

# Cerebral Specialization During Lucid Dreaming: A Right Hemisphere Hypothesis

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*Research has shown that certain individuals are able to carry out prearranged tasks while lucid dreaming, and that these tasks produce physiological effects on the body similar to what is observed during waking. It was hypothesized that the difficulty of performing cerebrally lateralized tasks during a lucid dream would vary with the dominant hemisphere for that task, with less difficulty for right hemisphere tasks. Twenty-seven participants rated the difficulty of performing three matched pairs of left hemisphere and right hemisphere tasks, first in a lucid dream, and later in their waking imagination. Results indicated right hemisphere dominance during lucid dreaming, especially among right-handed participants.*

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**Keywords:** lucid dreaming; hemisphere dominance; cerebral specialization

Lucid dreaming is the experience of becoming consciously aware that one is currently dreaming. Unlike ordinary dreams, during which it is impossible to have thoughts about (but separate from) the experience, lucid dreams introduce a strong element of self-reflective awareness (Rechtschaffen, 1978). With this awareness often comes a sense of freedom and control over the unfolding narrative. Thoughts may still be jumbled and dream-like or one may experience an exceptional clarity of mind rivaling that of waking life. Memories of past dreams or waking experiences may be called upon, and body movements can be willfully executed. Sensory functioning may sometimes be inhibited, but other times the dream can seem more vivid than reality (Tart, 1988). Despite the fact that around four in five people report having had at least one lucid dream (Schredl & Erlacher, 2004), there was no scientific evidence confirming the reality of this phenomenon until a few decades ago, when Hearne (1978) recorded his subject performing a prearranged distinctive pattern of eye movement during unequivocal rapid eye movement (REM) sleep.

Schatzman, Worsley, and Fenwick (1988) demonstrated that actions performed in a lucid dream produce physiological effects corresponding to those actions while awake. Electrodes placed on a single male subject's middle finger and forearm recorded electromyogram (EMG) bursts that matched a distinctive sequence of fist clenches planned before falling asleep. Electrodes placed on the subject's eyes recorded smooth, scanning eye movements when he dreamed of

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willfully watching his finger move from side to side. Similar tracking movements were recorded when the subject reported fixating on a doorknob and moving his head from side to side. Electrodes placed on the subject's larynx and forearm produced concurrent blips that matched his dream of intentionally counting out loud while drawing numbers, suggesting that breathing patterns associated with waking speech are no different while dreaming lucidly. As LaBerge (1985) points out, performing an activity in a lucid dream is, to the brain, highly akin to performing that activity in real life.

### Hemisphere Specialization

The human brain is divided into two hemispheres that, although structurally similar, are functionally quite different. The right hemisphere is relatively more active in REM sleep, during which dreams most often occur. For example, electroencephalograph (EEG) activity and cerebral blood flow during REM are right-lateralized and, upon REM awakening, right hemisphere tasks are easier and the left hand (controlled by the right hemisphere) is more functional (see Joseph, 1988 for a review). Then again, other EEG studies have found little if any cerebral asymmetry between REM and non-REM (NREM) sleep (Armitage, 1995; Ehrlichman, Antrobus, & Wiener, 1985). Dumont, Braun, and Guimond (2007) noted that, while REM sleep may be correlated with right hemisphere activity, the location of dream-generating mechanisms is still unclear. They reviewed the lesion literature and concluded that, excluding aphasics who may not recall dreams because they lack narrative abilities, complete cessation of dreaming is equally likely to be caused by right or left hemisphere damage. Physiological research to date has not yielded conclusive results regarding the relative importance of the cerebral hemispheres to dreaming. However, a closer look at the phenomenal nature of lucid dreaming uncovers several interesting connections.

