Induction of a pre-chosen melody inside a lucid dream

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Summary. Objective. Lucid dreams (LDs) are a specific condition of the mind, can happen either spontaneously or intentionally (mostly in the REM sleep phase), and are characterized by consciousness and awareness during sleep. LDs provide many perspective tools to improve real life (e.g., training motor skills, solving psychological issues, and obtaining inspiration in arts). In this study, we show the possibility of identifying or playing a particular melody in an LD to check how well people may reproduce these skills in LDs. Methods. A group of 254 LD practitioners were divided into two groups and asked to induce an LD and then find or hear a particular melody, chosen either by themselves or by the researchers. After that, they wrote reports describing their experiences in detail. Results. Finding a particular melody, either proposed by the researchers or chosen by the participants, appeared to be achievable, as 84% of the obtained reports described successful attempts (p-value < 2.2e-16). In many cases, the participants' brains were able to reproduce in LDs high quality and very detailed melodies. Interestingly, success did not depend on practitioners' overall LD experience, meaning the task is achievable for beginners. Discussion. The results add to the knowledge of abilities that can be used inside LDs. Considering a recent study showing the possibility of transmitting music rhythms directly from an LD in real-time, this finding extends an existing view of the creativity capacity of LDs. Further experiments using basic skills like this will expand the list of helpful LD applications.

Keywords: Lucid dreams, consciousness, music, REM sleep, phase state

1. Introduction

Lucid dreams (LDs) represent a special mind state characterized by specific brain activity, consciousness inside a dream, and awareness of this consciousness (Baird et al., 2019; LaBerge, 1985). This state occurs, either spontaneously or intentionally, mostly during REM sleep (Dresler et al., 2012), though it also happens, albeit rarely, during non-REM sleep (Dane & Castle, 1984; Mota-Rolim et al., 2015; Stumbrys & Erlacher, 2012). Due to their similarity, phenomena such as out-of-body experiences during sleep, sleep paralysis, false awakenings, and lucid dreams are united by the term *phase* as they all mostly occur during REM phase (Raduga, Kuyava, et al., 2020). Recently it was shown that women are better at lucid dreaming (Raduga, Shashkov & Zhunusova, 2023), however it is unknown if they are better at operating inside them.

Research shows that during LDs, people can perform math calculations (Konkoly et al., 2021), carry out conscious motor actions (Schädlich, 2018; Schädlich et al., 2018), and create environments for treating fears, phobias and anxiety (Schatzman, 1983; Wittmann et al., 2006; Zhunusova et al., 2022), among many other applications. However, the limitations of what is possible inside LDs, as well as the full list of possible applications, is a subject to be studied. Exploration of creativity is one of the possible applications of LD. Even though LDs are mostly used for entertainment, up to 27% of dreamers use them for creative endeavors, such as drawing, writing, and playing music (Schädlich & Erlacher, 2012).

Auditory sensations are quite important in lucid dreaming practice. Some techniques for inducing LDs use acoustic signals (Erlacher et al., 2020), focusing on audial or combined sensations (Adventure-Heart, 2020). Also, in cases of complete darkness inside an LD, sounds and music might be the only sensation for anchoring consciousness (Magallón, 1991). Moreover, the overall musical experience in dreams is different from that in wakefulness. Generally, playing music in a LD does not require any advanced motor skills essential for playing the piano, guitar, violin, and other instruments. Therefore, playing music in LDs is more achievable for non-professional musicians and even for people without any musical background.

Some music professionals use LDs for inspiration and training. Previously, five musicians practicing LDs were interviewed (Schädlich & Erlacher, 2018), and one of them reported enjoying playing solo music in LDs. However, the interviewees had a specific aptitude to music. A recent study reported the possibility of not only inducing a particular piece of music in an LD but also transferring its rhythm into reality through electromyography sensors and specific muscle contractions, four volunteers were involved (Raduga et al., 2023).

Here, we report results obtained from over 250 participants with random backgrounds. They were given a task to enter LD in any manner of their choosing and to try at least once to hear a particular melody in an LD. This study will aid further research on LD applications, specifically those associated with creativity.

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Hypotheses

The main hypothesis of this study was that melodies can be intentionally created and heard in LDs by volunteers with non-specific background. The secondary hypotheses were that possible differences in achieving melody perception in LD depend on several factors, such as LD induction method and gender. The results could provide a better understanding of possible LD applications and the psychophysiological nature of sound perception.

