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REVIEW ARTICLE

A systematic review of new empirical data on lucid dream induction techniques

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Summary

Lucid dreams are defined as dreams in which the dreamers are aware of the fact that they are dreaming as dreams continue. It has been ~12 years since the last review of the efficiency of lucid dream induction techniques was conducted. Hence, the present study aimed to review the lucid dream induction techniques published in the past decade. The second aim was to propose a modified classification for the existing lucid dream induction techniques, including cognitive techniques, external stimulation, substance intervention, and cortical stimulation. The third aim was to assess the methodological quality of the studies included in the review. It was hypothesised that, comparing with the studies included in the last review, the studies included in the present review had better overall methodological quality. A total of 19 peer-reviewed studies were included and analysed in the present review, from which 14 lucid dream induction techniques were identified. The results indicated that the mnemonic induction of lucid dream technique was the most effective for inducing lucid dreams. Moreover, two new techniques, the senses-initiated lucid dream technique and galantamine intervention, might also be competitive candidates for lucid dream induction but further replications are needed. As hypothesised, the overall methodological quality of the studies included in the present review was higher than that of the studies included the previous review. In all, 17 studies had moderate methodological quality, whereas only three studies had poor methodological quality.

KEYWORDS
classification, induction methods, lucid dreaming

1 | INTRODUCTION

Lucid dreams are defined as dreams in which the dreamers are aware of the fact that they are dreaming as dreams continue (Van Eeden, 1913). They can either occur naturally or be induced by certain strategies. Over the past few decades, to study this phenomenon, many researchers have explored reliable strategies to induce lucid dreams (e.g., Erlacher, Schmid, Schuler, et al., 2020; Paulsson & Parker, 2006; Taitz, 2011). However, most of the studies conducted before 2010 for this purpose failed to find a reliable lucid dream induction method with a high success rate (Stumbrys et al., 2012). It has been ~12 years since the last review of the efficiency of lucid dream induction techniques was conducted (Stumbrys et al., 2012), during which time many new studies on the topic have been published. In light of the potential existence of a more efficient technique, a new systematic review of lucid dream induction techniques

emphasising their success rates is believed to be beneficial for future research on lucid dreams.

In lucid dreams, the dreamers have access to their memories of their waking lives and can subsequently realise that they are dreaming by comparing their waking memories with their dream contents (Dane, 1984). They are able to deliberately control the elements in their dreams (Stewart & Koulack, 1989) and are aware of this capability (Dyck et al., 2017). Most of the dreamers' contents are usually pleasurable (Schädlich & Erlacher, 2012; Stocks et al., 2020), e.g., flying, performing magic, or having sex (Appel et al., 2020; Kumar et al., 2018; Schädlich & Erlacher, 2012). A previous meta-analysis of 34 studies reported that ~55% of 24,282 individuals had experienced one or more lucid dreams in their lives and that ~23% of the same sample were frequent lucid dreamers, with at least one lucid dream per month (Saunders et al., 2016).

According to previous studies, lucid dreams can be detected through both objective measures, such as eye signals (e.g., Blanchette-Carrière et al., 2020; Carr et al., 2020; LaBerge, 1980), and subjective measures, such as logbooks (e.g., Aspy et al., 2017; Erlacher & Stumbrys, 2020; LaBerge et al., 2018). Eye signals are predetermined one- or multiple-time left–right eye movements practiced before implementing lucid dream induction techniques and detected by electro-oculogram later if lucid dreams occur during sleep (Carr et al., 2020; Blanchette-Carrière et al., 2020; Erlacher, Schmid, Schuler, et al., 2020). Subjective measurements (i.e., self-reports) are usually conducted after dreamers wake up, with or without the induction techniques of interest adopted, to record whether lucid dreams have occurred (e.g., Schredl et al., 2020).

The study of lucid dreams is essential, as the phenomenon of lucid dreaming and its implied mechanisms can be used for various clinical and research purposes. For instance, lucid dreaming can be used as a therapeutic tool for nightmare (Spoormaker et al., 2003). Not only can it reduce nightmare frequency, but it can also make the nightmare content less stressful and horrifying due to its controllable nature (Carr & Nielsen, 2017; Holzinger et al., 2020; Schädlich & Erlacher, 2012; Spoormaker et al., 2003; Spoormaker & van den Bout, 2006). In addition, there is evidence of a link between lucid dreams and positive emotions (Stocks et al., 2020; Voss et al., 2013). One who dreams a lucid dream tends to feel more vigorous and satisfied the next morning (Konkoly & Burke, 2019). Researchers have attributed such a link to the spill-over of the satisfying lucid dream contents to waking life (Voss et al., 2013). Moreover, previous studies have corroborated that one can practice physical, creative-thinking, and problem-solving skills through lucid dreaming (Erlacher & Schredl, 2010; Schädlich & Erlacher, 2012; Stumbrys & Daniels, 2010). Practicing lucid dreaming can also lead to decreased depression and anxiety (Holzinger et al., 2020) and better mental health (Stocks et al., 2020). Although Soffer-Dudek (2020) has raised concerns about the possibility that lucid dreams can lower sleep quality, most researchers have suggested the opposite (e.g., Holzinger et al., 2020; Spoormaker et al., 2003). For instance, researchers have reported that lucid dreams do not affect sleep quality (Schredl et al., 2020) or make sleep quality even better (Aspy, 2020). There is also evidence of mitigated insomnia symptoms in lucid dreamers (Ellis, De Koninck, & Bastien, 2020).

Various lucid dream induction techniques have been established and the reliability of these techniques has been of utmost concern for the researchers in this field (Appel et al., 2020). Stumbrys et al. (2012) listed up to 17 lucid dream induction methods from studies conducted before 2010 and grouped them into three categories: 'cognitive techniques', 'external stimulation', and 'miscellaneous techniques' (Table 1).

Lucid dreams can be elicited either from the state of being awake or from the state of dreaming (LaBerge, 1986). Researchers named lucid dreams elicited from the state of being awake as 'wake-initiated lucid dreams' (WILD) and named those elicited from the state of dreaming as 'dream-initiated lucid dreams' (DILD) (LaBerge et al., 1986). For the latter, most are detected or can be induced during rapid eye movement (REM) periods (LaBerge, 1990) and some during non-REM periods (Dane, 1984). LaBerge and Rheingold (1990) further provided some examples for WILD, such as focusing on hypnagogic imagery, the dreamer's own breath, or sensations in the dreamer's own body. In the review by Stumbrys et al. (2012), the cognitive techniques were further categorised into DILD and WILD (Table 1), based on the LaBerge and Rheignold (1990) explanation of DILD and WILD. DILD included mnemonic induction of lucid dreams (MILD), reality test (RT), Tholey's combined techniques, autosuggestion, intention, post-hypnotic suggestion, and alpha feedback (Stumbrys et al. 2012). The autosuggestion technique is one of the three techniques in Tholey's combined technique, which requires one to suggest oneself, before falling asleep, to have a lucid dream (Tholey, 1983). Intention is another one of the three techniques in Tholey's combined technique (Tholey, 1983). It is similar to MILD as both techniques require one to imagine, before falling asleep, being in a dream (LaBerge et al., 2018; Tholey, 1983). However, one needs to *recognise* that one is in a dream when using the intention technique, whereas MILD requires one to *remember* that one is dreaming (Stumbrys et al., 2012). Post-hypnotic suggestion means to suggest to a participant in a hypnotic trance to have a lucid dream the following night (Stumbrys et al., 2012). In alpha feedback, participants were given electroencephalography (EEG) alpha activity biofeedback training prior to sleep onset to induce lucid dream but no effect was reported (Ogilvie et al., 1982). The MILD, RT, and Tholey's combined techniques will be discussed in detail in the following methods section. For the WILD techniques, two techniques, counting and body image, were included in the review by Stumbrys et al. (2012). Counting involves one to focus one's mind on counting while falling asleep, whereas the body image technique requires one to focus on one's body while falling asleep (Stumbrys et al., 2012).