Green and McCreery (1994) argued that lucid dreaming is characterized by greater right hemisphere activation. They noted that the left hemisphere mode of thought is considered to be analytical, serial, sequential, propositional, logical, preoccupied with particulars, and focused on ideas. Conversely, the right hemisphere is thought to be more synthesizing, parallel, nonsequencing, appositional, creative, holistic, and focused on images. Drawing on lucid dream reports of reading difficulties despite otherwise eidetic realism, they argued that lucid dreaming appears to fall on the right side of the hemispheric division. Indeed, lucid dreams can seem more vivid than reality (Tart, 1988). Specialization of the right hemisphere for visuospatial ability has been a steady finding (Gazzaniga, Ivry, & Mangun, 2002), and it appears that "lucid dreaming is *par excellence* a visuospatial task" (Green & McCreery, 1994, p. 37). Interestingly the right hemisphere has also been shown to be worse at detecting violations of reality in pictures (Zaidel, 1994). In line with the notion that logical thinking is the domain of the left hemisphere, Wolford, Miller, and Gazzaniga (2000) reported that the left hemisphere is better able to find patterns and form causal explanations. Puzzling and unpredictable, lucid dreams can hardly be characterized by such thought. "Minor lapses in rationality, unclear thinking, and drawing absurd conclusions" have been noted

(LaBerge & DeGracia, 2000, p. 300), despite the fact that metacognitive faculties appear to remain intact (Kahan & LaBerge, 1994).

Another connection involves the presence of affective behavior in lucid dreams. Joseph (1988) compiled a vast number of studies on cerebral specialization and found the right hemisphere to be superior for socioemotional capacities, including comprehension of emotion in words and faces and regulation of affective behavior. More recently, Devinsky (2000) studied lesion patients and concluded that the right hemisphere modulates consciousness of the socioemotional self. Lucid dreams certainly do not lack such a sense. Many researchers have noticed that lucid dreams tend to be highly emotional (Gackenbach & Bosveld, 1989; Green & McCreery, 1994). Kahan, LaBerge, Levitan, and Zimbardo (1997) surveyed 88 dreamers and found that emotion was reported more often in dreaming than in waking. As they noted, this finding supports Hobson's (1988) association of dreaming with an intensification of emotion.

Left hemisphere dominance for language has proven to be one of the most robust findings in the lateralization literature (Gazzaniga et al., 2002). This includes most aspects of reading, writing, and speaking (Corballis, 1991). Supportive of a right hemisphere basis for dreams, reading in any kind of dream is reportedly quite rare. Hartmann (2000) analyzed 456 dream reports and found not a single instance of reading or writing and only one instance of calculating (a serial, logical, analytical task). He then administered a questionnaire to 240 frequent dreamers. Despite spending an average of six hours on these activities while awake, nine out of 10 participants claimed to dream about reading, writing, typing, and calculating "never" or "hardly ever." Schredl and Hofmann (2003) collected waking activities questionnaires and 442 dream reports from 133 participants over a 2-week period and confirmed that reading was reported significantly less often in dreams. It was concluded that convergent thought, characteristic of the left hemisphere (Kane, 1984), plays a much smaller role in dreaming than it does in waking.

Conscious attempts at reading by lucid dreamers have been largely unsuccessful. Some cannot even make out the words, others can read but not understand, and still others can read and comprehend but are unable to repeat the process. Lucid dreamers report that words and letters frequently rearrange (Garfield, 1974; Green & McCreery, 1994). According to Fox (1962), "Reading is a very difficult matter. The print seems clear enough until one tries to read it: then the letters become blurred or run together, or fade away, or change to others" (p. 46). It seems that the text is more like a picture than a linguistic representation. LaBerge and DeGracia (2000) noted that "text, upon rereading, can change in either form, lexical structure, semantic structure, or based on rhyme and alliteration" (p. 293). Worsley (1988) consistently found that he could read no more than a few words in a lucid dream. In the category of reading, he reported reading single words successfully 9 out of 10 times and two words 8 out of 10 times. However, he could read short sentences only twice in seven instances, and all five attempts to read long sentences failed.

