

The effect of external stimuli on dreams, as assessed using Q-Methodology

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Summary. Dreams can sometimes incorporate external sensory stimuli (e.g. sounds, smells and physical sensations) into their course and content, either directly or indirectly. This shows that the brain is still able to monitor, process, and perceive what is happening in the surrounding environment during sleep. This study, considered a pilot study due to only a small number of participants, aimed to examine stimulus incorporation in dreams using two auditory stimuli of different languages – one semantically meaningful to participants and one non-meaningful. We hypothesised that participants exposed to the semantically meaningful language would all report similar experiences to each other, and different from those exposed to the non-meaningful language. All participants first spent several weeks improving their dream recall abilities, and then came to the Sleep and Cognition Laboratory at the University of Lincoln for a two hour morning nap, during which a stimulus was played to them in Rapid-Eye-Movement (REM) sleep. They were awoken shortly after to provide a dream report. All dreams contained conversation or speech of some description, but due to participants' poor verbal memory for dream speech, we could not conclusively say that the stimuli were responsible for this effect. There were, however, at least two dreams with strong evidence to suggest that the stimuli were directly incorporated. Q-Methodology was used to assess similarity of dream experience. This resulted in three distinct factors: (1) calm, consistent, slightly emotional dreams; (2) emotional, normal, understandable dreams; and (3) unstable, inconsistent, unrealistic dreams. The configuration of factors amongst participants did not fully meet the predictions of the hypothesis; however, positive participant feedback on Q-sorting their dream experiences gives promise and potential for the use of Q-Methodology in future dream research. Future studies should employ an unstimulated control condition, train participants to improve verbal recall of dream speech, and ultimately, develop a theory of dreaming that includes a plausible explanation of external stimulus incorporation.

Keywords: Dreams; External; Stimuli; Q-method

1. Introduction

It has been shown by numerous empirical studies (reviewed by Schredl & Stuck, 2009) that external events are sometimes simultaneously incorporated into dreams while the dreamer is still asleep. A range of stimuli of varying modalities, such as water droplets on the skin (Dement & Wolpert, 1958), positive and negative odours (Schredl, Atanasova, Hörmann, Maurer, Hummel & Stuck, 2009), and sounds (Berger, 1963) have all been incorporated into dream content, either directly or in disguised form. As well as these, the sleep lab setting itself has also seen frequent incorporation (Schredl, 2008). This phenomenon has been subjected to scientific research for decades, and has also been exploited for personal recreational activities, such as lucid dreaming (LaBerge & Levitan, 1995; Paul, Schädlich & Erlacher, 2014) and interactive shared 'gaming' experiences (Kamal, Al Hajri & Fels, 2012).

While the basis of this phenomenon remains unclear, it shows that the sleeping brain is still able to monitor, per-

ceive, and process events and information in the surrounding external environment, converting them into a somewhat understandable form and manifesting them into dreams.

On the more practical side of dream research, Kamal et al. (2012) tested a prototype of a device called the DreamThrower. This device is worn by the sleeper and has the ability to affect dream content with auditory and light stimulations selected by the sleeper before bedtime. Users then have the option to share the sound files and light patterns they used with other users of the device via an Internet site, thereby 'throwing' that dream to others to experience for themselves. Such an idea works under the assumption that everyone will process the external cues in a similar manner. However, due to small participant numbers, poor dream recall ability, and short periods of sleeping time, their results were inconclusive.

One of the aims of the current study was an attempt to better identify shared dream experiences as brought about by external stimuli and their incorporation into the dream scene. This was achieved by using Q-Methodology, chosen because of its emphasis on shared subjective experience and ways of thinking. Q-Methodology, developed by physicist and psychologist William Stephenson (1902-1989), involves participants sorting a sample of statements, which relate to a given subject matter (a Q-sample), onto a ranked grid according to their personal likes and dislikes (Watts & Stenner, 2005). The result is a detailed snapshot of an individual's subjective opinion and understanding about the topic under research, as shown by their configuration of the

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statements, and supported by the open-ended comments they are offered to make about their sort. A by-person factor analysis is conducted on all the completed sorts, and the generated factors group together participants who sorted the statements similarly, therefore representing a shared perception or way of thinking. It is a qualitative and exploratory method by nature, with subjectivity and phenomenology as its focus.

To the best of our knowledge, such a method has only been applied to dream research once before (Parker & Alford, 2010). In contrast to the conventional content analysis of dreams, Parker and Alford (2010) make the argument that Q-Methodology allows the researcher to address dreams from the phenomenological perspective of the dreamer, rather than treating them as homogenous phenomena that can be easily classified into distinct categories. While content analysis takes dream content into account, it sacrifices the subjectivity that is surely such a pivotal aspect of the dream; dreams are highly personal, varied, and complex, and Q-Methodology offers the tools to investigate such broad topics (Watts & Stenner, 2005). With Q-Methodology, people who share similar subjective dream experiences are identified, grounding the results solely in the data, rather than reducing a large sample of dreams to fit into the most frequently pre-defined occurring categories (Parker & Alford, 2010). The participant guides the interpretation of their dream, highlighting what was most salient for them in their experience, instead of the researcher deciding what is most significant. This is done by participants placing certain statements from the Q-sample at the tail-ends of the sorting grid, indicating those which are most agreed and most disagreed with. For these reasons, we believe that Q-Methodology is a valuable tool that dream researchers can make use of, and it deserves to be given a chance to demonstrate its merits.

The current study used verbal stimuli in two different languages (only one of which each participant was familiar with); to the best of our knowledge this is the first time different languages have been employed in the context of dream stimulation. It was hypothesised that semantically meaningful stimuli (in a language understood by the participants; in this case, English) would yield different dream reports to stimuli without semantic meaning (the same phrase, but in a language not understood by participants, which was German in this study). If supported, this could be interpreted as evidence for consistent stimulus incorporation across participants; the differences in dream content reflecting the differences in stimulus properties as understood by the participants. Exactly how the dreams would differ in content is difficult to predict, because again, we believe this study to be the first attempt to manipulate dreams with languages, so there is no previous evidence to go on. Also, predictions and hypotheses do not fit with the nature and philosophy of Q-Methodology. However, we hope to identify content that is specifically related to the semantic content of the stimuli.