External stimulation involves the use of light, acoustic, vibro-tactile, electro-tactile, vestibular, and water stimulation (Stumbrys et al., 2012). In the light stimulation technique, light cues were delivered via devices such as DreamLight (LaBerge, 1988). Acoustic stimulation involved spoken short sentence ('this is a dream'), buzzer noise, or a musical tone (Kueny, 1985; Ogilvie et al., 1983). Other techniques that did not fall under either of these two categories were categorised as miscellaneous techniques, which was the use of donepezil (Stumbrys et al., 2012).

TABLE 1 Comparison of the previous classification versus the modified classification

Classification by Stumbrys et al. (2012)	Cognitive techniques		External stimuli	Miscellaneous	
	DILD	WILD		Drug application	Others
	MILD	Counting	Light stimulus	Donepezil	WBTB
	RT	Body image	Acoustic stimulus		
	Tholey's combined techniques		Vibro-tactile stimulus		
	Autosuggestion		Electro-tactile stimulus		
	Intention		Vestibular stimulation		
	Post-hypnotic suggestion		Water stimulus		
	Alpha feedback				

Modified classification in the present study	Cognitive techniques (w/o WBTB)			External stimuli (w/o WBTB)	Substance intervention (w/o WBTB)	Cortical stimulation (w/o WBTB)
	DILD	WILD	Others			
	MILD	SSILD	Dream diary	Visual stimulation	α-GPC	tACS
	RT		MBSR	Auditory stimulation	Galantamine	tDCS
	Tholey's combined techniques			Tactile stimulation		
				Odour stimulation		

Abbreviations: α-GPC, L-alpha glycerylphosphorylcholine; DILD, dream-initiated lucid dreams; MBSR, mindfulness-based stress reduction; MILD, mnemonic induction of lucid dreams; RT, reality test; SSILD, senses-initiated lucid dream; tACS, transcranial alternating current stimulation; tDCS, transcranial direct current stimulation; WBTB, wake-up-back-to-bed (sleep protocol); WILD, wake-initiated lucid dreams; w/o, without.

Stumbrys et al. (2012) further evaluated the effectiveness evidence level of all lucid dream induction techniques. Six out of 17 lucid dream induction techniques have successfully induced lucid dreams in at least two studies, with no divergent evidence present; nine of the 17 techniques showed some success but the findings were ambiguous, or the studies were lacking in replications; two of the 17 techniques did not successfully induce lucid dreams (Stumbrys et al., 2012). Among all the techniques included, Tholey's combined technique and MILD seemed to be more promising than the others (Stumbrys et al., 2012). In addition, overall, the studies analysed in the last review suffered from small sample sizes and poor methodological quality (Stumbrys et al., 2012).

Indeed, the Stumbrys et al. (2012) lucid dream induction technique classification system is all-encompassing due to the inclusion of the third category (i.e., miscellaneous techniques). However, while this classification system could have been appropriate and sufficient for grouping lucid dream induction techniques 12 years ago, it seems to be limited now. With new lucid dream induction techniques emerging (Aspy, 2020; Blanchette-Carrière et al., 2020; Kern et al., 2017; LaBerge et al., 2018), more specific categories may benefit future studies.

With the foregoing in mind, we determined the objectives of the present study. The first aim of the study was to review studies on lucid dream induction techniques published after 2010, with an emphasis on the descriptive statistics of the efficiency of such techniques. The year of 2010 was chosen because that was the year when Stumbrys et al. (2012) completed their literature research. The results of the present review were analysed and compared with those of the Stumbrys et al. (2012) systematic review.

Second, the present review aimed to propose a modified version of the lucid dream induction techniques classification system proposed by Stumbrys et al. (2012). To elaborate, 'external stimulation' and 'cognitive techniques' were retained. 'Miscellaneous techniques' was changed to 'substance intervention', which includes substances taken by all means (e.g., pills). A new category, 'cortical stimulation', was added, which involves electrical stimulation delivered over the cerebral cortex. The use of cortical stimuli was not categorised as external stimulation because such stimuli are fundamentally different. External stimuli are used as cues to remind dreamers that they are dreaming (Carr et al., 2020; Erlacher, Schmid, Schuler, et al., 2020), while cortical stimuli influence dreamers' dreamed consciousness by affecting their cortical excitability (Stumbrys et al., 2013).

The third aim of the present study was to compare the methodological quality of the included studies with that of the studies examined in the Stumbrys et al. (2012) review. An elevated methodological quality was hypothesised because only peer-reviewed articles were involved in the present study.

2 | METHODS

2.1 | Literature search

Relevant studies were sourced from the following online databases: Ovid, PubMed, Ageline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Academic Search Complete, and SCOPUS. The search query string was Lucid* AND Dream* AND (induc*

OR learn* OR method* OR strateg*). The included articles were limited to peer-reviewed journal articles, and the publication year of the articles was set to 2010–2022.

2.2 | Inclusion and exclusion criteria

Articles reporting empirical studies including all the following elements were added to the present study: (i) one or more lucid dream induction strategies; (ii) objective and/or subjective lucid dream detection techniques; and (iii) empirical evidence of the efficiency (i.e., success rates) of the induction techniques, presented by technique or by sample group. Peer-reviewed articles were included solely for the sake of consistency and reliability. Studies with a sample size equal to or smaller than five were excluded. The language was restricted to English only. Studies conducted in laboratory settings or home environments were considered.

2.3 | Procedure

The literature search started in March 2022 and ended in April 2022. Articles were screened for the first time according to their titles and abstracts. Next, all the remaining articles were read scrupulously and sifted through for a second time based on the inclusion and exclusion criteria. Meanwhile, information on the following was extracted from the included studies: type of experiment performed, lucid dream induction techniques, participants' descriptive data, experimental procedure used, measurements taken, and empirical information on lucid dream induction technique efficiency.