### **The Present Experiment**

Compelling though lucid dream reports may be, it is difficult to empirically verify the nature of these experiences. Fortunately, studies that have collected

dream reports in tandem with physiological recordings attest to the validity of these reports. LaBerge and Dement (1982) corroborated reports of singing and counting in a lucid dream with EEG data. Four experienced lucid dreamers were to become lucid, execute a prearranged eye signal, sing for 10 seconds, signal again, count for 10 seconds, and finally signal one more time to indicate completion of the tasks. Recordings from electrodes placed on the subjects' eyes and temporal lobes allowed the experimenters to compare EEGs while subjects performed the appropriate actions in a lucid dream. Dream singing was accompanied by greater right hemisphere activity, and this lateralization shifted to the left during dream counting, similar to waking patterns. The implications of this study are twofold. First, it provides further support for the claim that when dreamers report doing something, they really did experience doing it in a dream. Moreover, it suggests that the brain areas called upon to carry out an action in a lucid dream are similar to those implicated in performing that same action while awake.

If the right hemisphere is preferentially activated during lucid dreaming, tasks requiring left hemisphere processes should prove to be relatively more difficult to accomplish in a lucid dream. As described above, many have reported problems with such tasks, but this has not been systematically investigated. In the present study, lucid dreamers rated the difficulty of performing cerebrally lateralized activities. If difficulty ratings differ between left and right hemisphere tasks, it would indicate that the lucid dreaming brain is lateralized.

Three left hemisphere (LH) and three right hemisphere (RH) tasks were devised, based on the lateralization literature. All three left hemisphere activities were language-related. The right hemisphere tasks were visuospatial or musical analogues, resulting in three pairs of related activities. The first pair measured the ability to understand something seen (perceptual comprehension). Task 1 involved a LH task: reading a sentence. Although the right hemisphere can sometimes read individual words, especially if they are emotional, the left hemisphere is clearly dominant for reading (Joseph, 1988; Kane, 1984). Task 2 involved a RH task: observing a painting, which certainly requires visuospatial ability. The second pair of activities measured the ability to utilize a pencil (manual production). Task 3 involved a LH task: writing a sentence. Studies have shown writing to be strongly lateralized to the left hemisphere (Beeson et al., 2003). Task 4 involved a RH task: drawing a cube. The right hemisphere is superior for drawing (Harrington, Farias, Davis, & Buonocore, 2007), especially three-dimensional shapes (Gazzaniga et al., 2002). The third pair of activities measured the ability to vocalize something new (novel generation). Task 5 involved a LH task: speaking a sentence. Research has confirmed that the left hemisphere is responsible for speech (Gazzaniga, LeDoux, & Wilson, 1977). This finding holds for left-handed individuals, despite the fact that their language tends to be more bilaterally represented (Bouton, 1985). Task 6 involved a RH task: humming a tune. Dichotic listening tests have shown that the left hemisphere processes the words of a song while the right hemisphere processes the melody (Gazzaniga et al., 2002).

To obtain baseline levels of task difficulty, a pilot study was conducted. Twenty-two right-handed subjects were asked to close their eyes (while awake) and rate the difficulty of imagining each of the six activities. Results showed that the left hemisphere (language) tasks were always easier, often significantly so. Therefore, higher difficulty ratings for language tasks during lucid dreaming would presumably

be an effect of the dream state. However, considering the variability in responses to the pilot study, it was decided that imagination ratings would also be collected from the actual participants and serve as a sort of control. In this way, the difficulty of performing each task in the lucid state could be compared with lucid performance of the contralateral task, while taking into account the relative ease of imagining those tasks in the waking state.

Given the nature and reports of lucid dreaming, research on hemisphere specialization, and studies documenting the rarity of reading and writing in dreams, it was first hypothesized that the left hemisphere (language) tasks would be rated more difficult than the corresponding right hemisphere (visuospatial/musical) tasks in a lucid dream. Second, it was predicted that the left hemisphere tasks would be harder to perform in a lucid dream than to imagine performing while awake. Third, the right hemisphere tasks were expected to be easier to perform in a lucid dream than to imagine performing while awake. In other words, lucidity would increase visuospatial/musical ability and decrease language ability. Fourth, it was hypothesized that these effects would be stronger among right-handed individuals, in light of evidence that their cerebral asymmetry is more pronounced (Bear, Schiff, Saver, Greenberg, & Freeman, 1986), especially as it relates to language (Isaacs, Barr, Nelson, & Devinsky, 2006).