2. Method

2.1. Participants

Participants with a clear interest in dreams were targeted. A total of 18 (7 male, 11 female) volunteers were initially recruited. Three participants withdrew during dream recall training, and a further three withdrew prior to lab testing, leaving a total of 12 participants (5 male, 7 female) aged

between 18 and 22 years old (mean: 19.9 years). All participants were native English speakers, provided full written consent and were rewarded with course credit for their participation. The study was approved by the School of Psychology Research Ethics Committee at the University of Lincoln in accordance with the principles of the British Psychological Society.

2.2. Materials

A dream recall training exercise (Appendix A) was devised to help participants improve their dream recall in the weeks leading up to the main experiment. Instructions and tips were based on empirical research endorsing dream recall as a learnable skill, independent of stable personality traits (Levin, Fireman & Rackley, 2003), with the most important prerequisites being a positive attitude towards dreams and a motivation to want to improve dream recall (e.g., Reed, 1973; Rochlen, Ligiero, Hill & Heaton, 1999; Schredl, 2013; Wolcott & Strapp, 2002). The exercise was broken down into "prospective tips" and "retrospective tips", to be practised before going to sleep and after awakening respectively. This included going to bed with a clearly defined goal in mind to remember the night's coming dreams, and the encouraged use of dream journals, keeping one open at bedside and writing down in it anything that can be remembered immediately after awakening.

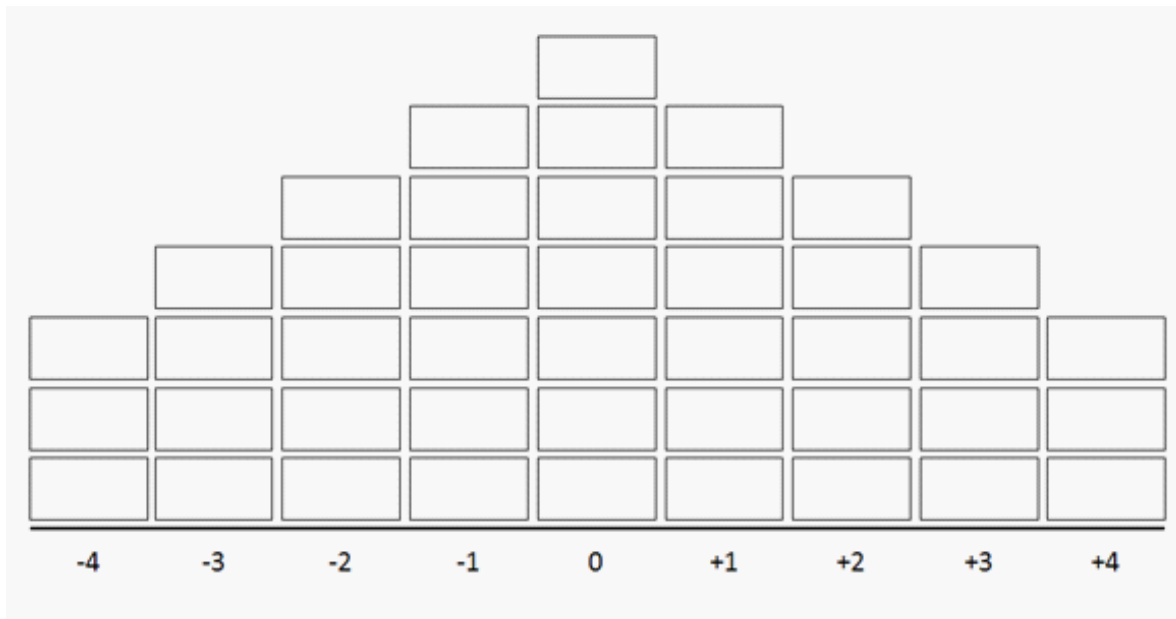
Two audio stimuli were recorded for use in the study. One featured three directional phrases spoken in English ("Where are you going? Now turn right. Now turn left."), by a male native English speaker, and the other featured the same three phrases spoken in German ("Wo gehst du hin? Jetzt rechts abbiegen. Jetzt links abbiegen."), by a male native German speaker from Austria. The sentences were played in the order specified at 5-second intervals; "Where are you going?" played at 0 seconds, "Now turn right." played at 5 seconds, and "Now turn left." played at 10 seconds. This configuration was repeated at 15 seconds, 30 seconds, and 45 seconds, gradually increasing in volume, and ending at 60 seconds. An awakening stimulus was also produced, starting with 30 seconds of silence to allow for incorporation effects, followed by three seconds of a loud 800Hz sine tone.

An Olympus WS-450S digital voice recorder was used to record verbal dream reports and Q-sort discussions during the study. PQMethod software (<http://schmolck.userweb.mwn.de/qmethod>) was utilised when analysing Q-sorts. The Q-sorting grid (Figure 1) consisted of nine columns, numbered from -4 on the left to +4 on the right, with three rows at both poles, incrementing by one row towards the 0 position, which had seven rows. This quasi-normal distribution allows participants to identify the most salient aspects of their dreams, placing the few statements that reflect their dream experience most accurately at the tail-ends (-4 and +4). The Q-sample was comprised of 43 statements referring to dream experience (Table 1).

2.3. Polysomnography

Sleep was monitored with an Embla N7000 polysomnography system, using RemLogic 1.1 software (<http://www.embla.com>). Electrodes were applied according to the 10/20 system, at positions C3, C4, F3, and F4, together with left and right EOG, and upper, left and right chin EMG, referenced against contralateral mastoids A1 and A2. Sleep

Figure 1. The Q-sorting grid used in this study.



monitoring was undertaken in order to ensure that the stimulus was played during a period of REM sleep.

2.4. Procedure

A representative Q-sample of 43 statements was created, with statements drawn from academic literature on the subject of dream experiences, as well as sample dream reports obtained from volunteers and acquaintances. To aid this, a message was posted on an online dream discussion forum (www.dreamviews.com/forum) calling for contributions from the community. These were then randomly numbered and printed onto separate cards for ease of sorting.