2.4 | Data analysis

The descriptive data extracted from the included studies are shown supplemental table (Table S1). The Downs and Black (1998) checklist was used to determine the studies methodological quality for two reasons. First, as the methodological quality of the studies included in the present review was compared with that of the studies included in the last review (Stumbrys et al., 2012), the same checklist should be used for them to be comparable. Second, according to the creators of the Downs and Black (1998) checklist, most of its items have high validity and reliability. Although further improvements are necessary, the Downs and Black (1998) checklist is a comprehensive and qualified tool suitable for the assessing the methodological quality of both randomised and non-randomised studies (Deeks et al., 2003; Downs & Black, 1998).

The Downs and Black (1998) checklist has five question sections: Reporting (10 items), External validity (three items), Internal validity – bias (seven items), Internal validity – confounding (selection bias) (seven items), and Power (one item), totalling 27 items (see Figure S1). Questions 1–4, and 6–10 are answered by choosing 'Yes' or 'No' (scored 1 and 0, respectively); question 5 is answerable by 'Yes', 'Partially', or 'No' (scored 2, 1, and 0, respectively); and questions 11–26 are answerable by 'Yes', 'No', and 'Unable to determine' (scored 1, 0, and 0, respectively) (Downs & Black, 1998). The last question should have six score levels (Downs & Black, 1998), but to be consistent with the Stumbrys et al. (2012) study, the maximum score for item 27 was determined to be 1. The answer choices for the last item were changed to: 'Yes', 'No', and 'Unable to determine' (scored 1, 0, and 0, respectively). The total score was thus 28 points. The grading criteria were the same as those used by Stumbrys et al. (2012): total scores <11 were rated as 'Poor'; those ranging from 11 to 20 were rated as 'Moderate'; and those >20 were rated as 'Good' (Hartling et al., 2004). The studies were independently assessed by two researchers according to the aforementioned checklist. Differences in grading were discussed, and unity was reached. The average scores overall and by section were recorded. However, the mean scores by lucid dream induction technique were not calculated due to overlapping studies using mixed induction techniques. An independent *t* test was conducted to assess the difference between the average scores of the studies included in the last review (Stumbrys et al., 2012) and in the present review.

3 | RESULT

3.1 | Included and excluded studies

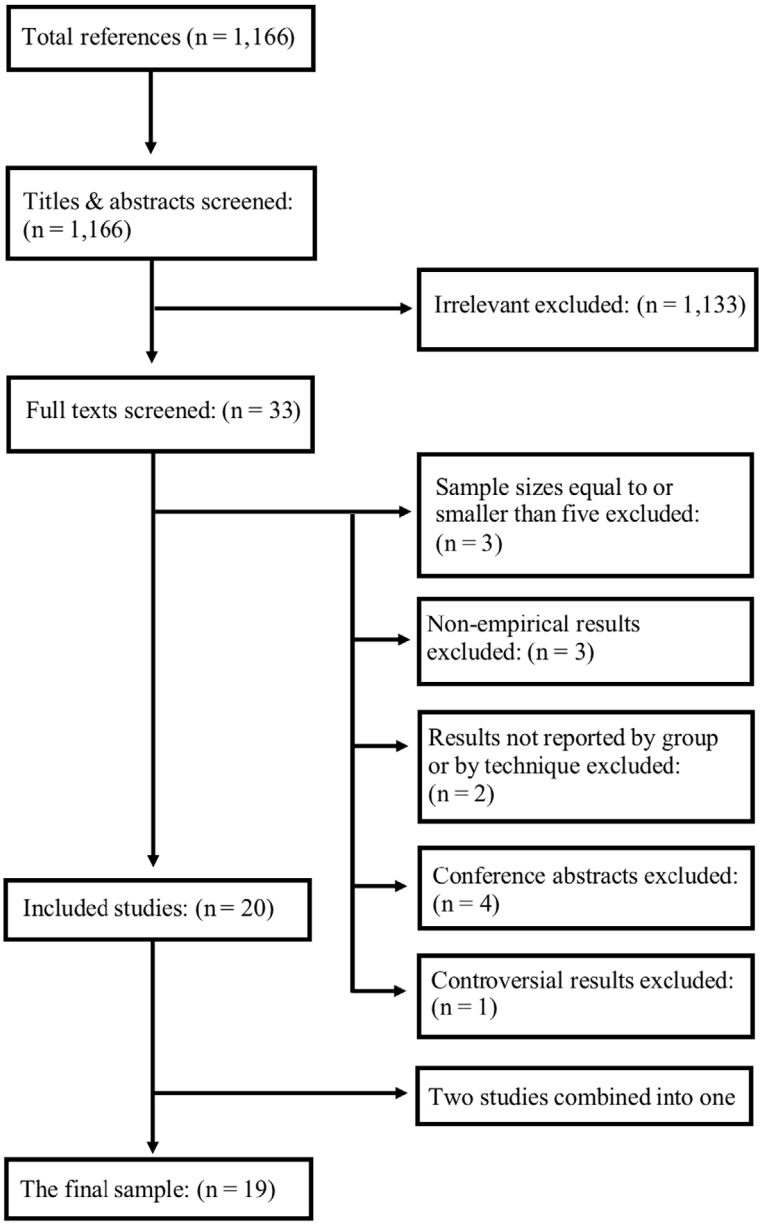
The search query results demonstrated a total of 1,166 studies, among which there were repeated articles. The initial article screening yielded 33 studies. The remaining 1,133 references were excluded due to irrelevant titles and abstracts. After the full texts of all the 33 articles were perused, 11 studies were rejected for the following reasons: their sample sizes were equal to or smaller than five (three articles); no empirical data on success rates were provided (three); the study results were not reported by groups or by technique (two); they were conference abstracts and the full texts were not available (four); and the results were controversial (one). The flowchart of the literature search is shown in Figure 1.

The studies by Dyck et al. (2017, 2018) were counted as one study and their results were combined together because both of the studies involved the same group of data and the difference lay solely in the types of measurements the researchers adopted (i.e., self-rated and judge rated Dyck et al., 2017, 2018). Our aim was not to compare the consistency between different measurements for lucid dream induction; therefore, the final sample of the present review comprised 19 studies published within the period from 2011 to 2020.

3.2 | Descriptive information

Specific information was extracted from the included studies and is listed in the supplemental table (Table S1) as follows: type, method(s), participants, procedures, measure(s), success rates, and

FIGURE 1 Flowchart of the literature search



methodological quality. As displayed in the 'Type' column, nine studies were conducted in laboratories, nine in home settings (fields), and one in both laboratory and home settings. Eight studies employed a within-subjects design, five used a between-subjects design, and five adopted both within- and between-subjects designs. Two studies had neither a within-subject design nor a between-subjects design. The minimum sample size was 11, and the maximum sample size was 355. In all, 12 studies had sample sizes <60, whereas seven studies had sample sizes >100.

The lucid dream induction strategies are showed under the 'Method(s)' column. A total of 14 techniques were identified: seven cognitive and behavioural techniques, four kinds of external stimulation, two types of substances, and two kinds of cortical stimulation. The techniques identified in the present review are also shown in Table 1, with a comparison between the previous classification and the new classification.

