[LaBerge, S. and Levitan, L. (1995). Validity Established of DreamLight Cues for Eliciting Lucid Dreaming. *Dreaming, 5*(3): 159-68.]

Validity Established of DreamLight Cues for Eliciting Lucid Dreaming

Stephen LaBerge[1] and Lynne Levitan

Lucid dreaming is a learnable, but difficult skill. Consequently, we have sought methods for helping dreamers to realize that they are dreaming by means of external cues applied during REM sleep, which if incorporated into dreams, can remind dreamers that they are dreaming. Here we report on an experiment testing the validity and effectiveness of a portable computerized biofeedback device (DreamLight®) designed to deliver light cues during REM sleep. The 14 subjects used DreamLights on 4 to 24 nights. They were unaware that the DreamLights were specially programmed to deliver cues only on alternate nights. Eleven subjects reported 32 lucid dreams, 22 from nights with light cues, 10 from nights without cues. All lucid dreams scored (by judges blind to DreamLight condition) as being "cued" by the DreamLight's stimuli occurred on nights when the DreamLight was actually delivering cues. Subjects reported seeing in their dreams what they believed to be DreamLight cues significantly more often on light cue nights (73 total) compared to nights without light cues (9). The conclusion is that cueing with sensory stimuli by the DreamLight appears to increase a subject's probability of having lucid dreams, and that most of the resulting lucid dreams are due to the specific effect of light cues rather than general "placebo" factors.

KEY WORDS: lucid dreaming, DreamLight, REM sleep.

In a lucid dream the dreamer is aware, during the course of the dream, that the experience is a mental construction, not derived from current sensory experience of the physical environment (LaBerge, 1985, 1990). The overwhelming majority of lucid dreams occur during REM sleep. Most lucid dreams begin after the onset of REM sleep, when the dreamer realizes that the current experience is a dream (LaBerge, Levitan, & Dement, 1986). This type of lucid dream, a dream-initiated lucid dream (DILD) is associated with an increase in phasic and autonomic activity in the thirty seconds preceding the onset of lucidity. A minority of lucid dreams occurs when the sleeper enters REM sleep with unbroken self-awareness directly from the waking state. This type is referred to as a wake-initiated lucid dream (WILD) (LaBerge, Levitan, & Dement, 1986).

[1] Correspondence to: Stephen LaBerge, Ph.D. slab@psych.stanford.edu

Once lucid in a dream, people can often choose their actions and exert some deliberate control over the dream content. This ability has been utilized in the laboratory to study lucid dreaming and dream psychophysiology. For example, proof that lucid dreams occur in REM sleep was achieved by having subjects give a prearranged distinct signal with deliberate eye movements to mark the points in time when they realized they were dreaming. The dreamers' reports of the eye movements they had made in the dreams corresponded exactly to their physical eye movements as recorded by means of electro-oculograms on a polygraph record. Reports from experiments conducted using eye movement signaling in lucid dreams can be found in the literature (Dane, 1984; Fenwick et al., 1984; Hearne, 1978; LaBerge, Nagel, Dement & Zarcone, 1981; Ogilvie, Hunt, Kushniruk, & Newman, 1983).

Lucid dreams may be valuable not only for the scientific study of dreaming and REM sleep, but also for a variety of psychological and recreational applications. Anecdotes and preliminary studies suggest that lucid dreaming can be a powerful tool for overcoming nightmares (LaBerge, 1985; Gackenbach & LaBerge, 1988; LaBerge & Rheingold, 1990). In therapy, lucid dreams appear to be promising for providing personal insight, assisting with integration, and as a safe environment for experimentation with new behaviors (LaBerge & Rheingold, 1990).

Many lay people are attracted to lucid dreaming because it offers an outlet for fantasy, an opportunity for adventure unfettered by the laws of physics or society, and free of risk. As such, lucid dreaming is for many a source of creative and inspiring recreation. Anecdotes indicate that lucid dreams are helpful for artistic creativity, problem-solving, and practicing skills for waking life (LaBerge & Rheingold, 1990). Furthermore, because dreams are the most vivid mental images attainable by most people, lucid dreaming possibly could be the best method for achieving the benefits of visualization, such as enhancing physical performance and facilitating healing.

All of these potential applications of lucid dreaming merit study. A prerequisite, however, for such research, and for the application of findings, is the ability to reliably and frequently produce lucid dreams. Survey studies have shown that although the majority of college students report having experienced at least one lucid dream, only about 20 percent report lucid dreams once a month or more (Snyder & Gackenbach, 1988).