Participants were first read the full brief and then given time to practise the dream recall training exercise at home. After spending at least a few weeks following the exercise, participants returned to see the experimenter in the University of Lincoln Sleep and Cognition Laboratory on a convenient morning at 9AM for the main experiment. Morning naps were chosen over afternoon naps because research has shown that more REM sleep is present in morning naps (Schoen & Badia, 1984; Webb, Agnew & Sternthal, 1966), therefore yielding a greater chance of eliciting a vivid and detailed dream report. Participants were first invited to share any comments about the usefulness of the dream recall training exercise, and whether they believed they had improved at all. Then, they were reminded of the main experiment procedure and asked if they still wished to proceed. Participants were informed that an external stimulus would be presented to them during sleep, but were not informed about its exact nature until the end of the experiment, to avoid biasing expectations and dream content. In order to allocate participants to stimulus groups, they were asked if they had any prior knowledge of other languages; those who had experience with German were played the English stimulus, while those who did not were allocated to either stimulus group to ensure a balanced number of participants in each. Participants were then wired up for polysomnography, and given two hours to sleep in the lab bed. The

experimenter remained in the next room monitoring sleep on a computer, and upon seeing patterns characteristic of REM sleep, played one of the stimulus sound files from the same computer which was connected to two speakers in the bedroom. The awakening tone sound file was set to play immediately after the stimulus sound file.

After the tone sounded, the experimenter knocked sharply on the bedroom door and entered to check if the participant was awake, and then asked "What was happening in your mind just now?" The dream report was recorded with a digital recording device, and the experimenter prompted participants to give as much detail as they could possibly remember from their dream. Once this step was over, participants got out of bed and had the electrodes removed. They then proceeded to complete a Q-sort about their subjective dream experience. Participants were advised to sort the statements into three initial piles (agree, disagree, and neutral), and then systematically sort them further on the Q-grid to help them decide which statements were more important in regards to each other. Once sorting was complete, the experimenter encouraged participants to review the sort in order to maximise the accuracy of representation, and then discussed the sort with the participant to gain a greater understanding of their dream experience, including open questions such as: "Can you elaborate on why you chose these statements as most important/unimportant?" and "Is there any other statement not included in this sample that could more accurately conceptualise your dream experience?". This discussion was also audio-recorded. Participants were lastly asked to provide comments on how well they thought the Q-sample covered their dream experiences and how suitable Q-sorting is more generally for describing subjective dream experiences.

Once this was done, participants were debriefed and the stimulus was revealed to them. Lastly, they were asked to reflect on whether they thought the stimulus had influenced or become incorporated into their dream, now that they knew what it was, in order to obtain explicit incorporation confirmation.

2.5. Data Analysis

The audio recordings of participants' dream reports and Q-sort discussions were transcribed verbatim. All Q-statements and Q-sorts were loaded into PQMethod software. A Principal Components Analysis was conducted, retaining components with eigenvalues greater than 1 and at least two Q-sorts loading significantly onto a single factor. Factors were interpreted based on statement factor scores (particularly those of +4, +3, -3 and -4), distinguishing statements (those with significantly different scores across factors, to identify differences between them), and consensus statements (those without significantly different scores across factors, to identify similarities between them). Interview comments from participants whose sorts loaded onto the respective factors were selected to exemplify the factors' meanings.

3. Results

In this section, we present a brief account of dream recall improvement across participants, potential stimulus incorporation effects, the factors which were drawn from the Q-sorts, and participant feedback on the Q-sorting process.

3.1. Dream Recall

While not the main aim of this research, all 12 returning participants felt that the dream recall training exercise had helped them to successfully improve their dream recall, in both the frequency and recalled detail of their dreams. Some also reported that the memories of their dreams lingered for longer after waking up and one participant even reported that the exercise had helped them to start dreaming in colour for the first time, instead of black and white. Aspects of the exercise which were seen as most useful included: keeping a dream journal and writing down the dreams, making them more memorable, easier to share, and serving as a reminder during the day; increased awareness and thinking about dreams, or getting into a pre-bedtime routine; having earlier bedtimes to aid winding down and relaxation, or getting more sleep to improve sleep quality; and having self-belief to improve.

3.2. Stimulus Incorporations

Of the 12 returning participants, only nine were able to sleep well enough to produce dream reports and Q-sorts, and it is these which are reported here. These nine were all able to sleep through the stimulus presentation, and were successfully awoken by the tone.

One common feature present across all of the reported dreams is people engaged in conversation with each other or with the dreamer. Some participants reported actively engaging in conversation with a group of people or friends, sometimes in the presence of many other people, such as in a crowded public space; other participants reported hearing words being spoken around them but did not engage directly in speech themselves. This may represent stimulus incorporation on a broad level, as both stimuli were verbal material, so there is plenty of scope for the stimuli to have been directly incorporated as part of these dream conversations. However, it is difficult to be certain, as nearly all of the participants could not remember the exact topics of discussion or the exact words which were spoken. Some participants thought that their respective stimulus did sound

somewhat familiar when they heard it again after the end of the experiment, while others were not so confident.

Although it is difficult to ascertain if the speech in these dreams was an effect of the stimuli, there were at least two dream reports that contained very strong evidence to suggest the stimuli were directly incorporated. The following extract illustrates one of these dreams:

"I remember as we were entering what would [be] the English corridor of my old school, there was... I can't remember what it said but there was like a voice like a train conductor, like a male train conductor saying something erm... I don't know, just in the sort of uh "please mind the gap" style sort of voice but I can't remember at all what it was..." (Participant 14, male, 18, English stimulus)

Participant 14's imitation of what the muffled voice sounded like was almost identical to how the stimulus sounded, and this was something he agreed on when he heard the stimulus again once the study was over. He could not remember exactly what the voice said, but he could remember the style in which it was spoken, likening it to a train conductor making an announcement at a train station platform. As an added interest, the voice came at a time when he was navigating turns in the corridor, first left and then right shortly afterwards. Therefore, it may be that the physical characteristics of the stimulus (how it sounded) were incorporated directly, but its semantic characteristics (its meaning) were incorporated indirectly, as evidenced by the turns in the corridor. Again, it is difficult to know if this was a coincidence or not.