Essential information relevant to the participants (e.g., sample size, gender distribution, mean age), and the experimental procedures (e.g., duration of the experiments) were recorded in the 'Participants' column and the 'Procedures' column, respectively. Additionally, the means for detecting lucid dreams (objective, subjective, or both) are given in the 'Measure(s)' column.

In the 'Success Rates' column, empirical evidence of the efficiency of each lucid dream induction technique was reported. Lucid dream frequencies (LDFs) have been operationalised differently in previous studies. Some counted the nights when lucid dreams occurred (e.g., Aspy et al., 2017; Schredl et al., 2020), whereas others calculated the proportion of participants who reported having had lucid dreams (e.g., Carr et al., 2020; Erlacher, Schmid, Schuler, et al., 2020; LaBerge et al., 2018). The former was recorded as LDF and the latter was recorded as lucid participants (L participants) in Table S1.

TABLE 2 Methodological quality of the 19 included studies

Reference	Reporting										External validity			Internal validity – bias							Internal validity – confounding (selection bias)						Power	Total	Quality level
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		
Appel et al. (2020)	Y	N	Y	Y	N	Y	Y	N	U	Y	U	U	N	N	N	Y	U	Y	Y	Y	U	N	U	Y	U	U	U	11	Moderate
Aspy (2020)	Y	N	Y	Y	Y	Y	N	N	U	Y	U	U	Y	U	U	Y	U	Y	Y	Y	N	U	Y	Y	N	U	U	14	Moderate
Aspy et al. (2017)	Y	N	Y	Y	Y	Y	N	Y	U	Y	U	U	Y	Y	U	Y	U	Y	Y	Y	N	U	Y	Y	N	U	U	16	Moderate
Baird et al. (2019)	Y	N	Y	Y	Y	Y	N	N	Y	Y	U	U	Y	U	U	Y	N	Y	Y	Y	U	U	N	Y	Y	U	U	15	Moderate
Blanchette-Carrière et al. (2020)	Y	N	Y	Y	Y	Y	N	N	U	Y	U	U	N	Y	N	Y	U	Y	Y	Y	Y	U	N	Y	Y	U	U	15	Moderate
Carr et al. (2020)	Y	N	Y	Y	Y	Y	Y	N	U	Y	U	U	N	U	Y	Y	U	Y	Y	Y	N	U	Y	Y	Y	U	U	16	Moderate
Dyck et al. (2017, 2018)	Y	N	N	Y	Y	Y	Y	N	U	Y	U	U	Y	U	U	Y	U	Y	U	Y	N	U	Y	Y	Y	U	U	14	Moderate
Erlacher, Schmid, Bischof, et al. (2020)	Y	N	N	Y	N	Y	Y	N	U	Y	U	U	N	U	Y	Y	U	Y	Y	Y	Y	U	Y	Y	N	U	U	13	Moderate
Erlacher, Schmid, Schuler, et al. (2020)	Y	N	Y	Y	Y	N	Y	N	U	Y	N	N	N	U	Y	U	U	Y	Y	Y	Y	U	N	Y	U	U	U	13	Moderate
Erlacher and Stumbrys (2020)	Y	N	N	Y	Y	Y	Y	N	U	Y	N	N	N	U	Y	Y	U	Y	Y	Y	Y	U	N	Y	Y	U	U	15	Moderate
Kern et al. (2017)	Y	N	Y	Y	N	Y	Y	N	U	Y	U	U	N	Y	Y	Y	U	Y	Y	Y	U	U	Y	Y	N	U	U	14	Moderate
Kumar et al. (2018)	N	N	Y	N	N	N	Y	N	U	N	U	U	U	U	U	Y	U	Y	U	Y	Y	U	Y	Y	N	Y	U	9	Poor
LaBerge et al. (2018)	Y	N	Y	Y	Y	Y	Y	Y	U	Y	U	U	Y	Y	Y	Y	U	Y	U	Y	Y	U	Y	Y	Y	U	U	19	Moderate
Paul et al. (2014)	Y	N	N	Y	N	Y	Y	N	U	N	N	N	N	N	N	U	U	Y	Y	Y	Y	Y	U	Y	U	U	U	10	Poor
Saunders et al. (2017)	Y	N	Y	Y	Y	Y	Y	N	U	Y	U	U	Y	Y	N	Y	U	Y	Y	Y	U	U	Y	Y	Y	U	N	17	Moderate
Schmid & Erlacher, 2020	Y	N	N	Y	Y	N	Y	N	U	U	U	U	N	Y	Y	U	U	U	Y	U	U	U	Y	Y	Y	U	U	11	Moderate
Schredl et al. (2020a)	Y	N	N	Y	N	Y	Y	N	U	Y	U	U	Y	Y	U	Y	U	Y	U	Y	Y	U	Y	Y	N	U	U	13	Moderate
Stumbrys et al. (2013)	Y	N	Y	Y	N	Y	Y	Y	U	Y	U	U	N	Y	Y	Y	U	Y	Y	Y	Y	U	Y	Y	N	U	U	16	Moderate
Taitz (2011)	Y	N	Y	Y	Y	N	Y	N	U	N	U	U	Y	N	N	Y	U	Y	U	Y	Y	U	Y	Y	Y	U	U	14	Moderate
Average										5.50			0.40							4.10						2.65	0	13.95	
Total																													17 Moderate; 2 Poor

TABLE 3 Means and standard deviations of the Downs and Black (1998) checklist scores of the studies included in the previous review and in the present review

Groups	N	Mean (SD)
Stumbrys et al. (2012)	35	9.09 (4.33)
The present study	19	13.95 (2.48)

Lastly, the score of each study on the Downs and Black (1998) checklist is displayed in the 'Methodological Quality' column.

3.3 | Methodological quality

The scores of the included studies on the Downs and Black (1998) checklist are shown in Table 2. The average score of all the studies was 13.95 out of 28, which represents moderate methodological quality. The scores of 17 studies reached the standard of moderate methodological quality, whereas two studies had poor methodological quality. No study scored >20. Section Reporting, External validity, Internal validity – bias, Internal validity – confounding (selection bias), and Power scored 5.50 out of 11, 0.40 out of 3, 4.10 out of 7, 2.65 out of 6, and 0 out of 1 on average, respectively.

The independent *t* test was administered using the Statistical Package for the Social Science (SPSS), version 22.0. The assumption of homogeneity of variance was tested via Levene's *F* test, $F(52) = 12.38$, $p < 0.001$, and was therefore not satisfied. There was a significant difference in the average Downs and Black (1998) checklist scores between studies included in the last review (Stumbrys et al., 2012) (mean [SD] 9.09 [4.33]) and the studies included in the present review (mean [SD] 13.95 [2.48]; $t[51.78] = -5.24$, $p < 0.001$). The descriptive statistics are listed in Table 3.