## METHOD

### Participants

Participants were members of DreamViews, an online forum for lucid dreaming enthusiasts, who responded to a request posted on the DreamViews website. Forum members span all ages, genders, and nationalities. Many use techniques to induce and enhance lucidity, while others simply have lucid dreams naturally. Twenty-seven members took part in the experiment, 15 male and 12 female. Ages ranged from 15 to 48, and all were self-selected. Accordingly, participants were advanced enough as lucid dreamers to remember presleep directions and curious enough to spend some of their lucid dreaming time on relatively mundane tasks. Many other members responded to the study, but their data could not be used because they did not follow all instructions.

### Materials

The lucid dreaming survey consisted of six tasks and two open-ended questions. Participants were instructed to “rate the difficulty of performing each activity in a lucid dream, on a scale from 1 (extremely easy) to 7 (extremely difficult/impossible).” The importance of intentionally trying the tasks and not simply guessing or rating past experiences was emphasized. The tasks and questions were as follows:

1. Read and understand a sentence.
2. Observe and understand a painting.

3. Write a sentence with a pencil.
4. Draw an outline of a cube with a pencil.
5. Speak a sentence you have never heard before.
6. Hum a song you have never heard before.

–How many lucid dreams do you have in the average month?

–With which hand do you write?

Lucid dreaming frequency was intended as a potential covariate but eventually dismissed as it has heavy demand characteristics and did not display any significant correlations. Writing hand was assessed because, although certainly not a complete measure of cerebral dominance (Beaton, 2003), it is straightforward and perhaps the “most reliable of laterality measures” (McManus, 1985, p. 14). While requiring dream reports would have been useful for the verification of task completion, this was avoided to maximize participation.

The imagination survey consisted of the same six tasks and response scale, but this time participants were instructed to rate the difficulty of imagining each activity while awake. They were encouraged to take a first-person perspective and retain the relevant aspects of the entire mental picture in their mind, in hopes of simulating the lucid dreaming experience.

### Procedure

The lucid dreaming survey was posted as a new topic on the DreamViews forum, and members were invited to participate. All communication occurred through posts and private messages on the forum. Several members were unclear on the requirement for Task 5. Some thought they were supposed to speak in a new language, and others thought they were to speak gibberish. It was explained that grammatical English was required, but that the sentence need not make sense, similar to Chomsky’s (1957) famous “colorless green ideas sleep furiously” (p. 15). In response to a claim that Task 5 is not feasible, it was also noted that the task only required a sentence that the participant had never heard, not something that nobody has ever said.

In response to confusion regarding past lucid experiences and nonlucid dreams, participants were reminded of the crucial difference between having done a task in the past, on the one hand, and knowing a task and intentionally doing it, on the other. This distinction was especially important for Tasks 5 and 6. To ensure data reliability, all ratings were confirmed, by means of explicit additional messages, to be from new lucid dreams before they were accepted.

About one month after the original posting, the imagination survey was sent individually to the 27 participants. Responses from both surveys were then tabulated. Clarification was requested for non-numeric answers such as “easy” for a task or “every day” for monthly lucid dreaming frequency. Ranges such as “about 6–7” were averaged. Handedness answers were divided into two groups—“righties” and

“non-righties”—to take advantage of the fact that cerebral lateralization varies as a function of handedness (Isaacs et al., 2006). By categorizing only clear right-handed responses as righties, a strongly lateralized group could be compared with a group likely to be less strongly lateralized. Accordingly, answers indicating any level of ambidexterity were scored as non-right. Notably, this group included two “right-handed” individuals: one who mentioned a left-handed preference for scissors and another who claimed to have been left-handed many years ago. Answers such as “ambidextrous” and “left” were scored as non-right as well.