Lucid dreaming is a skill that can be developed with practice. LaBerge was able to increase his own lucid dream frequency from one per month to four or five per night over the course of three years by using a mental exercise to set his intention to remember to recognize when he was dreaming (the exercise was called "MILD" for Mnemonic Induction of Lucid Dreams) (LaBerge, 1980a,b). In one study with 84 subjects, the use of MILD increased the average number of lucid dreams per week for each subject by 76 percent (from 0.21 to 0.37 lucid dreams per week) over a baseline condition. In the same study, another mental exercise called Reality Testing, involving repeated questioning by the subjects of whether they were awake or dreaming combined with visualization of dreaming, increased average lucid dream frequency by 152 percent (from 0.21 to 0.53 lucid dreams per week) (Levitan & LaBerge, 1989).

Thus, mental techniques are of some use for improving the chances of having lucid dreams. Yet, most people do not have the time and energy for concentration required to learn to have lucid dreams on demand by employing the mental exercises known at present.

An alternative approach to lucid dream induction is to apply sensory stimuli to individuals while they are in REM sleep, to remind them to notice that they are dreaming. This approach is based on the fact that dreamers, while continuing to dream, occasionally perceive some sensory stimuli from the sleeping environment. Sounds, lights, or tactile sensations can become incorporated into an ongoing dream (Dement & Wolpert, 1958).

A few studies have demonstrated that subjects can achieve lucidity by recognizing a sensory stimulus incorporated into a dream as a cue to realize that they are dreaming. This result was obtained with a taped message saying, “This is a dream,” or “[Subject’s name], you’re dreaming,” (LaBerge, Owens, Nagel & Dement, 1981) a vibration applied to the bed (Rich, 1985), and flashing lights administered through goggles worn by the sleeper (LaBerge, Levitan, Rich, & Dement, 1988). These experiments were conducted in a sleep laboratory, where a technician turned on the cueing stimulus when the subject’s polygraph readout showed unambiguous REM sleep.

The results of the study using light as the cue to become lucid appeared most promising. The light cue induced lucidity 33 times over a total of 58 nights with 44 subjects, as determined by the appearance of a deliberate eye movement signal marking lucidity onset on the polygraph record following the administration of the cue and a dream report by the subject claiming that awareness of dreaming was prompted by the incorporation of a flashing light in the dream. An additional 11 lucid dreams occurred after stimuli had been applied although no mention of the cue appeared in the subjects’ subsequent lucid dream reports. Two out of the three subjects who had never before experienced a lucid dream had one as a result of recognizing the flashing light cue in a dream (LaBerge, Levitan, Rich, & Dement, 1988).

To increase the general usefulness of the technique of cueing lucidity with sensory stimuli, an automated mechanism for detecting REM sleep and applying a cue would be desirable. We have developed such a device, now commercially available, called the DreamLight (note 1). The device detects rapid eye movements with an infrared emitter-detector pair located over the eyelid in a sleep mask, and distinguishes the eye movements of REM from those of waking by also detecting head motion, which only occurs in waking. The signals are processed and a discriminating algorithm is calculated by a 68HC11 microprocessor. When the criterion for identifying REM sleep is satisfied, the device flashes tiny incandescent lamps also mounted in the sleep mask worn by the user.

The current DreamLight device offers a second potential method of attaining lucidity, based on the Reality Testing technique. When the user presses a button located on the mask, it triggers the mask lights to flash briefly and a speaker in the mask to chirp. The button's primary purpose is to initiate a delay period, during which the device will not give stimuli, allowing the wearer to pass through Stage 1 sleep, which physically resembles REM sleep, without being awakened by cues. In trials, it was found that people would dream of awakening wearing the mask, and would press the button (as it appeared in the dream) to find that no flash or chirp happened. Subsequently, instructions to DreamLight users and subjects have included advice to press the button and observe the response of the device (correct flash and chirp versus no response or an anomalous response) anytime they awaken wearing the mask. An incorrect response to the button press indicates that the wearer is dreaming both of being awake and of pressing the button.