3.4 | Lucid dream induction techniques

A total of 14 lucid dream induction techniques were identified, which included six cognitive techniques, four kinds of external stimulation, two types of substance intervention, and two kinds of cortical stimulation. According to the LaBerge and Rheingold (1990) definitions of DILD and WILD, cognitive techniques were further divided into three subgroups: DILD, WILD, and others (refers to the techniques that do not fit into the first two subgroups). A comparison of the present classification and the previous one by Stumbrys et al. (2012) is presented in Table 1.

3.5 | Cognitive techniques

In all, 14 of the 19 studies in the present review adopted cognitive and behavioural techniques, including MILD, RT, dream diary, Tholey's combined technique, senses-initiated lucid dream (SSILD), and mindfulness-based stress reduction (MBSR).

3.5.1 | Mnemonic induction of lucid dreams

The MILD technique requires the dreamer to wake up in the middle of the night, imagine a previous dream, convince themself to remember dream signs if dreaming again, go back to sleep and become lucid while falling asleep (LaBerge et al., 2018). This induction technique was applied in eight studies (i.e., Appel et al., 2020; Aspy, 2020; Aspy et al., 2017; Dyck et al., 2017, 2018; Erlacher & Stumbrys, 2020; LaBerge et al., 2018; Saunders et al., 2017; Schredl et al., 2020). Six of the eight studies showed a significant increase in the number of lucid dreams or lucid participants, in which five studies applied MILD independently. The sample sizes ranged from 20 to 355. Six studies were conducted in home settings, and two were conducted in laboratory settings.

3.5.2 | Reality test

When one practices a RT, one will attempt to elicit lucidity in dreams by frequently asking oneself 'Am I in a dream?' and examining one's surroundings (Taitz, 2011). In most of the previous lucid dream studies, the participants were asked to perform RT at least 10 times a day, in the daytime and/or during their dreams (Aspy, 2020; Dyck et al., 2017). On some occasions, this technique was also conjoined with external cues so that the participants would check their surroundings whenever a stimulus was delivered (Erlacher, Schmid, Schuler, et al., 2020). Variations in RT were also proposed in a previous study: RT Hands and RT Breath (Aspy, 2020). For the former, the participants were asked to use the fingers of one hand to poke through the other hands palm; for the latter one, the participants were asked to breathe through their mouth as their lips were closed (Aspy, 2020).

The aforementioned technique was assessed independently in three studies (i.e., Aspy et al., 2017; Dyck et al., 2017; Taitz, 2011), combined with other techniques in three studies (i.e., Aspy, 2020; Erlacher, Schmid, Bischof, et al., 2020; Saunders et al., 2017), and conducted with the wake-up-back-to-bed (WBTB) sleep protocol in two studies (i.e., Erlacher, Schmid, Schuler, et al., 2020; Schmid & Erlacher, 2020). Only one study showed a significant increase in LDF, but the effect of RT could not be identified due to the presence of other techniques.

3.5.3 | Dream diary

A dream diary is usually adopted to increase dreamers' dream recall frequency (Schredl, 2002). In one study (Dyck et al., 2017), the participants were asked to write entries for their dream diaries every morning for 3 weeks, but their LDF eventually did not increase significantly. In addition, the dream diary was combined with other lucid dream induction techniques in another study (i.e., Saunders et al., 2017) in which the participants wrote entries for their diaries every day for 4 weeks. The result (45% LDF) was significant (Saunders et al., 2017), but it could be attributable to other techniques (e.g., MILD).

3.5.4 | Senses-initiated lucid dream

The SSILD technique was used in only one study (i.e., Aspy, 2020). When the participants woke up after 5 h of sleep, they were asked to focus on their vision, hearing, and bodily sensations. Four fast cycles and six slow cycles were required before they went back to sleep. The results indicated that SSILD elevated LDF significantly and that SSILD was as effective as MILD (Aspy, 2020).

3.5.5 | Mindfulness-based stress reduction

The MBSR technique is a meditation course for alleviating anxiety, stress, and depression (Baird et al., 2019; Kabat-Zinn et al., 1985). Baird et al. (2019) assigned a portion of meditation- naïve participants to attend MBSR training for 8 weeks. Ultimately, this method was ineffective in terms of inducing lucid dreams. However, it is worth noting that long-term meditators experienced significantly more lucid dreams than meditation-naïve participants (Baird et al., 2019).

3.5.6 | Tholey's combined technique

Tholey's combined technique requires a dreamer to perform reflection, intention, and autosuggestion before attempting to fall asleep (Tholey, 1983). Reflection is a technique similar to RT, which asks a dreamer to examine one's surroundings and check if one is in a dream. The intention technique means to rehearse being in a dream and autosuggestion means to suggest that one is lucid in one's dreams (Tholey, 1983), as discussed earlier. This method was applied in only one study (i.e., Kumar et al., 2018). Six naïve lucid dreamers were asked to practice Tholey's combined technique for 3 months (Kumar et al., 2018). The results reported much higher success rates than the control group, whose members did not attend the training (Kumar et al., 2018).

3.6 | External stimulation

Five of the 20 studies (Erlacher, Schmid, Bischof, et al., 2020; Erlacher, Schmid, Schuler, et al., 2020; Kumar et al., 2018; Paul et al., 2014; Schmid & Erlacher, 2020) used external stimuli to induce lucid dreams, including odour, auditory, visual, and tactile stimulation.

3.6.1 | Odour stimulation

In the Erlacher, Schmid, Schuler, et al. (2020) study, the participants were conditioned through odour stimulation with RT. The desired outcome was that the participants would be able to perform RT in their dreams and become lucid when odour cues were delivered. The results did not indicate a significant increase in lucid participants compared with the control group (Erlacher, Schmid, Schuler, et al., 2020). This not only implied that odour stimulation might not be a powerful induction technique but also further confirmed that RT with WBTB might not be effective.

3.6.2 | Auditory stimulation

Auditory stimulation was employed in four studies (i.e., Carr et al., 2020; Erlacher, Schmid, Bischof, et al., 2020; Schmid & Erlacher, 2020). In the Carr et al. (2020) study, significant increases in LDF and the number of lucid participants were detected. However, auditory stimulation was combined with visual cues. Hence, the effectiveness of this technique alone could not be confirmed. In another study the results were ambiguous, as a significant difference was detected only in subjectively measured LDF and lucid participants (Erlacher, Schmid, Bischof, et al., 2020).

3.6.3 | Visual stimulation

Two studies (i.e., Carr et al., 2020; Paul et al., 2014) delivered visual stimuli (flashing red light-emitting diodes), while the participants were sleeping. Significant results were reported in the study by Carr et al. (2020) but it could not be explained by either visual or auditory cues, as discussed earlier. Paul et al. (2014) concluded that this induction method was ineffective in their study.

3.6.4 | Tactile stimulation

Paul et al. (2014) delivered tactile stimuli to the ankles, wrists, and index fingers of another group of participants. The researchers reported that the proportion of lucid participants was also rather low (Paul et al., 2014).

3.7 | Substance intervention

Two of the 20 studies (Kern et al., 2017; LaBerge et al., 2018) used substances to induce lucid dreams in the participants, including L-alpha glycerylphosphorylcholine (α-GPC) and galantamine.