## RESULTS

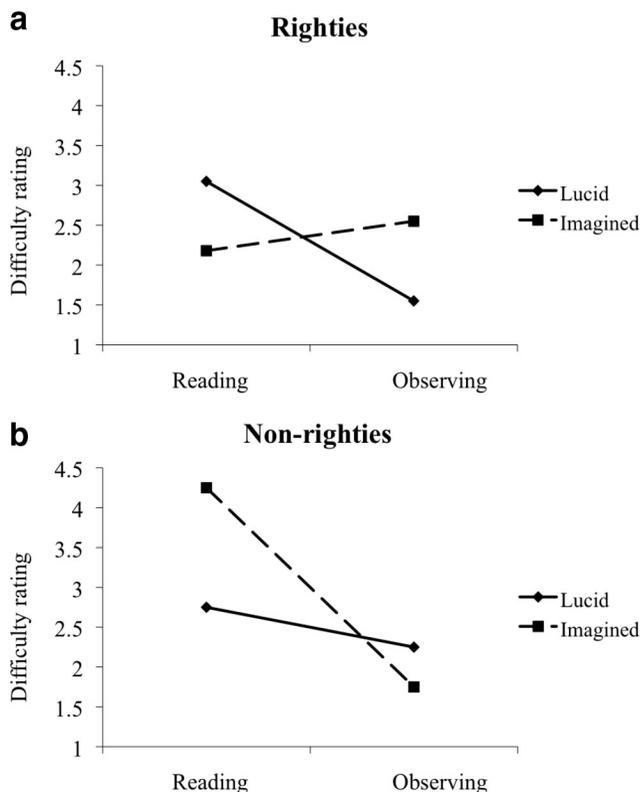
Eighteen of the 27 participants sent in results for only a subset of the lucid dreaming and imagination tasks. All valid data, partial or otherwise, was analyzed. For each task pair (1 vs. 2, 3 vs. 4, and 5 vs. 6), difficulty ratings were analyzed in a 2 by 2 by 2 analysis of variance (ANOVA) with the following factors: state (lucid, imagined), handedness (right, non-right), and task laterality (left, right). Because of the missing data for some participants, each of the three ANOVAs compared a unique subset of only about half of the participants.

### Task 1 (Reading) Versus Task 2 (Observing)

Eleven righties and four non-righties completed the perceptual comprehension tasks, reading (LH) and observing (RH), in both the lucid (dreaming) and the imagined (awake) condition. The ANOVA showed a main effect of task laterality,  $F(1, 13) = 8.93$ ,  $MSE = 12.55$ ,  $p = .01$ , with the LH task ( $M = 3.06$ ,  $SD = .44$ ) rated as more difficult than the RH task ( $M = 2.02$ ,  $SD = .25$ ). A significant three-way interaction,  $F(1, 13) = 14.58$ ,  $MSE = 10.55$ ,  $p = .002$ , can be seen in Figure 1a: Righties rated the LH task as more difficult than the RH task in a lucid dream. They judged dreaming the LH task to be more difficult than imagining the LH task, and they judged dreaming the RH task easier than imagining the RH task. As shown in Figure 1b, non-righties also rated the LH task harder than the RH task, but not to the same extent as righties. Non-righties also rated as more difficult imagining the LH task than performing it in a lucid dream, but they had less trouble imagining the RH task than dreaming it.

### Task 3 (Writing) Versus Task 4 (Drawing)

Eight righties and five non-righties completed the manual production tasks, writing (LH) and drawing (RH), in both conditions. The ANOVA showed a main effect of state,  $F(1, 11) = 5.12$ ,  $MSE = 14.22$ ,  $p = .045$ , with difficulty ratings greater for lucid dreaming ( $M = 3.08$ ,  $SD = .40$ ) than imagining ( $M = 2.01$ ,  $SD = .33$ ). Additionally, state interacted with task,  $F(1, 13) = 5.48$ ,  $MSE = 6.25$ ,  $p = .039$ , because, as seen in Figures 2a and 2b, the difference between lucid and imagined ratings was greater for the RH task than the LH task.