Another participant (who was played the German stimulus) dreamed of sunbathing on a beach with her family, while other beach-goers around her were doing likewise. She came to the conclusion that these other beach-goers were from different countries because they were not speaking English, but she couldn't identify any specific language:

"...they were on holiday as well [...] they all spoke different languages [...] I don't recall any other English speaking people. I can't remember what, erm, where they were from, erm but yeah they were definitely foreign [...] there were no other English people that I can remember. I don't remember any languages as such, I just remember hearing... something that wasn't English..." (Participant 17, female, 19, German stimulus)

Because she was able to identify the speech she heard as a foreign language in her dream, this participant gives strong evidence for the direct incorporation of the German stimulus into the background conversation going on in the scene.

Four participants dreamed about being in a sleep lab setting of some description. To add to that, these lab dreams all featured the presence of other people. For two participants, someone explicitly walked into the room and spoke something before leaving. Of greatest interest, two participants in these lab dreams believed that they were perceiving the external stimuli while lying in the bed. The dream with the best example of this occurrence is quoted next:

"...there was like a board at the front [of the room] that kept playing adverts... loads of adverts kept playing... because I thought that was the stimuli, I don't know, in my mind I told myself that... in my dream I told myself that was the stimuli." (Participant 03, female, 20, German stimulus)

Table 1. Factor Q-sort values for each statement, with distinguishing statements in bold.

Statement	Factor 1	Factor 2	Factor 3
1. I felt in control of events in my dream.	1	1	0
2. I did not feel particularly aware of what was happening in my dream.	-1	-3	-1
3. My dream felt dull and uninteresting.	-1	0	-4**
4. I felt I was able to make sense of what was happening during my dream.	1	4	3
5. I felt like I was in danger during my dream.	-2	-3	-4
6. My dream felt unrealistic.	-2	-2	3**
7. My dream was emotionally pleasant.	2	-3**	1
8. My dream filled me with a sense of wonder.	0	0	0
9. My dream contained elements of personal concern to me.	-3**	2	1
10. Things seemed pretty stable and consistent in my dream.	4**	0	-4**
11. My dream featured a change in mood or emotion.	0	3**	0
12. My behaviour in my dream reflected my everyday life behaviour.	4	4	-1
13. I felt sympathetic for the other characters in my dream.	0	0	-2
14. I felt safe during my dream.	3	-1	2
15. Nothing seemed out of place in my dream.	0	2	-1
16. My dream felt fairly normal.	3	2	-3**
17. My dream was transcendental.	1	-2	0
18. My dream made me feel sad.	-2	-1	-2
19. I was not concerned too much about elements of my dream.	3	-4**	1
20. Emotions did not feature prominently in my dream.	3*	-2	1
21. In my dream, I behaved differently to how I would usually do in everyday life.	-1	-1	0
22. I felt good about what was happening in my dream.	2	0	1
23. My dream felt bizarre or strange.	1	-3**	4**
24. I felt embarrassed during my dream.	-1	1	-2
25. During my dream, I felt a heightened sense of general awareness.	2	3	2
26. During my dream, I felt confused and unable to make sense of what was happening.	0	-4**	2
27. I felt bad about what was happening in my dream.	-4	1	-3
28. My dream was emotionally unpleasant.	-3	2	-1
29. My dream was disturbing.	-4	-1	-3
30. My dream was humorous.	-1	-2	0
31. I felt curious about what was happening in my dream.	2	2	4*
32. Emotions played a strong and dominant role in my dream.	-1	3**	-1
33. I felt frustrated in my dream.	-2	3	3
34. My dream felt erratic.	-3*	0	3**
35. I was faced with moral challenges in my dream.	-2	1	-1
36. Things seemed hopeless or desperate in my dream.	-3	0	-2
37. Something seemed out of place in my dream.	1	-4**	1
38. My dream felt exciting and engaging.	0	-1	2
39. Things seemed distorted or unstable in some way in my dream.	0	-1	4**
40. I was actively involved in the events of my dream.	2	3	2
41. My dream felt calm.	4**	-2	-1
42. I was an observer of events in my dream.	1	0	-2
43. My dream was frightening.	-4	1	-3

Note. *Distinguishing statement significant at <0.05; **Distinguishing statement significant at <0.01.

This participant reported numerous false awakenings (dreaming about waking up), and her quote above details the experience she had before awakening for real. Her dream demonstrates not only a potential incorporation of the stimulus, but also the participant's immediate concerns, that is, knowing she was taking part in an experiment and needing to recall a dream for it. This knowledge is manifested in this particular dream by the participant's awareness that an external stimulus was going to happen, even though she did not know what it would be at this time, and this salient thought continued to be processed into the dream as the participant began speculating about the nature of the stimulus, influencing how she interpreted the events happening around her. It is important to note that while she was aware of the presence of the stimulus, she was not aware that she was still dreaming and not actually awake at all.

3.3. Q-Factors

Principal Components Analysis yielded, by default, eight initial factors. Three of these had eigenvalues greater than 1, together accounting for 71.42% of the variance. These three were retained and varimax rotated, and each had at least two Q-sorts significantly loading onto them.

The factors are described in the following with their distinguishing and defining statements and with illustrative quotes from participants who loaded onto them. It is worth remembering, however, that because of the subjectively variable nature of dream experiences, some individual comments and statements from the sorts may not perfectly fit the experience defined by the factor. The potential effect of the external stimuli on these experiences is also discussed. Factor scores for all statements are in Table 1.