3.7.1 | L-alpha glycerylphosphorylcholine

L-alpha glycerylphosphorylcholine is one of the precursors of acetylcholine that can cross the brain–blood barrier (Kern et al., 2017). Compared with donepezil, which was analysed in the previous systematic review (i.e., Stumbrys et al., 2012), α-GPC may have fewer side-effects (Kern et al., 2017). The researchers provided two α-GPC capsules, each containing 1.2 g α-GPC, to each of the 40 participants. No significant effect was reported (Kern et al., 2017).

3.7.2 | Galantamine

Galantamine is a fast-acting acetylcholinesterase inhibitor with few side-effects (LaBerge et al., 2018). The researchers distributed 0, 4, and 8 mg galantamine to 121 participants. A significant positive correlation was found between the dose of galantamine and the number of lucid participants (LaBerge et al., 2018).

3.7.3 | Cortical stimulation

Two of the 20 studies included in the present review (i.e., Blanchette-Carrière et al., 2020; Stumbrys et al., 2013) adopted cortical stimulation, including transcranial alternating current stimulation (tACS) and transcranial direct current stimulation (tDCS).

3.7.4 | Transcranial alternating current stimulation

For tACS an alternating current, at a pre-determined frequency and intensity, is delivered to the scalp of a participant via electrodes for lucid dream induction (Blanchette-Carrière et al., 2020). It was suggested that tACS could modulate cerebral oscillations and subsequently alter the pertinent cognitive processes (Blanchette-Carrière et al., 2020). In the study by Blanchette-Carrière et al. (2020), tACS at 40 Hz with an intensity of 250 μA was delivered to the participants for a total of 2.5 min. Comparing with the sham group, no effect on lucid dream induction was detected (Blanchette-Carrière et al., 2020).

3.7.5 | Transcranial direct current stimulation

The Stumbrys et al. (2013) study was the only one that used tDCS. They first tested the participants' sensitivity to tDCS and then delivered 1 mA tDCS over the dorsolateral prefrontal cortex (DLPFC) for 10 min while the participants were in REM periods (Stumbrys et al., 2013). The results indicated that the self-reported dream lucidity increased under the condition of tDCS, although the effect was mild (Stumbrys et al., 2013).

4 | DISCUSSION

The present review summarised and analysed 19 articles reporting empirical studies on lucid dream induction techniques published after 2010, with a focus on the efficiency of such techniques. A total of 14 induction techniques and an induction condition (i.e., WBTB) were identified, several of which were potentially efficient, although future replications are necessary to verify their reliability. In addition, a modified classification system of lucid dream induction techniques based on the Stumbrys et al. (2012) work was proposed (Table 1), including categories 'cognitive techniques', 'external stimulation', 'substance intervention', and 'cortical stimulation'. Two new categories in the present classification replaced the 'miscellaneous techniques' in the previous classification (Stumbrys et al., 2012): 'substance intervention' represents the application of drugs; 'cortical stimulation' involves the delivery of electrical current to the cerebral cortex. Furthermore, the methodological quality of all the 19 studies included in the present study was assessed via the Downs and Black (1998) checklist and is listed in Table 2. Overall, the included studies had a moderate methodological quality as the mean score was 13.95. The average Downs and Black (1998) checklist score of the studies included in the last review (Stumbrys et al., 2012) was significantly different from that of the studies included in the present review.

In order to assess the effectiveness of all the lucid dream induction techniques from a clearer perspective, we created a table similar to the 'traffic light' metaphor in the Stumbrys et al. (2012) review to define the effectiveness evidence levels (Table 4). Level 'effective' means that the technique was shown to be effective in more than one study without inconsistent evidence; level 'insufficient/ambiguous' represents that the technique successfully induced lucid dreams in only one study or that the results were ambiguous; and level 'ineffective' represents that the technique was not effective. These three levels corresponds to the 'green', 'yellow', and 'red' in the Stumbrys et al. (2012) review. In the previous review, six techniques were coded as 'green' (i.e., MILD, reflection, intention, Tholey's combined technique, light stimulation, and WBTB), nine were coded as 'yellow' (i.e., autosuggestion, post-hypnotic suggestion, counting, body image, donepezil, and auditory, vibro-tactile, electro-tactile, and vestibular stimulation), and two were coded as 'red' (i.e., alpha feedback and water stimulation) (Stumbrys et al., 2012). In the present review, only one was rated as 'effective' (i.e., MILD), seven were rated as 'insufficient/ambiguous' (i.e., RT, Tholey's combined technique, SSILD, dream diary, galantamine, and visual and auditory stimulation), and six were rated as 'ineffective' (i.e., MBSR, α-GPC, tACS, tDCS, and tactile and odour stimulation).

Prior to the discussion of all the other lucid dream induction techniques, a modification to WBTB should first be discussed. In WBTB, dreamers first need to sleep for several hours, wake up in the early morning, stay awake for a short period of time, and go back to sleep (e.g., Dyck et al., 2017; LaBerge et al., 2018; Schmid & Erlacher, 2020). While it is true that WBTB was considered as an independent lucid dream induction technique in some of the previous studies (e.g., Appel et al., 2020; Stumbrys et al., 2012), we identified it as a condition that can be added to other techniques for the following reasons. First, in the majority of the previous studies on lucid dream induction techniques, the effect of WBTB could not be separated from that of MILD, a technique that contains WBTB, as both of them were applied together. Specifically, all the studies adopted WBTB in the last review (Stumbrys et al., 2012) and five of 10 studies applied WBTB in the present review (e.g., Appel et al., 2020; Aspy, 2020; Saunders et al., 2017) combined WBTB with the MILD technique. Second, researchers sometimes confused the operation of WBTB with that of MILD (Dyck et al., 2017; Schredl et al., 2020). Third, even in cases where WBTB was not mixed with MILD, it was rarely applied independently. Four of the 10 studies combined it with other

cognitive techniques (e.g., dream diary), substance intervention (galantamine) and external stimulation (odour stimulation) (e.g., Erlacher, Schmid, Schuler, & Rasch, 2020; Erlacher & Stumbrys, 2020; LaBerge et al., 2018). Only one of the 10 studies separated the effectiveness of WBTB from other techniques by distributing participants into 'RT' group, 'RT + WBTB' group, and 'RT + WBTB + MILD' group (Aspy et al., 2017). The results neither showed a significant difference between 'RT' group and 'RT + WBTB' group nor did they report a significant pre- to post-test difference in both of these groups (Aspy et al., 2017). However, even if a significant effect of WBTB was presented, it might be equivalently attributable to the combination of RT and WBTB as it might be to WBTB itself. In light of this, we decided to identify WBTB as a condition that could affect the induction rates of the independent lucid dream induction techniques. For instance, if Aspy et al. (2017) adopted the present lucid dream induction techniques classification, they should describe the first group as 'RT without WBTB' and the second group as 'RT with WBTB'. It needs to be mentioned that although we identified WBTB as a condition available for all techniques, there was no study that combined WBTB with cortical stimulation. Future studies may apply such a combination and assess if WBTB could affect the lucid dream induction rates of cortical stimuli.