2. Method

2.1. Resources and participants

This online study took place from December 15, 2018, to July 18, 2022. Enrolment was open to anyone, allowing LD practitioners from anywhere in the world to register to participate. During registration, volunteers agreed to provide their personal data. Following ethical and legal standards, before receiving assignments, all volunteers gave informed consent to participate in the experiments and assumed responsibility for any possible consequences of completing the assignments.

2.2. Experimental task

There were two types of instructions. Group A was asked to induce LDs in any way they wanted, try to hear any music of their choosing, and report the results. They were asked to try only once in order to avoid possible bias: volunteers, capable of staying in a LD longer, would have better results by making more efforts. Group B had a similar task, but they were asked to hear a particular melody per the following instructions:

"Enter a LD using any method. After separating from your body or becoming conscious while dreaming, you need to hear "Jingle Bells" by listening in your head or all around you. In order to do so, you can also turn on music players or find a music source or band in adjacent rooms and spaces. After the experiment, make a mental note of whether you were able to hear the song, and if so, evaluate how close it was to the original track and how it sounded in terms of quality: whether it was better or worse. There is no need to repeat the experience until you manage to hear the song! Try at least once and report what happens. Make a mental note of this task, and make it the first item in your plan of action in your next phase. The experiment should be performed at least once." See Supplementary File 1 for an example response.

2.3. Reports processing

The reports were obtained via on-line platform. All research participants confirmed through an online form their consent to participate in experiments and assume responsibility for any adverse consequences resulting from completing the assignments. In the reports, it was obligatory to describe the full experience in the details, including its inducing, completing the task, and ending. Each report was validated by the analysts with LD experience. By reading the report they fulfilled particular variables in a pre-created table: volunteer ID, report ID, how the LD was induced, how it ended, successfulness of the task - wether a volunteer succeed in hearing a particular melody or not, subjective quality - volume and clarity of the music (0 - no music heard, 1- low, 2 - normal, 3 - excellent, 4 - hyperrealistic), source of the music, volunteer's gender and overall LD experience.

Table 1. Study participants.

Participants	Group A	Group B	Total
Male	104	57	161
Female	67	26	93
Total	171	83	254

Note: Group A participants were asked to induce LDs in any way possible and try to hear any music of their choosing; Group B participants were asked to induce LDs in any way possible and try to hear the song "Jingle Bells."

2.4. Statistical analysis

Overall, 259 reports were received (see Supplementary Table 1). Each report included information on gender, the outcome of the task, the quality of the sound, the source of the sound, overall lucid dreaming experience, how the LD was induced, and how the LD ended. Reports from participants who provided several reports (n=4) were excluded from the analysis. In total, 250 reports from unique participants were analyzed.

The analysis was done using R programming language (v. 4.2.2). A Chi-square test was done using the chisq.test function. The metadata associations with the outcomes were analyzed using generalized linear models (glm function), which is suitable for non-uniformly distributed data. The U-test was chosen to test the equality of means in groups, the wilcox.test function was used for binary factors, and the pairwise.wilcox.test function was used for multiple-level factors. The visualizations were done using the "ggplot2" package (Wickham, 2016). Boxplots were drawn using a jitter option. P-value adjustment for multiple comparisons was made using a false discovery rate method.

3. Results

Overall, 254 participants (171 from Group A and 83 from Group B) provided 259 results; 176 results were obtained from Group A, and 83 were obtained from Group B (see Table 1). The participants comprised 36.6% females and 63.4% males (Table 1).

A homogenous sub-cohort was constructed to check if gender or differences in the group tasks influenced the outcomes. It consisted of randomly chosen 26 male Group A participants, 26 female Group A participants, 26 male Group B participants, and all 26 female Group B participants. The analysis with generalized linear models did not reveal any significant dependencies of gender or group with the outcomes (the presence or absence of the music) or with the quality of the sound (see Supplementary Table 2). Here, quality refers to the volume and clarity of the music.

Since no dependencies with gender or group were observed, the full cohort of reports from unique participants (250 reports) was used for the following analysis (see Methods). Of these, 210 reports expressed a positive result, meaning 84% of the participants succeeded in finding a particular piece of music in an LD. The Chi-square test

showed that the task of finding a particular melody inside an LD is achievable (χ^2= 115.6, p-value < 2.2e-16).