During the development of the DreamLight device, a set of prototypes was constructed and testing by subjects sleeping at home. These devices detected eye movements and triggered flashing light cues, but did not distinguish REM from waking. There was no "reality test" button on these devices. They also did not give feedback on how many cues were applied in a night, like the current DreamLights do, so it was difficult to ascertain if they were working properly. Nonetheless, while using these devices, subjects reported an average of 0.12 lucid dreams per night, compared with 0.04 when using no induction method. When subjects combined use of the device with practicing the MILD (Mnemonic Induction of Lucid Dreams) technique (LaBerge & Rheingold, 1990), they reported an average of 0.22 lucid dreams per night (LaBerge, 1988).

The purpose of the present experiment was to examine the effectiveness of DreamLight devices for inducing lucid dreams when used by subjects in their own homes. This study controlled for the possibility of a "placebo" effect—an increase in lucid dream probability resulting from the act of using a device believed by the subject to induce lucid dreams—by comparing lucid dreaming rates when the DreamLights gave cues to rates when the DreamLights did not give cues. In the latter condition, subjects believed that the devices were functioning normally.

METHOD

Subjects

Fourteen subjects participated in the experiment, 10 men, and 4 women. Their ages were between 20 and 50 years. They were selected for their high interest in lucid dreaming, and ability to carry out the experimental protocol correctly. All of the subjects had previous experience with lucid dreaming.

Preparation

Before beginning the controlled experimental protocol, the subjects undertook a preparation period of becoming accustomed to sleeping with the device and adjusting it to suit their individual requirements. This involved adjusting the sensitivity of the detection algorithm so that the device would give a reasonable number of cues (subjects aimed for between 10 and 30 cues per night) and establishing how brightly and for how long they needed the light stimulus to flash so that it would be incorporated into their dreams without causing awakenings. The flash frequency was fixed at two flashes per second. Subjects proceeded to the experimental protocol after finding stimulus parameters that produced at least two recalled incorporations of light stimuli in dreams. The number of nights required to establish proper settings ranged from 1 to 15, with a median number of six.

Protocol

After establishing appropriate cue brightness and length settings in the preparation phase, subjects were to use the same settings throughout the experiment. If a subject decided that it was necessary to change the settings after beginning the protocol, the subjects was to do so only after having used the DreamLight an equal number of times in the A and B conditions (described below) with the particular setting.

The protocol called for the subjects to alternate between using the device in two conditions, labeled A and B. Subjects selected the condition by using a special mode in the DreamLight, and setting it to "Regular," "A," or "B." In Regular mode, the DreamLights functioned normally, giving cues when REM was detected. Subjects used this mode in the preparation phase. In mode B, the DreamLights also operated normally, exactly as in Regular mode. In mode A, the DreamLights did not give cues when they detected REM sleep, although they otherwise operated the same as in mode B (including the same operation of the "reality test" button), so that the subjects could not determine the difference between the modes. The subjects were informed that they were testing two types of DreamLight cues, and they were requested not to try to guess or to find out the difference between the modes.

Subjects used both mode A and mode B between 2–12 nights (median, 5). The protocol nights were completed in 4 to 24 nights (median, 11), not necessarily consecutive.

Throughout the course of the experiment, subjects kept a log, recording data for each night, whether or not they were using DreamLights. The information collected included: the mode used (A, B, or Regular), the number of dreams recalled from the night, the number of lucid dreams recalled, the number of times subjects believed they perceived cues in dreams, the number of lucid dreams in which they realized they were dreaming because they noticed something they believed was a cue incorporation, and the number of lucid dreams in which they realized they were dreaming because of an anomaly of the "reality test" button. The number of cues the DreamLight delivered was recorded in the device's memory.

Subjects also made reports on all of the lucid dreams they recalled during the experiment, including details on how they attained lucidity, and the role of the DreamLight, if any. Two independent judges, blind to the identity of the subjects and the mode conditions used on the nights of the dreams, evaluated these reports to verify that they were true lucid dreams, in which the subjects were explicitly aware of dreaming, and to classify them according to involvement of the DreamLight.

There were three categories of possible DreamLight involvement in the initiation of lucidity. They were defined as follows:

ANY-DL: According to the subject's report, the appearance of the DreamLight in the dream helped the subject to become lucid. This could include appearance of a light or flashing identified by the subject as the DreamLight, a reality test based on pressing the DreamLight mask button in the dream, or appearance of any part of the DreamLight device, as identified by the subject. It must be clear that the DreamLight appeared in the dream before the onset of lucidity and that the subject specifically reflected on or noticed the DreamLight in the dream before becoming lucid. (E.g. saying after the dream that a certain item may have been the DreamLight does not qualify if the subject did not think so during the dream).