As shown in Table 4, the most effective lucid dream induction technique reviewed in the present study was MILD, consistent with the Stumbrys et al. (2012) results. The MILD technique successfully induced lucid dreams in six studies (e.g., Aspy, 2020; Aspy et al., 2017; Erlacher & Stumbrys, 2020), confirmed either objectively or subjectively, and was coded as 'effective' in Table 4. It was reported to have had a considerably low success rate only in the judge-rated results of the Dyck et al. (2017) study. However, it must be remembered that the significant results were polarised. Half of the studies (e.g., Dyck et al., 2017; Erlacher & Stumbrys, 2020) reported induction rates >40%, whereas the other half (e.g., Aspy, 2020; Aspy et al., 2017) were <20%. No pattern that could explain such discrepancies was found in study design, participants (e.g., previous experience with lucid dreams, gender, sample size), procedures, and measures. A possible explanation for this is that MILD is more effective when the sleep onset latency (SOL) after mnemonic practices is shorter (Aspy et al., 2017). However, relevant information was absent. Future studies could include the participants' SOL as a variable and explore the possible correlation between SOL and MILD efficiency.

The RT techniques seemed ineffective in five of six studies that including it (e.g., Aspy, 2020; Erlacher & Stumbrys, 2020). It was rated as 'insufficient/ambiguous' in Table 4, as the only study reported significant results for combined RT with other techniques. Hence, it cannot be firm evidence proving the efficiency of RT. Inconsistent with the Stumbrys et al. (2012) review, the effectiveness evidence level of Tholey's combined technique was 'insufficient/ambiguous' because only one study corroborated its effectiveness (Kumar et al., 2018). Moreover, in their study, the sample size was extremely small (six in the experimental group; five in the control group) and the sample was not representative as all the participants were male students (Kumar et al., 2018). Nevertheless, considering that the Tholey's combined technique was coded as 'green' in the Stumbrys et al. (2012) review, it can still be a competitive candidate for future lucid dream studies.

Two new cognitive techniques, SSILD and MBSR, were added to the present review. In the present review, SSILD was coded as 'insufficient/ambiguous' because it successfully induced lucid dreams in only one study (Aspy, 2020). However, both of the groups that applied SSILD also conducted WBTB. Therefore, it was unknown if the results could be attributed to SSILD alone. As for the MBSR technique, the finding was unexpected: experienced meditators who did not attend MBSR training sessions reported significantly more lucid dreams than naïve meditators who received an 8-week MBSR training (Baird et al., 2019). The researchers suggested that lucid dreaming was indeed correlated with meditation, but the nature of this relationship was unclear (Baird et al., 2019). SSILD might be inspirational to the study of such a relationship. One explanation for the mechanism of SSILD is that increasing attention to perceptual stimuli will elevate the dreamer's awareness (Aspy, 2020). As this process continues during one's sleep and REM periods, one will realise that one is in a dream (Aspy, 2020). Similarly, the researchers speculated that meditation training could increase one's awareness of one's consciousness (Schooler, 2002). For future studies, researchers could either combine SSILD and MBSR, or adjust the latter to raise the lucid dream induction rate.

Visual and auditory cues may be ideal if one intends to induce lucid dreams with external stimuli, as they were the only two external techniques applied successfully in the included studies (Carr et al., 2020; Erlacher, Schmid, Bischof, et al., 2020), although they are lacking in more evidence and replications and were rated as 'insufficient/ambiguous' in Table 4. They might also be able to boost LDF if employed with cognitive training (Erlacher, Schmid, Bischof, et al., 2020), but additional research is required to test more combinations. It must be mentioned that if visual and auditory cues are chosen as the lucid dream induction techniques, the researchers should first find the threshold for each participant before the real study commences. Moreover, the source of auditory stimuli may also be essential. In the Schmid and Erlacher (2020) study, where no significant result was obtained, the auditory cues that were used were a song and a musical piece. In contrast, in the two other studies were significant increases in LDF were found (i.e., Carr et al., 2020; Erlacher, Schmid, Bischof, et al., 2020), the auditory cues that were used were beeping sounds and a ring tone. It is possible that the amount of information that a cue contains affects its effectiveness in inducing lucid dreams.

The original category, 'miscellaneous techniques', was changed to 'substance intervention', referring to the exclusive use of substances. Galantamine was reported to be effective in one study and was therefore coded as 'insufficient/ambiguous'. In LaBerge et al.'s (2018) study, three doses of galantamine (0, 4, and 8 mg) were distributed to 121 participants in a random and counterbalanced order. The results indicated that as the dose of galantamine increased the participants' lucidity increased (LaBerge et al., 2018). However, the participants of this study were recruited from a highly-interested group in a lucid dream retreat (LaBerge et al., 2018). Although they adopted a double-blind approach and a control group, this could still bias the results.

TABLE 4 Empirically based effectiveness evidence level of the included lucid dream induction techniques

Technique	Effectiveness evidence/number of studies including the technique	Level	Reference
Cognitive techniques			
MILD	6/8	Effective	Appel et al. (2020), Aspy (2020), Aspy et al. (2017), Erlacher and Stumbrys (2020), Saunders et al. (2017)[a], Schredl et al. (2020)
RT	1/6	Insufficient/ ambiguous	Saunders et al. (2017)[a]
Tholey's combined techniques	1/1	Insufficient/ ambiguous	Kumar et al. (2018)
SSILD	1/1	Insufficient/ ambiguous	Aspy (2020)
Dream diary	1/2	Insufficient/ ambiguous	Saunders et al. (2017)[a]
MBSR	0/1	Ineffective	
External stimulation			
Visual stimulation	1/2	Insufficient/ ambiguous	Carr et al. (2020)[a]
Auditory stimulation	1/3	Insufficient/ ambiguous	Carr et al. (2020)[a]
Tactile stimulation	0/1	Ineffective	
Odour stimulation	0/1	Ineffective	
Substance intervention			
α-GPC	0/1	Ineffective	
Galantamine	1/1	Insufficient/ ambiguous	LaBerge et al. (2018)
Cortical stimulation			
tACS	0/1	Ineffective	
tDCS	0/1	Ineffective	

[a]Means that the technique was combined with other techniques and was not assessed independently.
Abbreviations: α-GPC, L-alpha glycerylphosphorylcholine; MBSR, mindfulness-based stress reduction; MILD, mnemonic induction of lucid dreams; RT, reality test; SSILD, senses-initiated lucid dream; tACS, transcranial alternating current stimulation; tDCS, and transcranial direct current stimulation.