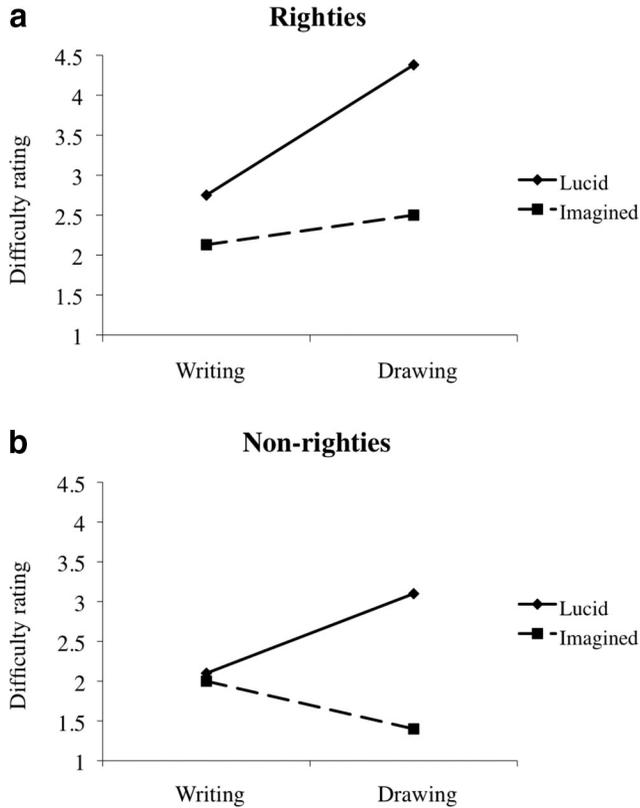
**Figure 1.** ANOVA results depicting reading versus observing difficulty ratings while dreaming (lucid) or awake (imagined) among righties (a) and non-righties (b).

### Task 5 (Speaking) Versus Task 6 (Humming)

Ten righties and five non-righties completed the novel generative tasks, speaking (LH) and humming (RH), in both conditions. The only significant effect in the ANOVA was a marginal two-way interaction effect between task and state,  $F(1, 13) = 3.04$ ,  $MSE = 7.25$ ,  $p = .105$ . As depicted in Figure 3, the LH task was more difficult in dreaming than imagining, whereas the RH task was less difficult in dreaming than imagining.

## DISCUSSION

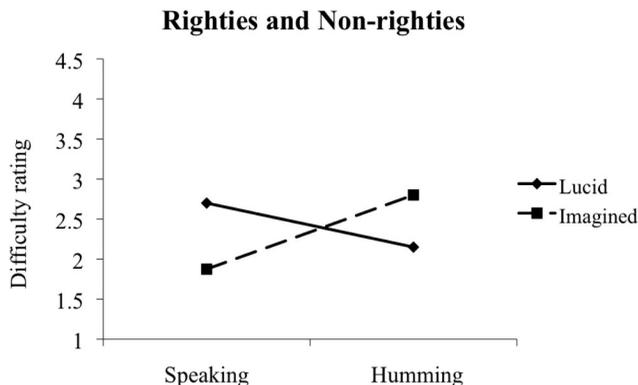
Supportive of the right hemisphere dominance hypothesis, right-handed participants consistently found reading a sentence (Task 1) harder than observing a painting (Task 2) in a lucid dream. Comparing imagination and lucid dreaming, they also reported that reading was hindered by the lucid dream state, but observing was facilitated. Non-righties showed little difference between the two tasks, which is precisely what would be expected given that they exhibit less lateralization of brain function (Annett, 1985).



**Figure 2.** ANOVA results depicting writing versus drawing difficulty ratings while dreaming (lucid) or awake (imagined) among righties (a) and non-righties (b).