CUED: According to the report, the subject became lucid as the result of perceiving a flash or light that the subject identified at that time as being the DreamLight cue. Lucidity onset could be an immediate response to the perceived cue or it could come after reflection of Reality Testing.

RTB: Before becoming fully convinced of being in a dream, the subject attempts to operate the button on the DreamLight mask. The subject becomes lucid after observing that the button does not work correctly, as it would in waking. The subject may be non-lucid or pre-lucid (questioning whether awake or dreaming but not certain) before pressing the button and becoming lucid.

Each lucid dream report could be classified as belonging to one or more categories or none. All CUED lucid dream reports or RTB lucid dream reports were also ANY-DL lucid dream reports. The judges agreed 100 percent on the ratings of the lucid dream reports. Any lucid dream not fitting one or more of these categories was considered not to have been related to DreamLight use.

RESULTS

Eleven of the fourteen subjects reported at least one lucid dream during the experimental protocol (79%). The total number of experimental nights was 162, with 81 each in mode A (hereafter referred to as the "Q-OFF" condition) and mode B (the "Q-ON" condition). Because subjects contributed unequal numbers of data points to the study, the statistical tests following use mean values per subject (N=14 rather than N=162).

Subjects reported a total of 32 lucid dreams, verified by the judges; 22 (69%) occurred during the Q-ON condition and 10 (31%) during the Q-OFF condition. The mean rate of lucid dreaming per subject per night was significantly higher for the Q-ON condition (mean of 0.30 lucid dreams per night per subject) than for the Q-OFF condition (mean of 0.09 lucid dreams per night per subject) (paired t-test, $t_{13} = 2.54$, $p < .025$). Eight subjects had more lucid dreams per night in the Q-ON than in the Q-OFF condition, two subjects had equal numbers in both conditions (subjects with at least one lucid dream), and one subject had more lucid dreams per night in the Q-OFF condition (Binomial test, $p < .02$).

All lucid dreams judged to be stimulated by the recognition of an event perceived as a cue by the subject (CUED lucid dreams) occurred during Q-ON condition nights. This accounted for 6 of the 32 lucid dreams recorded (19%). Five subjects (36%) reported judge-verified CUED lucid dreams, all during Q-ON nights (binomial test, $p < .03$). The mean rate of CUED lucid dreams per Q-ON night per subject (0.071) was significantly greater than the rate (0.00) for Q-OFF nights (paired t-test, $t_{13} = 2.53$, $p < .025$). The following are examples of reports classified as CUED lucid dreams:

[1] *"I was walking along a road with my boss and the whole scene flashed, cueing me that I was dreaming. I mentioned it to him, and flew a little to prove it."*

[2] *"One dream, the whole environment lights up for a long time. I become lucid at the cue and remember to do the hand exam [the hand exam was for another experiment]."*

[3] *"Visit Mom and Dad. Missed flight. Bought new tix, missed that one, too. Very worried about money. Looking over schedules—bright flashes of red. Annoyed at whoever was doing it. Looked around. No possible source of light. Shakily conclude DreamLight. Excited."*

Six subjects (42.8%) reported a total of eight judge-verified RTB lucid dreams (lucidity initiated after dreamed "failure" of the "reality test" button). Six (75%)occurred on Q-ON condition nights, and two (25%) on Q-OFF condition nights. The mean number of RTB lucid dreams per Q-ON night per subject was 0.091, and 0.016 for Q-OFF nights (paired t-test, $t_{13} = 1.77$, $p < .10$). Five subjects had more RTB lucid dreams on Q-ON than on Q-OFF nights, and one had more on Q-OFF nights (binomial, $p < 0.10$). The following are examples of reports classified as RTB lucid dreams:

[1] *"I'm certain I'm awake in bed, but force of habit warrants that I press the mask button anyway. ... Nothing happens! I know I'm dreaming now, and observe that I am in a fairly good replica of the room I'm sleeping in. I have a momentary thought to pursue sexual activity, but decide against it because someone else is sleeping in the room with me, veridically...."*

[2] *"I was adjusting the settings on the DreamLight. It occurred to me to press the reality tester. It didn't work. I tried it again and again it didn't work. An electric jolt of excitement ran through my body as I realized I was dreaming."*