3.4. Factor 1 – Calm, consistent, slightly emotional dreams

Factor 1 explained 37% of the total variance, and was identified by five participants, three of whom were exposed to the English stimulus, and two to the German stimulus. To summarise, the dreams experienced by Factor 1 participants remained stable and consistent without changing much (10. "Things seemed pretty stable and consistent in my dream" **+4**; 34. "My dream felt erratic"; **-3**). There was not much emphasis on emotional content (20. "Emotions did not feature prominently in my dream" **+3**), but there was a feeling of calmness ranked highly by everyone (41. "My dream felt calm" **+4**). This calmness and lack of emotional prominence may have helped create the lack of concern for personal elements in the dream as well (9. "My dream contained elements of personal concern to me" **-3**), since events were mostly relaxed and there was nothing to be worried about happening. This may have led to a feeling of normality, as evidenced in participants' choice of words, but statement 16 ("My dream felt fairly normal"), although ranked at **+3**, was not significantly different to its score on Factor 2. The following quotes demonstrate these experiences:

"...I didn't think that much happened and it was all, again, it all just seemed pretty normal and nothing out of the ordinary happened that to be concerned about, erm, again that links into the things were pretty stable and consistent, nothing... apart from like the location, nothing much changed, nothing drastic happened, no big event happened." (Participant 10, female, 20, English stimulus)

"Well I think the main sort of emotion I got was almost nostalgia from the dream, so I wouldn't say that that's a particularly powerful emotion and there wasn't really many other range of emotions, so that's why [...] emotions weren't particularly prominent 'cause no one was having massive emotional reactions and such. [...] it was a very laid back dream..." (Participant 14, male, 18, English stimulus)

"...I would say the main part of the dream for me was just the calm feeling, like I felt just really calm and that was probably the... the biggest feeling." (Participant 17, female, 19, German stimulus)

"...things were stable and consistent in that everyone was normal... no one was erratic [...] Everything was just pretty much staying [...] as it would be." (Participant 18, male, 20, English stimulus)

Factor 1 contains dreams from both the English and the German stimuli, so does not in itself support the hypothesis that the different stimuli created different dream experiences. However, it is interesting to note that the English stimulus dreams in this factor all feature locations familiar to the dreamer (the sleep lab and Participant 14's old school), whereas the German stimulus dreams feature unfamiliar locations (such as the foreign beach in Participant 17's dream). If the stimuli influenced the locations, it could be plausible that the unfamiliar language yielded an unfamiliar location, but it is more likely that the dream was already underway before the stimulus was noticed, and the stimuli simply materialised appropriately into the scene. A good example to illustrate this would be Participant 17's beach dream, when the foreign voice made her realise she must be in a foreign location surrounded by foreign people. On the other hand, Participant 14 reported the voice coming from nowhere, so in this case at least, it didn't quite fit the scene, especially since he reported that the voice didn't feel like it could appear in a school. In conjunction with evidence from other factors, it may be more to do with the actual context of the dream, and the feelings that accompany it, which affect the perception of the stimuli.

3.5. Factor 2 – Emotional, normal, understandable dreams

Factor 2 explained 18% of the variance, and was identified by two participants, one being exposed to the English stimulus and the other the German one. To summarise Factor 2 dream experiences, they featured a feeling of normality which was shared with the other factors (37. "Something seemed out of place in my dream" **-4**; 26. "During my dream, I felt confused and unable to make sense of what was happening" **-4**; 19. "I was not concerned too much about elements of my dream" **-4**; 23. "My dream felt bizarre or strange" **-3**). However, they were more emotional than Factor 1 dream experiences (32. "Emotions played a strong and dominant role in my dream" **+3**; 11. "My dream featured a change in mood or emotion" **+3**), and more to a negative degree (7. "My dream was emotionally pleasant" **-3**). This was most prominent for Participant 11, who reported feeling upset and embarrassed because she had received a low mark on an assignment hand-back, and is probably the best example of this kind of dream experience:

“...I was very upset in the dream because I’d failed me assignment and everyone else had passed and I felt embarrassed and stupid. [...] the dream changed obviously ‘cause like it was just uh normal, and then something upsetting happened...” (Participant 11, female, 20, English stimulus).

The other participant in this factor thought that emotions were not so prominent.

“...it wasn’t particularly like a negative dream... erm but it weren’t I suppose a massively happy dream either...” (Participant 08, female, 22, German stimulus)

What was more prominent for both participants was the sense of normality in the dream, something which is shared with Factor 1 dreams. Both dreamers were engaged in activities which they normally do in their waking life, and therefore these situations would have felt familiar to them:

“...it was sort of like a normal conversation that I would have and also the erm dream felt pretty clear to me [...] it wasn’t like a strange kind of dream, it’s fairly normal.” (Participant 08, female, 22, German stimulus)

“Well, nothing seemed out of place ‘cause it just was like a normal day.” (Participant 11, female, 20, English stimulus)

This sense of normality and being able to understand what was happening in the dreams may be a better way to interpret and define Factor 2, since the perception of emotion between participants varied. This may have been more to do with the context and setting of the dreams (being at University), and since both participants did not feel that their respective external stimuli played an important or noticeable role in their dreams, their effect on the dream experience probably was not great.

3.6. Factor 3 – Unstable, inconsistent, unrealistic dreams

Factor 3 explained 17% of the variance, and was identified by two participants, both exposed to the German stimulus, and both having lab dreams. These dreams were highly unstable and erratic (39. “*Things seemed distorted or unstable in some way in my dream*” +4; 10. “*Things seemed pretty stable and consistent in my dream*” -4; 34. “*My dream felt erratic*” +3), and unrealistic (6. “*My dream felt unrealistic*” +3; 16. “*My dream felt fairly normal*” -3; 23. “*My dream felt bizarre or strange*” +4). Because of this absence of anything normal, there was a sense of curiosity present (31. “*I felt curious about what was happening in my dream*” +4), and events were by no means boring (3. “*My dream felt dull and uninteresting*” -4). The following quotes illustrate these experiences:

“Well it was just a very messed up dream, like I wasn’t sure what was going on erm, like I said I kept feeling as if I had woken up already and then I’d go back to sleep and I was somewhere else, so that’s what I mean by erratic, like it was just completely... well I just can’t make sense of it, erm and also that’s why it seems distorted or unstable [...] well I wanted to know what was going on, like I wanted to make sense of it and obviously I kept thinking about the dream recall, and... the sleep lab... [...] ...it was really bizarre and strange, I couldn’t make sense of what was

going on, everything was just all over the place, erm but it did feel exciting...” (Participant 03, female, 20, German stimulus)