Cortical stimulation, previously deemed as an external stimulation (Stumbrys et al., 2012), was isolated and set as a new category. Two kinds of cortical stimulation were tested in the selected studies: tACS and tDCS. The study that applied tACS reported no effect of the technique to lucid dream induction (Blanchette-Carrière et al., 2020). It is noteworthy that prior to this study, Voss et al. (2014) had reported that the application of frontal tACS at 25 and 40 Hz had an effect on self-reflective awareness in dreams. In addition, they further stated that 58% and 77% of the results of the selected factors in Lucidity in Dreams (LuCiD) scale with tACS at 25 and 50 Hz were significant (Voss et al., 2014). However, such findings were not corroborated in the study conducted by Blanchette-Carrière et al. (2020) despite tACS being applied at the same frequency. Although both cortical stimuli did not successfully induce lucid dreams in the previous studies, the category 'cortical stimulation' was not removed from the modified classification we proposed. Researchers have suggested a connection between lucidity and the activation of the DLPFC, which allows metacognition during dreaming (Hobson et al., 2000). Moreover, in a study conducted later, a shift in frontal EEG power at 40 Hz was detected when the participants were becoming lucid (Voss et al., 2009). Information relevant to the effectiveness of cortical stimulation is scarce compared to the other techniques. Cortical stimulation and the relationship between brain activity and lucid dream is still worth exploring in future studies.

Stumbrys et al. (2019) later published an update of the previous review, in which four studies were not covered by the present review. First, Sparrow et al. (2013) practiced middle-of-the-night meditation and 'dream re-living' exercise (i.e., MNM/DR intervention), which required participants to wake up at night, have a meditation period, rehearse a dream dreamt before, and go back to bed. To interpret with the present classification, the lucid dream induction techniques would be meditation and DR with WBTB. The MNM/DR intervention continued for 3 weeks, and pre- and post-intervention dream reports were assessed by blinded judges (Sparrow et al., 2013). The results showed that there was an increase in the number of lucid and pre-lucid (wondered but did not conclude that the dream was a lucid

dream) dreams (Sparrow et al., 2013). However, the sudden peak of the increased number of lucid participants in Week 3 post-awakening was not explained. Researchers pointed out that such a pattern was overall consistent with that of participants' constructive engagement and reflectiveness but the relationships between lucidity and these two elements were not assessed (Sparrow et al., 2013). Second, Holzinger et al. (2015) reported that 12 of 16 participants reported being lucid after writing the dream diary and listening to a hypnosis recording for lucid dreaming for 9 weeks. Nevertheless, the frequency and duration of recording listening during the 9-week period was not clarified. In addition, researchers mentioned that participants could apply other lucid dream learning techniques as long as they were recorded in the diary. Hence, the increased results could be attributable to the other techniques participants applied. Third, Sanatkaran et al. (2016) adopted odour stimulation, the smell of red rose essential oil and lavender essential oil, in 26 participants for lucid dream induction. No significant effect was detected. Lastly, LaMarca and LaBerge (2016) employed galantamine in 4 and 8 mg doses and a placebo, all with WBTB, in 121 participants. Comparing with the placebo group, the number of self-rated lucid participants significantly increased as the dose increased (LaMarca & LaBerge, 2016), which was consistent with the findings by LaBerge et al. (2018). Thus, there is evidence that the MNM/DR intervention, hypnosis recording, and galantamine intervention may have an effect on lucid dream induction. However, further replications are needed to corroborate such effects, for instance, by assessing them independently.

As hypothesised, the average methodological quality in the present review was significantly higher than that in the Stumbrys et al. (2012) study because only peer-reviewed articles were considered and analysed in the present review. All the studies, except for two, had moderate methodological quality. The average score for external validity was lower than that in the previous review, while the average scores for reporting, internal validity – bias, and internal validity – confounding (selection bias) were higher (Stumbrys et al., 2012). Most of the studies did not report power and therefore scored zero for item 27 ('Unable to determine'). The Downs and Black (1998) checklist is provided in Figure S1.

There were several differences in the rating criteria that could have contributed to the elevated scores. First, the ratings for item 5 were loose. Considering that the field of lucid dreams is relatively new and that most of the previous lucid dream studies were explorative, studies comparing at least one confounder obtained a 'Yes' answer (2 points). Studies that recruited only one sample group obtained a 'Yes' answer for item 5. Second, for item 24, as long as the researchers reported the random assignment of induction techniques after participant recruitment, it was automatically assumed that the actual process was in the same sequence, and the study obtained a 'Yes' answer (1 point).

While the loose ratings for items 5 and 24 might have made the average score higher than it really was, the overall moderate methodological quality was also underrated in terms of the other items. First, most studies did not report their main findings in the 'Introduction' or 'Methods' section for the sake of clarity. Thus, the scores for item 2 may not reflect the methodological quality of the studies. Second, as Stumbrys et al. (2012) mentioned, the Downs and Black (1998) checklist might be overly strict for such a young field of study such as lucid dreams. For instance, it may be challenging for researchers to list all the confounders and adverse events when an agreement on the possible effects of lucid dreams on sleep quality has not even been reached. Moreover, most of the studies that were included in the present review did not report the proportion of the population and subsequently scored zero for items 11 and 12. For future experimental reviews, a less rigorous or more appropriate checklist should be adopted. For instance, based on the analysis above, item 2 should be discarded as it no longer applies to the American Psychology Association (APA) seventh edition. Moreover, for fields that are new and explorative such as lucid dreaming, it may be better to change item 5 into a question asking whether possible confounders were controlled for in the study. The answers for item 5 can be decreased to only two answer choices, a 'Yes' answer (1 point) for those who report at least one confounder, and a 'No' answer (0 point) for those who fail to report any confounder. Items 11 and 12 can be combined into one question asking if the sample was representative of the population from which the sample participants were recruited. The answer choices for these two items can remain unchanged, namely, a 'Yes' answer (1 point), a 'No' answer (0 point), and an 'unable to determine' answer (0 point). Lastly, for studies assessing lucid dream induction techniques, item 17 can be changed into a question asking if any follow-up was conducted or can be even discarded until evidence showing a long-term effect of lucid dream induction techniques appear. The reason is that most of the lucid dream induction techniques are to bring immediate effect and that most of them were unreliable and ineffective, as shown in previous studies. Stable long-term effects of lucid dream induction techniques should therefore be a topic to be discussed in the future rather than in the present.

The present study had several strengths. First, it provided integrated information on the lucid dream induction techniques published in the past 12 years, supplementing the existing information in this field. Second, only peer-reviewed studies were included. Hence, to a certain extent, the reliability of the results was ensured. However, this could also be a drawback because non-peer-reviewed studies, unpublished studies, dissertations, and conference contents were neglected. This implies that the findings of the present review are less comprehensive. Third, a modified classification system of lucid dream induction techniques was proposed so that the types of techniques included would be more varied. This classification system version could be beneficial if an increasing number of substances and kinds of cortical stimulation were found to be applicable to lucid dream induction. Fourth, the empirical data about the methodological quality of the included studies might be helpful references for assessing the reliability of lucid dream induction techniques. However, as discussed earlier, the Downs and Black (1998) checklist scores might be biased. Thus, care must be exercised when referring to the results of the Downs and Black (1998) checklist.

CONFLICT OF INTEREST

We do not have conflicts of interests.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated during the current study

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