Further, we explored which factors could influence the success of the task. Regression analysis with a generalized linear model revealed that success in finding music in LDs was not associated with overall experience in LDs or the LD induction method (see Supplementary Table 3). The quality of the sound did not depend on the source of the sound (see the p-values in Supplementary Table 4). However, if sources are divided into those coming from outside and those generated inside participants' "dream bodies", it can be seen that participants who used both approaches simultaneously got better results than those who did not (U-test, p-value FDR adjusted both vs. inside = 0.02, p-value FDR adjusted both vs. outside = 0.03) (see Fig. 1). Particularly, 40% (n=11) of those participants, who used both approaches got music quality scores 3 and 4, which corresponds to «excellent» and «hyperrealistic» estimate. Only 24% (n = 6) and 32% (n = 39) participants, generating the music either inside or outside their "dream bodies" respectively, got music quality scores 3 and 4.

4. Discussion

We showed that finding music in an LD, whether a random or specific melody, is achievable, as 84% of the participants successfully completed the task. Interestingly, success depended on neither the LD induction method nor the participant's overall experience in lucid dreaming. Thus, hearing music in LDs is possible for beginners and can be done using any kind of induction technique, including dream-induced LDs, inducing upon awakening (indirect methods), and inducing upon falling asleep (direct methods). The induction techniques can be quite various and include «phantom» wiggling, sensory-motor visualization, visualising hands, etc. (Raduga, 2021). Even though women tend to have a predisposition for LD practice (Raduga, Shashkov & Zhunusova, 2023), in this case gender did not influence the outcome.

The results represent a step towards the broader aim of exploring the possibilities of LDs. The current experiment is part of a greater research project in which different aspects of acting in LDs are being studied (Drøm et al., 2023; Raduga, Shashkov, et al., 2020; Zhunusova et al., 2021). LDs are used by writers (Roklicer, 2023), musicians (Schädlich & Erlacher, 2012), and artists (Bogzaran, 2003) for inspiration. This is reasonable since LDs are characterised by different levels of consciousness with access to subconscious (Holzinger & Mayer, 2020). This combination is perspective for reaching an inner source of creativity.

The phenomenon of hearing music in dreams is already studied for some time (Massey, 2006; Raduga et al., 2023). Music dreams represent 4–8% of all remembered dreams (Olbrich & Schredl, 2019). Music is associated with the right cerebral hemisphere, which is also responsible for emotions (Joseph, 1988). Overall, the right hemisphere is active during REM sleep dreams, while lucid dreaming is characterized by activity in the right parietal lobe (Holzinger et al., 2006). A parietal lobe is involved in spatial processing, motion analysis (Husain & Nachev, 2007), auditory stream segregation,