“...things seemed unstable or distorted in the dream because... this guy doesn’t go to this uni... and he was completely random and he had not been in the room previously to leave his keys, so that was really distorted. [...] so I don’t understand why... I would think of him, which is why it just seemed really distorted... and to turn over in bed and have a fork, that’s strange. [...] ...during the dream I was curious about why the guy was entering the room... why his keys were there and why I had a fork in my hand and why there was an extension...” (Participant 07, female, 20, German stimulus)

Both participants reported strange, unrealistic dream experiences of being in the sleep lab, and events inconsistent with the sleep lab setting were going on around them. They struggled to make sense of what was going on, and at times became confused because of these inconsistent happenings.

Both participants here were exposed to the German stimulus, but only Participant 03 thought that it had a noticeable effect, materialising as a repeated advert on a large board at the front of the room she was in. Participant 07 also thought she had perceived the stimulus during the dream as a “ripple vibration” in the bed, though this was unlikely an effect of the specifically German utterance. But both dreams were strange and unrealistic, possibly an effect of the unfamiliar language stimulus, similar to Factor 1 where all German stimulus dreams featured unfamiliar locations.

Factor 3 contrasts well with the other factors, especially the feeling of normality which was present across both Factors 1 and 2 but was absent in Factor 3, and the extreme instability and inconsistency of the settings and surroundings. Overall, statement 10 (“*Things seemed pretty stable and consistent in my dream*”) was the most distinguishing statement of all three factor dream experiences, being most positively ranked in Factor 1 (+4), most negatively ranked in Factor 3 (-4), and irrelevant in Factor 2 (0).

3.7. Q-Sorting Feedback

Participant feedback on using Q-sorts to describe their subjective dream experience was generally positive. Participants found that Q-sorting helped them to gain a deeper and more detailed understanding of their dream experience and feelings, the selection of statements was generally considered broad and representative enough to convey their experiences, and they agreed that it was a useful tool to apply to dream research. The following quotes highlight the general opinion and the most positive aspects:

“I actually really enjoyed it ‘cause I feel as if you can understand it, my dream a lot more ‘cause obviously when I’d first woke up I was really disorientated and couldn’t really explain things properly but I think... it’s made me be able to express how my dream was and I think it’s allowed you to grasp the concept of my dream a lot more clearly, I definitely liked this...” (Participant 03, female, 20)

“...it’s more helpful than I initially thought that it would be actually [...] the statements they seemed quite ap-

plicable in general sort of thing [...] I can see how you could erm easily describe a big range of dreams, I didn't really feel restricted by it at all [...] this seems like an interesting thing to be able to do on quite a vivid dream I should imagine [...] it's made me realise that, you know, the dream I had was probably a little bit more relevant than I initially thought actually..." (Participant 14, male, 18)

"I think this is a really good idea the Q-sort, I really do think it's a good idea, I think it helps you make, like understand your own dream a lot more, erm and it sort of helps you get a structured idea of what happened, helps you remember what happened and keep it in your mind..." (Participant 17, female, 19)

Some participants recommended other statements that could be included in the Q-sample. They included statements about the roles of other people in the dream, whether they or the environment seemed normal, the general visual appearance of the dream, and a statement about guilt. These types of statements could potentially be included in future studies of dream content using Q-methodology.

3.8. Results Summary

All participants in this study were able to successfully improve their memory for dream frequency and detail by following the training exercise. All of the dreams elicited from participants showed tentative evidence for direct incorporation of the verbal stimuli, in the forms of conversation or speech happening in the dreamers' vicinity, though this was more noticeable and clear-cut for some than for others. Feedback from participants and the three factors identified suggests that Q-Methodology is a useful method in dream research, helping participants to gain a greater and deeper understanding of their dreams, and helping researchers to identify categories of similar dream experiences drawn straight from the data.

4. Discussion

In this study, we investigated incorporation of semantically meaningful and non-meaningful external verbal stimuli into dreams. Our hypothesis was dreams with meaningful stimuli would be similar to each other, and distinct from dreams with non-meaningful stimuli, with similarity of dream experience assessed using Q-Methodology. Our results offered only partial support for this hypothesis, though small participant numbers and complex and varied dream content means that any conclusion must be treated with caution.

Using Q-Methodology, we were able to systematically draw naturally occurring categories of dreams directly from participant data, and assess their similarity of subjective experience. Five participants had calm, consistent and slightly emotional dreams; two had emotional but normal and understandable dreams; and two had unstable, inconsistent and unrealistic dreams. This configuration of factors does not clearly support our hypothesis, but from our results and the opinion of the participants, it seems that Q-Methodology did suit the task and is a potentially useful tool for dream researchers.

All of the dreams obtained from participants contained conversation or some kind of speech. It is difficult to verify if this was a result of the stimuli or not, due to participants'

relatively low verbal memory for dream speech. The two dreams with the strongest evidence of direct incorporation were remembered based on the phonological properties of the speech – how it sounded – rather than its meaning. Berger (1963) reported similar effects in his 'Direct' incorporation category, wherein speech stimuli were incorporated into the dream as background thoughts or voices. Because speech and other auditory sensations are quite common in dreams anyway (Kilroe, 2001; Shimizu & Inoue, 1986; Zadra, Nielsen & Donderi, 1998), it is entirely plausible that the reported speech had nothing to do with the stimuli. Strong evidence for incorporation would be if the reported dream speech was directly related to the semantic content of a stimulus, but this only seemed to happen clearly once in the present study (Participant 17's beach dream). Had participants been able to remember more detail about the content of the speech, incorporation levels may have been conclusively higher.