Although writing (Task 3) was indeed harder for right-handed participants to dream than to imagine, drawing (Task 4) was overall more difficult than writing while lucid dreaming. This result runs contrary to predictions because writing is a left hemisphere (language) task. The dream reports spontaneously provided by participants suggest a potential explanation. Both tasks suffered from similar complications. As one participant noted, “The act itself wasn’t difficult, but my handwriting was horrible sloppy, and the cube turned out uneven.” A couple of participants reported difficulties holding their hand steady. Many more had problems keeping the created image still. Text jumbling was a common problem. Beyond distortions and rearrangements, disappearing letters and lines were also frequently mentioned.

It therefore seems likely that language difficulties were overshadowed by problems with manual dexterity and image stability, especially with the finer details. Interestingly the left hemisphere has been found to better control sequential hand movements (Joseph, 1988) and be more detail-oriented (Kane, 1984). It appears better able to detect local changes and high spatial frequencies, whereas the right hemisphere seems more specialized for global processing and low spatial frequencies (Bedson & Turnbull, 2001; Gazzaniga et al., 2002; Martinez et al., 1997).



**Figure 3.** ANOVA results depicting speaking versus humming difficulty ratings while dreaming (lucid) or awake (imagined) among righties and non-righties combined.

Furthermore, left hemisphere damage has been shown to diminish detail in drawings (Joseph, 1988). If details are handled by the left hemisphere and were responsible for the difficulty in these tasks, then it is consistent with the hypothesis that drawing a cube would be harder. Well-formed letters are not crucial to the act of writing a sentence, but well-placed lines are essential to forming a complete cube. Once a letter has been written, the writer can forget about it and move on to the next, but this is not the case with a complex shape such as a cube, because a cube is merely a scattered collection of lines until the last segment is drawn. Thus the drawing task, while not requiring language, still depended on the left hemisphere's ability to focus on details.

Moreover, several participants complained that sketching a cube is never an easy task. Even if the sentence-writing task were made difficult by language issues, it still has a clear advantage over the cube-drawing task in that it is vastly more practiced. The imagination ratings were intended to control for this, yet among righties, the ANOVA found that imagined drawing was barely more difficult than imagined writing. However, *t* test results for righties indicated that the writing task (but not the drawing task) was significantly harder to dream than to imagine. Thus, using the difficulty of imagining the tasks as a baseline, the writing task was indeed more difficult, but only for righties. Dream reports supported this conclusion. Some of the participants who struggled with the cube had no trouble at all drawing a square.

Participants spontaneously reported difficulties that implicate a specific language deficit in writing. One participant had no problems with text stability and instead noticed a curious linguistic barrier: "I felt limited in the words I could write, like I could not be creative . . . . My thoughts felt limited, but my writing ability was fine." Others reported that words produced were incoherent or in the wrong symbolic form. Yet no participant reported forgetting what a cube looks like or drawing the wrong shape. Problems with the drawing task were superficially performance-related (e.g., many could not match up the lines), whereas problems with the writing task were often suggestive of a deeper linguistic obstruction.

Results for the speaking and humming tasks showed the predicted pattern. During lucid dreaming, speaking was rated more difficult than humming, whereas during imagining humming was rated more difficult than speaking. This is consistent with the hypothesis that the right hemisphere is disproportionately active in lucid dreaming. As with the reading/observing task pair, non-righties exhibited the expected bilateral trend, performing about equally well on both tasks while lucid dreaming. In all three task pairs, difficulty ratings differed between righties and non-righties, and this fact alone is evidence that lateralization indeed occurs during lucid dreaming.

But it remains to be explained why the interaction effect for the speaking and humming tasks was only marginally significant. Again, dream reports provide several clues. Similar to what was observed for the writing/drawing task pair, problems reported for the right hemisphere task were alike in nature to those reported for the left hemisphere task, but the left hemisphere task caused additional language-related problems. Participants had more issues with ensuring novelty than generating the actual words or melodies. Like the cube drawing task, humming a novel tune, awake or not, was quite challenging for some. Moreover, difficulty ratings indicated that humming a novel tune was somewhat harder to imagine than to perform in a lucid dream. Some specifically mentioned increased creativity while lucid, a process thought by some to be modulated by the right hemisphere (Katz, 1978; Katz, 1983). Several respondents who did not provide proper ratings nonetheless reported singing to be a highly frequent activity in their lucid dreams. While respondents found it difficult to distinguish new from old in dreams, they certainly had no problem generating a melody, suggesting that lucid dreams are characterized by greater right hemisphere activation.

