SD	(2.89)	(2.18)	(3.79)		
Range	8-22	10-19	8-27		

Note. Different subscripts indicate reliable differences between the two pairs of means

Table 2

Mean Frequency of Mind-Pops and Mean Number of Different Types of Mind-Pops Reported as a Function of Group (Schizophrenia vs. Depressed vs. Non-Clinical Controls).

	Participant Group		
	Schizophrenia	Depressed	Controls
Frequency of mind-pops [a]			
Mean	6.05	3.74	3.13
SD	(2.04)	(2.99)	(2.11)
Range	1-8	1-8	1-8
Number of participants	N=37	N=31	N=31
Number of different types of mind-pops [b]			
Mean	4.24	3.80	2.88
SD	(2.20)	(2.27)	(1.80)
Range	1-8	1-9	1-7
Number of participants	N=37	N=25	N=26

[a] Frequency was assessed on an 8-point scale (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; 8=three or more times a day).

[b] This number could range from 1 to 9 (see Table 3 for types of mind-pops endorsed)

Table 3

Proportion of Participants in Each Group (Schizophrenia, Depressed, Non-Clinical Control) who Reported Experiencing Each Type of Mind-Pop Listed Below at Least Once in Their Lifetime.

Type of reported mind-pop	Schizophrenia (N=37)	Depressed (N=25)	Control (N=26)
1. A word in your native language	0.57	0.36	0.35
2. A phrase or a sentence in your native language	0.60	0.44	0.39
3. A proper name	0.54	0.52	0.31
4. A word in a foreign language – and you know its meaning	0.32	0.32	0.19
5. A word in a foreign language – and you do not know or have forgotten its meaning	0.27	0.16	0.08
6. A visual image	0.65	0.84	0.65
7. A sound	0.43	0.48	0.23
8. A melody	0.81	0.56	0.65
9. Other (please, specify)	0.05	0.12	0.04

Appendix

Examples of Mind-Pops Reported by Participants in Optional Question 4 of the MPQ

Type of the Mind-Pop	Content of the Mind-Pop
Words and phrases	*"While shaving, sometimes I have experienced a word or a phrase which has nothing to do with this activity."* *"… I was on the couch and a strange word kept coming to mind – in exploring I realized it was the name of a character in a movie I'd seen many years ago."* *"Sometimes I recall (involuntarily) words or phrases of some meaningful to me conversations (or evaluated by me as meaningful at a later time)."*
Visual images	*"Visual images that seem to appear spontaneously, especially at bedtime, they are like moving photos."* *"As I am traveling I have a visual image of my mother unrelated to my thought processes."* *"While doing dishes, something pops into my head and its what I am wearing tomorrow."*
Melodies	*"A line from a song, or a piece of music (musical phrase) that comes into my mind suddenly without any conscious precipitant; sometimes will re-occur several times over 1-2 day period."* *"Distracting music, specific songs unrelated to what I am doing at the time."* *"A melody, or commercial jingle, will continue to 'stay with me' or 'go through my head', after having heard it".*