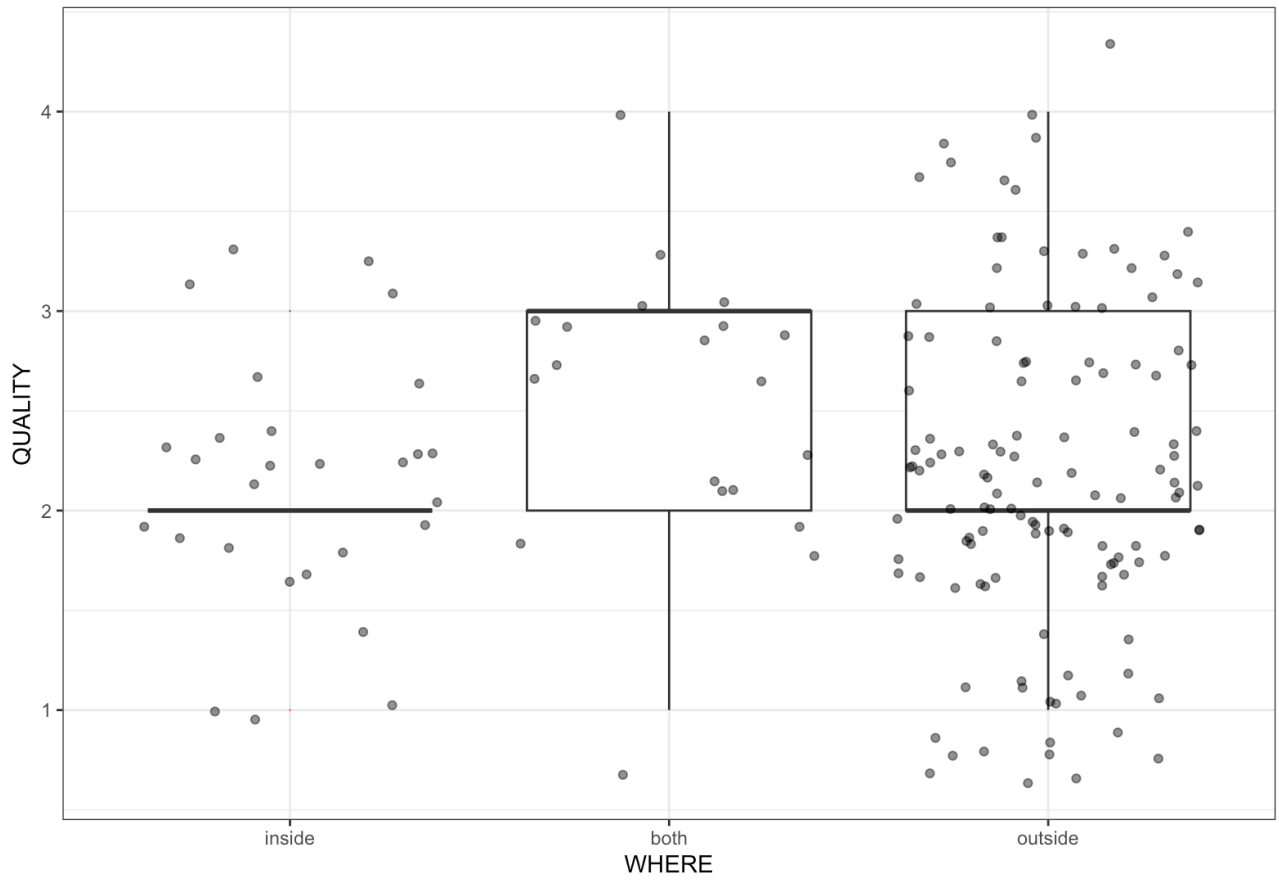

Figure 1. Boxplot showing the distribution of dream sound quality scores grouped by sound source.

and counting (Cusack, 2005),(Cappelletti, 2010). The right parietal lobe is also active in improvising musicians (Harris & De Jong, 2015). Previously, it was hypothesized that LD tasks involving the right hemisphere are easier to complete than those involving the left hemisphere (Piller, 2009), which also might be a circumstantial evidence of a higher activity of the mentioned brain part during LD. These are separate observations that give a hint on a potential neurobiological basis of LD, audial perception, and creativity, however the subject is yet to be studied.

Interestingly, music, unlike language and imagery, does not undergo distortion in dreams (Massey, 2006). This has led to the idea of obtaining original information in an unchanged manner in dreams in the form of music. Also, experiments have shown the possibility of transferring music rhythms directly from LDs in real-time (Raduga et al., 2023). As mentioned above, proficient skills in singing or playing music are unnecessary for a successful experience in a LD. In addition to motor skills, there are other barriers of psychological nature that hinder the arts during wakefulness but might be absent in LDs, such as self-judgment, fear of making mistakes. This is a subject to be studied in the future.

Taken together, the information presented above provides a background for highly creative LD applications that are available to everyone. Furthermore, LDs are a mental space for developing creative skills and inspiration, as well as an art playground.

Hypotheses confirmation

In line with our main hypotheses, people could hear both random and specific melodies in LDs. We did not observe any correlations between success in hearing a melody in LDs with the participants' experience, gender, or LD induction method (dream-induced LDs, techniques done upon awakening, or techniques done upon falling asleep).

5. Conclusions and Recommendations for Future Studies

We showed the possibility of inducing a particular melody in LDs, even by participants with little experience. Methods of the melody induction and how the participants intended to hear it did not influence the sound quality (volume and clarity). However, participants had slightly better results when they tried to hear the melody inside themselves and by finding external devices in the dream simultaneously. This highlights a particular skill that can be used with other approaches to complete complex tasks in LDs. Other types of arts should be tested in a similar way.

Future studies could be focused on finding unique melodies in LD and its overall quality. Also, future studies could clarify how the task of creating melodies in LD is associated with musical skills.

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Supplemental materials

Supplementary File 1 is available in the online version of the paper.

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