Four participants dreamed about being in a sleep lab setting, a common occurrence across sleep lab experiments (Schredl, 2008). Two of these lab dreams however evidenced anticipation of the external stimulus; these participants experienced a false awakening, dreaming about waking up in the lab but were actually still dreaming, and attributed events in the dream (an advert board and a vibration in the bed) as being the stimulus. To the best of our knowledge, this effect has not been observed before; the closest similarity is possibly reported by Berger (1963), where two participants dreamed that names were being played to them as they slept, but they were not informed that a stimulus would be played, whereas participants in the current study were informed, but the nature of the stimulus was not revealed until the experiment was over. Such results may support the continuity hypothesis of dreaming; conscious anticipation of the stimulus only happened in these lab dreams, possibly representing the continuation of immediate concerns and thoughts from waking life into sleep and dreams, and suggesting that the dream scene triggered related thoughts and memories.

While not the main aim of this study, it is worth noting that all participants felt that the dream recall training exercise helped them to improve their dream recall abilities, which adds further support to the literature that suggests dream recall is a learnable skill (e.g. Levin et al., 2003; Reed, 1973). It is particularly interesting that one participant reported being able to dream in colour for the first time using the exercise. This unanticipated improvement is worth further investigation in future studies, to see if this effect can also be induced in other black-and-white dreamers. The findings could be interpreted in the context of existing research, relating colour in dreams to waking-life cognitive functions such as colour memory (Schredl, Fuchedzieva, Hämig & Schindele, 2008). On the other hand, it could be that this certain participant was simply able to remember more details in dreams once they were paying more attention to them in general.

This study may overlap with literature on sleep and memory consolidation. It has been shown before that a sensory cue associated with a certain learning memory, if presented again during sleep, can potentially reactivate those memories and accelerate their consolidation, leading to improved memory performance on the learned task after waking up. This has been done with odour cues (Diekelmann, Biggel, Rasch & Born, 2012; Rasch, Büchel, Gais &

Born, 2007) and auditory cues (Rudoy, Voss, Westerberg & Paller, 2009) including linguistic cues (Schreiner & Rasch, 2014). Most of these benefits, however, came about by re-activating memories during Stage 2 or Slow-wave sleep, when dreaming is less vivid. There has been some success in a few early studies replaying auditory cues during REM sleep (e.g., Guerrien, Dujardin, Mandai, Sockeel & Leconte, 1989), though this may depend on the modality of the cue and the exact nature of the task to learn. Indeed, odour cues have been re-applied during REM sleep to no apparent benefit of memory (Cordi, Diekelmann, Born & Rasch, 2014). Since there was no memory task associated with the verbal stimuli in the present study, we cannot say of any potential consolidation effects they may have produced. It may be worth pursuing, however, the possibility that dreams are the conscious correlate of memories undergoing consolidation (Murkar, Smith, Dale & Miller, 2014; Zhang, 2009), incorporating external cues and stimuli only if they are relevant to the memory being consolidated.

A full-scale ERP analysis may offer further insight into how external stimuli are neurologically processed during sleep, but this was not carried out in the current study due to the dynamic nature of the stimuli, and the main focus was on dream content rather than sleep patterns. This should be done in future studies, because any change in sleep patterns as a result of the stimuli can be analysed in detail, and may offer some support for the possibility that they reflect memory consolidation in the dream state.

Arguably the biggest limitation of the current study is participants' poor verbal memory for dream speech, rendering conclusive results difficult. Future studies could address this by training to improve verbal memory in dreams, similar to the approach used by Schredl et al (2008) for colour memory. Another obvious improvement in this regard would be a larger number of participants to counter the attrition rate and provide a more robust sample for Q-factor interpretation.

Our study compared two conditions (semantically meaningful and non-meaningful). However, a future study could also benefit from a control condition where no stimulus is applied in order to obtain a baseline level of dream content to compare with experimental groups. This would allow significant patterns related to any stimulus incorporation to be detected, rather than related specifically to the difference between conditions.

Finally, our study used morning naps. While this seemed to be generally effective, it may be the case that dream recall would be better during overnight sleep due to circadian processes related to memory function. The sleep pattern would also be more natural, provided a habituation night in the lab was included (Agnew, Webb & Williams, 1966).

There is much potential for the further use of Q-methodology in dream research. Because a Q-sample can never be fully complete (Watts & Stenner, 2005), there is always room for improvement and expansion. Parker and Alford (2010) also suggest that a content analysis of the factors after they have been extracted may be possible, in order to give a more detailed insight into them. This was only done in brief in the current study due to issues of length and time. The present factor descriptions give a suitable insight into their content, but a more comprehensive analysis would probably result if there were more participants in each factor. This is something to consider should this study ever be repeated to a larger scale. Q-methodology can also be ap-

plied to multiple dreams of a single participant if so desired, and in the current study's context, to test the consistency of the external stimulus incorporation across a night of sleep; dreams seem to differ across the night in regards to continuity with waking life (Malinowski & Horton, 2014), so this may have an effect on how the stimuli are incorporated, if at all. It could also be used to examine stimulus incorporation in other modalities, such as for odour stimuli which are known to influence emotional content (Schredl et al, 2009) and so are likely to be more memorable.

In summary, our study found some tentative evidence of stimulus incorporation in dreams in a highly controlled lab setting. We also showed that Q-methodology can be used effectively for this type of research, and we believe this approach could be very beneficial in future dream research if adopted into the right paradigm. Despite the limitations encountered, there are plenty of opportunities to improve and many alternatives to explore.

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Appendix A: Dream Recall Training Exercise content

How to Improve your Dream Recall

Improving your dream recall is under more personal control than you might think. It is possible, with practice and the right techniques, to get your dream recall up to one or more dreams a night, and this exercise contains tips and instructions on how to help you on your way to becoming a proficient dream recaller. This is a self-guided exercise to practise in your own time at home, and you are expected to spend a few weeks doing it, the more the better obviously. It will help you to increase both the frequency of your dreams, and the amount of detail you are able to remember.