The speaking task, in sharp contrast, was hardly found to be so natural. Again, ascertaining the originality of thoughts was reportedly difficult. One participant ended up using a word that does not exist and could not explain why. However, these were minor problems compared to the marked aphasia experienced by some individuals, as described in the following response to the speaking task: "This was still difficult for me, but it didn't wake me up like the first time. I had a hard time thinking of words, similar to writing the sentence. My speech was also slurred as I started speaking." Reports such as this demonstrate that speech in lucid dreams can be nonexistent, dysfunctional, or even jarring to the point of physiological arousal. It is as if the lucid dreamer cannot fully activate the left hemisphere, and if an attempt is made to deliberately activate it (via speaking), the entire body is forced into another mode of consciousness (i.e., it wakes up). To determine the prevalence of such problems, a poll was conducted on the DreamViews forum, independent of the study at hand, and 59 members responded. About a third reported that, in general, their ability to speak in lucid dreams is "slightly impaired," and three described their ability as "highly impaired." Whereas musical composition is effortless, speech seems abnormal to various degrees, supporting a model of right hemisphere superiority during lucid dreaming.

Dream reports suggested that ratings for the perceptual comprehension tasks (reading and observing) were probably the least affected by unanticipated confounding variables, which may explain why they showed the strongest support for the experimental hypothesis that the right hemisphere is dominant during lucid dreaming. Problems with detail and motor coordination seemed to be the overrid-

ing factor in the manual production tasks (writing and drawing), and problems ensuring originality appeared to partially overshadow linguistic difficulties in the novel generative tasks (speaking and humming).

To summarize, evidence from difficulty ratings and dream reports supported the view that the right hemisphere is specialized for lucid dreaming. Participant reports, though subjective, often described similar problems, which provided a certain degree of reliability. In cases where numerical data failed to find an effect, dream reports revealed that unexpected performance issues were diminishing the reliability of ratings, as was confusion regarding the activities and what specifically to rate. Further, qualitative analyses of the dream reports yielded compelling evidence that right hemisphere functions during lucid dreaming were enhanced while left hemisphere functions were inhibited.

These findings must be taken with caution, however, because as with any dream study, many factors could not be controlled. As noted by LaBerge and DeGracia (2000), lucid dreams are quite bizarre and unstable. Instability is a serious problem facing any researcher who wishes to investigate the lucid dreaming world. Physical objects in a dream are nothing but mental constructs, and they are difficult to keep still. Fortunately, this annoyance may actually lend valuable insight into the nature of dream-generating mechanisms, for as was shown, certain objects tend to be less stable than others.

One last point is worth considering. Lucid dreams can occur not only during REM sleep, but also during the early stages of NREM sleep (Dane, 1986). It is likely that the psychological and physiological characteristics of each differ simply because brain activity during REM and NREM sleep differs. Lucid dreams can alternatively be classified according to whether the individual entered the lucid dream from within a nonlucid dream or from waking consciousness (after a brief nocturnal arousal, for instance, or by falling asleep while maintaining awareness). The former is known as a dream-initiated lucid dream, or DILD, while the latter is called a wake-initiated lucid dream, or WILD (LaBerge & Rheingold, 1990). Again, each type is probably unique to some extent. One participant rated the reading task difficult, but then sent a new rating a few days later, explaining that it was hard in a DILD but easy in a WILD. The present study did not distinguish between the various types of lucid dreams, and it is possible that variation in task difficulty was greatly affected by the type of lucid dream a participant was experiencing. A future study testing REM versus NREM and WILD versus DILD differences would be helpful in disentangling these empirical limitations.

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