[3] *"I think I'm awake and try to push myself up in bed. I either press the mask button or the mattress, and hear a "boing." I press the mask button again, and get the same faint sound... but "boing" is not right; I must be dreaming!"*

Nine subjects (64%) reported lucid dreams fitting into the ANY-DL category, in which the subject related that any occurrence of the DreamLight in the dream resulted in lucidity. The total number of such lucid dreams was 18 (56% of the total). The mean rate of ANY-DL lucid dreams per Q-ON night was 0.174, and per Q-OFF night was 0.04 (paired t-test, $t_{13} = 2.17$, $p < .025$). Six subjects reported more ANY-DL lucid dreams for Q-ON than Q-OFF nights; two subjects reported the opposite, and one subject reported equal numbers (binomial test, $p < .04$). The following are examples of reports classified as ANY-DL lucid dreams, but not also as CUED or RTB lucid dreams:

[1] *"I'm watching my cat play on the floor near the bed. She's shredding the papers and boxes and I'm concerned because I don't want her to ruin the DreamLight box. However, I recognize it's not where I left it before going to bed and that it looks different... so this must be a dream."*

[2] *"While dreaming I lifted my mask and noticed that it was still dark even though it was late in the morning and I knew it was light. I immediately realized I was dreaming..."*

[3] *"...I hear the radio alarm go off and I hurry to turn it off so R won't have to wake up. I can't seem to silence it however; all the buttons are wacky and now the entire face of the clock has disappeared, leaving the circuitry exposed. I'm beginning to get suspicious and look over at the DreamLight. The screen is lit, but the numbers seem odd. I look back at the clock and between the device. I sense the time is off or strange somehow. Suddenly, it dawns on me that this is a false awakening [a dream of awakening]—that explains everything! Unfortunately, I awaken (truly) almost immediately, as the radio alarm has indeed gone off."*

Ten subjects reported a total of 82 incorporations of DreamLight cues into their dreams. These numbers were necessarily estimates, because the subjects were unable to recall all dream content from the nights. The mean number of reported cue incorporations per subject during Q-ON nights was 0.91 (73 total), and the mean per subject from Q-OFF nights was 0.06 (9 total) (paired t-test, $t_{13} = 2.30$, $p < .02$). All ten of the subjects reporting incorporations reported higher rates for Q-ON nights (binomial test, $p < .001$).

The number of dreams recalled per subject was also significantly greater in Q-ON condition nights. The Q-ON condition mean was 2.4 dreams per night versus 1.5 per night in the Q-OFF condition (paired t-test, $t_{13} = 2.99$, $p < .01$). Ten subjects recalled more dreams for Q-ON nights than Q-OFF nights; four recalled more on Q-OFF nights (binomial test, $p < .09$).

DISCUSSION

This experiment has shown that the sensory cues given by the DreamLight lucid dream induction device are effective for stimulating the initiation of lucidity in dreams. More than twice as many lucid dreams were reported with cueing activated (the Q-ON condition) than when the DreamLight was used with cueing deactivated (the Q-OFF condition).

That no subjects reported becoming lucid in response to a cue on nights when no cues were given probably indicates that the cues they recognized in their dreams were in fact real incorporations of the flashing lights in the DreamLight's mask. The greater number of lucid dreams initiated by failure of the "reality test" button on nights when the cues were given may be attributable to false awakenings (dreams of awakening) provoked by cues, although this was not examined in the analysis.

The fact that the rate of cue incorporations reported from Q-ON condition nights was more than fifteen times higher than from Q-OFF nights provides further evidence that the subjects were perceiving the stimuli from the devices in their dreams. The increase in dream recall from the Q-ON condition nights over the Q-OFF condition nights, although not predicted, is potentially explicable again as the result of awakenings caused by DreamLight cues.

Based on this study's findings, it is justifiable to conclude that the REM detection and stimulus delivery algorithm, and the stimulus type employed in the DreamLight together constitute an effective means of stimulating lucid dreams. The study does not address the question of how much of an increase in lucid dreaming frequency is achievable with this device, or of how long it takes an individual to succeed at having a device-induced lucid dream. These are prime topics for further research, as are the questions of the optimal cue type, the best time during REM sleep for cue application, and the most effective methods for subjects to use in preparing to recognize the cue in dreams.

ACKNOWLEDGMENTS

This work was supported in part by a gift from the Fetzer Foundation. The authors gratefully acknowledge the helpful comments of several anonymous reviewers.