Prerequisites

First of all, it is important to understand that training your dream recall will take time, which is why you will have several weeks to spend doing this exercise. Just like with every other learnable skill, practice really is the key to success. The first step therefore is to have patience. Do not get discouraged and give up if you have gone several nights without remembering a single dream. Just stay persistent, keep focussed on the goal at hand, and it will happen. Research also suggests that the most important prerequisites for improving dream recall are a positive interest in dreams, and a motivation to improve them. You have to really want to improve your dream recall to make real progress. As long as you stay motivated, you will most likely put forward the necessary effort to make improvements.

You will need a little bit of spare time, but most of this exercise will take place during time you will have set aside for sleeping and bedtime preparations.

What to do before going to bed – prospective tips

Improving your dream recall is something that you can very much prepare for before you even fall asleep. Many dreamers keep dream journals, a bedside book which is used solely for recording dreams. It is recommended that you get one, and you must keep it by your bedside at all times. Before you go to bed, leave it open on a fresh page by your bed, with a pen and a torch if necessary, so that you have easy and immediate access to it. Your dream journal should be a good sizable book, like an A4 notebook, so you have plenty of room to write down all of your dreams and all the details you remember. Don't use your dream journal for any other purpose; it is a book that is dedicated to your dreams and nothing else.

As you're getting ready for bed, it helps to get yourself into a little routine. Don't just go to bed and fall asleep; reserve a period of time for yourself when you can sit down quietly and have a little think about the possible dreams you could have that night. Everybody dreams every night, but not many people remember them very frequently. So just have a think about it, and firmly resolve to yourself that you will remember your dreams that night. Give yourself a goal to achieve, and just say to yourself, out loud if it helps: "Tonight I want to remember my dreams." By doing this, you're preparing your mind for sleep, and the concept of dreaming before you even enter the dream world. You may also wish to do this at quiet moments during the day as well. It really helps to have the right mindset as you're going to sleep.

Building on that point, try and give yourself an earlier bedtime occasionally, maybe about 30-60 minutes earlier than you normally would. It might sound unusual, but going to bed tired won't help your dream recall; you're drowsy, you're not thinking clearly, and you just want to switch off and sleep. You need to have enough of a commitment and motivation to make the effort to remember your dreams that night. Also, an obvious tip, don't go to bed under the influence of drinks or drugs. This will kill your dream recall, and it's just the same kind of thing as going to bed tired; your mind isn't clear and focussed enough, and will be preoccupied with your recovery.

Finally, as you lie down in bed, just repeat to yourself over and over again: "Tonight I will remember my dreams." This reasserts your goal and keeps your mind focussed as you're falling asleep. Ideally, you want to make this the last thought in your head before finally falling asleep. If any other thoughts spring into your mind while you're doing it, dismiss them and return to repeating your statement. Don't worry if it takes you a long time to fall asleep; the more time you spend repeating it to yourself, the more likely it will work. And really believe that it will work. If you anticipate success, then you will most likely find success.

So to summarise, before you go to bed, have your dream journal open and ready by your bedside, remain focussed on the task of remembering your dreams, and be confident, patient, and optimistic.

What to do upon waking up – retrospective tips

If you wake up and you remember a dream, then the first thing you want to do is to reach for your dream journal and write down what you remember. The memory of the dream will fade quickly upon awakening, so it really is vital to write it down before it fades away completely. By keeping your dream journal open by your bed, you will instantly know where it is, and there's no looking around for it which could lead to losing details of the dream. Keep replaying what happened in your head as you write it down to keep the memory alive for as long as you need it. Even if it's just a small fragment of a dream or a lone thought, write it down; anything is good, and you may remember more of it later.

If it's the middle of the night and you can remember a long and detailed dream, you are advised to not write the whole thing down right then and there. Chances are you'll still be quite tired, and scrawling down this long dream in the dark is the last thing you'll want to be doing. So instead, just write down a few brief notes and key points about the dream, and then write it down properly when you wake up in the morning. This keeps the interruption of your sleep pattern to a minimum, and the notes will serve as a reminder for you when you wake up in the morning, by which time you may have forgotten the dream, but your notes will trigger the memory of it again. Writing things down really helps you to commit them to memory, especially dreams.

On the other hand, if you wake up and don't remember any dreams or you feel that you've had one but can't quite remember what happened, a great tip is simply to lie still in bed with your eyes closed. If you do this, and think on the fact that you were just dreaming, then parts of your dream may come flowing back to you, and each part will remind you of another part that happened, and so on. You can start piecing the dream back together and then you can write it down.

If all these tips fail to work and you still don't remember any dreams, don't give up hope. Remember, learning such a skill takes time and practice. The brain is very receptive to repetition, so if you've been spending years of just not bothering to remember your dreams, it's going to take effort to break out of that rut. But it is possible, you must just stick at it and it will happen. You may even wish to try setting an alarm during the early morning in the hope that it will awaken you during a dream. Of course, don't do this too frequently so as not to disrupt your sleep pattern too much, and obviously it is not recommended you do this on days when you have to get up early for something. You tend to have more dreams late in your sleep, so if you do want to try an alarm, set it for maybe 6 or 7 hours after you go to sleep.

When writing down your dream, try to write down as many details as you can possibly remember. This includes not only what happened in the dream, but also how you felt during the dream, what you remember seeing, hearing, experiencing etc. This aims to increase your attention to detail in dreams, because anything you remember could be important. Some people find it helps to recount the dream in the present tense, as if reliving it. It's also important that you try not to con-fabulate too much; the human mind has a tendency to logically rationalise and relate things together in a coherent way, but with dreams there is often very little sense and logic. For example, if you dreamed you were in a city and then suddenly appeared in a forest, don't write: "I travelled from a city to a forest..." because there was no travelling involved; you simply switched scenes instantly. Your choice of words in describing the dream is very important, and you ought to select ones which you think best describe the events and feelings of the dream.

Correspondence

It would be appreciated if you could provide regular updates to the researcher. The researcher may even contact you at times to check that you are remembering to do the exercise and are making progress. Please do not send in your actual dream reports, unless you have one that you particularly want to share; this exercise is meant for your own benefits and practice. The preferred form of contact is by the University email system. Please use this email address to pass on updates or if you wish to ask any questions about the exercise.

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Thank you, and good luck.