REFERENCES

Dane, J. (1984). *An empirical evaluation of two techniques for lucid dream induction.* Unpublished doctoral dissertation, Georgia State University.

Dement, W. C.. & Wolpert, E. (1958). Relation of eye movements, body motility, and external stimuli to dream content. *Journal of Experimental Psychology, 55*: 543-553.

Fenwick, P., Schatzman, M., Worsley, A., Adams, J., Stone, S., & Baker, A. (1984). Lucid dreaming: Correspondence between dreamed and actual events in one subject during REM sleep. *Biological Psychology, 18*, 243-252.

Gackenbach, J. & LaBerge, S. (Eds.), (1988). *Conscious mind, sleeping brain: Perspectives on lucid dreaming.* New York: Plenum.

Hearne, K. M. T. (1978). *Lucid dreams: An electrophysiological and psychological study.* Unpublished doctoral dissertation, University of Liverpool.

LaBerge, S. (1980a). Lucid dreaming: An exploratory study of consciousness during sleep. (Ph.D. thesis, Stanford University, 1980). (University Microfilms No. 80-24,691)

LaBerge, S. (1980b). Lucid dreaming as a learnable skill: A case study. *Perceptual & Motor Skills, 51,* 1039-1042.

LaBerge, S. (1985). *Lucid dreaming.* Los Angeles: J. P. Tarcher.

LaBerge, S. (1988). The induction of lucid dreams including the use of the DreamLight, *Lucidity Letter, 7*: 15-21.

LaBerge, S. (1990). Lucid dreaming: Psychophysiological studies of consciousness during REM sleep. In R.R. Bootsen, J.F. Kihlstrom, & D.L. Schacter (Eds.), *Sleep and Cognition.* Washington, D.C.: American Psychological Association (pp. 109-126).

LaBerge, S., Nagel, L., Dement, W., & Zarcone, V. (1981). Lucid dreaming verified by volitional communication during REM sleep. *Perceptual & Motor Skills, 52,* 727-732.

LaBerge, S., Levitan, L., & Dement, W. (1986). Lucid dreaming: Physiological correlates of consciousness during REM sleep. *Journal of Mind & Behavior, 7,* 251-258.

LaBerge, S. & Rheingold, H. (1990). *Exploring the world of lucid dreaming.* New York: Ballantine.

LaBerge, S., Levitan, L., Rich, R., & Dement, W. (1988). Induction of lucid dreaming by light stimulation during REM sleep. *Sleep Research, 17,* 104.

LaBerge, S., Owens, J., Nagel, L. & Dement, W. C. (1981). “This is a dream”: Induction of lucid dreams by verbal suggestion during REM sleep. *Sleep Research, 10*: 150

Levitan, L. & LaBerge, S. (1989). A comparison of three methods of lucid dream induction. *NightLight, 1(3)*, 3-12.

Ogilvie, R., Hunt, H., Kushniruk, A. & Newman, J. (1983). Lucid dreams and the arousal continuum. *Sleep Research, 12*, 182.

Rich, R. (1985). Lucid dream induction by tactile stimulation during REM sleep. Unpublished Honors Thesis, Department of Psychology, Stanford University.

Snyder, T.J. & Gackenbach, J. (1988). Individual differences associated with lucid dreaming. In J. Gackenbach & S. LaBerge (Eds.), *Conscious mind, sleeping brain: Perspectives on lucid dreaming* (pp. 221-259). New York: Plenum.

Reference Notes

1. DreamLight® is a registered trademark of the Lucidity Institute, Inc., US Patent 5,507,716.

LUCID DREAM CONTENT BY CUE CONDITION

	Q-ON	Q-OFF	Q-OFF/ON[a]	TOTAL
ALL LDs	22 (69%)	10 (31%)	2.2 **	32 (100%)
ANY DL LDs	14 (44%)	5 (16%)	2.8 *	18 (56%)
CUED LDs	6 (19%)	0 (0%)	– **	6 (19%)
RTB LDs	6 (19%)	2 (6%)	3.0 *	8 (25%)
OTHER LDs	8 (25%)	5 (16%)	1.6 (n.s.)	14 (44%)
INCORPORATIONS	73 (89%)	9 (11%)	8.1 *	82 (100%)

[a] Ratio tested with paired t-test with mean values per S (N=14), *: $p < .05$, **: $p<.01$