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Is there a relation among REM sleep dissociated phenomena, like lucid dreaming, sleep paralysis, out-of-body experiences, and false awakening?

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ABSTRACT

During REM sleep we normally experience dreams. However, there are other less common REM sleep phenomena, like lucid dreaming (LD), false awakening (FA), sleep paralysis (SP), and out of body experiences (OBE). LD occurs when one is conscious during dreaming, and FA occurs when one is dreaming but believes that has woken up. SP is characterized by skeletal muscle atonia and occurs mainly during awakening or falling asleep. OBE is the subjective sensation of 'leaving the physical body'. Since all these phenomena happen during REM sleep, their frequency is probably connected. The goal of this research is to explore how these phenomena are connected to each other in terms of frequency. We surveyed 974 people on the streets of Moscow and found significant correlations between the phenomena. Of those surveyed, 88% have experienced at least one of the phenomena of interest (i.e., LD, OBE, FA, and SP), which appeared to be closely correlated to each other. Furthermore, 43% of respondents stated that they often experience at least one of these phenomena. We found that the recurrence of these phenomena correlated with sleep duration and dream recall frequency. The results of the survey provide better understanding of the nature of REM sleep dissociative phenomena.

Cross-correlations between REM sleep dissociated phenomena, like lucid dreaming, sleep paralysis, out-of-body experiences, and false awakening, revealed by a survey.

Introduction

Lucid dreams (LD) are dreams of which people are conscious during REM sleep [1,2], although they can also occur during non-REM sleep [3–5]. The study of LD explicates our knowledge of consciousness, dreaming, and sleep, and is relevant to many scientific disciplines, such as psychology and psychophysiology. The LD term was first introduced to the scientific sphere in 1913 by Dutch psychiatrist Frederik Van Eeden [6], but the possibility of this concept was finally confirmed by science only in 1978 by observing eyelid movements during REM sleep [7]. It is possible, that unintentional and vividly perceived LD could be responsible for some 'supernatural' phenomena like alien abduction [8,9], but some studies highlight the practical possibilities of LD as well. For example, it is possible to control PC functions from LD [10], to exercise motor skills during LD [11] or to prevent nightmares [12,13]. A *meta*-analysis of studies from 1966 to 2016 shows that 55% of people have experienced at least one LD [14].

At least a few phenomena could share specific primary features, like REM sleep and consciousness, with LD. These states can be summarized as dissociated REM states [15]. In our research work, we use the term *phase state* (PS) or simply *phase* [16]. PS includes all phenomena that occur when humans are conscious during REM sleep. Studying these phenomena together could lead to a better understanding of each of them. In this study, we choose sleep paralysis (SP), out-of-body experiences (OBE), and false awakening (FA) as primary PS phenomena, as well as LD.

SP is characterized by the inability to move or speak upon awakening or while falling asleep [17,18] and lasts no longer than a couple of minutes [19,20]. SP occurs during REM sleep [21]. The most notable characteristics of SP (e.g., that it occurs during REM sleep when one is conscious), also characterize LD [22–24].

An online survey of 1928 respondents shows that there is a correlation between the frequencies of LD and SP [25]. SP is widely known among LD practitioners and can be manipulated to create proper LD experiences [26]. Although much research has been conducted on the prevalence of SP among humans, the outcomes of these works are quite inconsistent. The rate of SP in humans has been estimated to be as low as 5% and as high as 60% [27,28].

OBE, or out-of-body travel, consists of a dissociative feeling of leaving one's body [29]. During an OBE, the person feels a sense of

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dissociation from the bed, creating an illusion of leaving the body. In our research, we consider only PS-related OBE – that is, we look only at OBE that occur during times of relaxation, sleeping, falling asleep, or waking up. Studies show that these OBEs can take place during REM sleep, and for this reason, SP has been found to be correlated with OBE [30,31].

One of the main differences between OBE and LD is in how they begin: OBE can be considered an LD that starts upon falling asleep or awakening rather than during the middle of a dream scene. LD practitioners create sensations of leaving the body as a way of inducing LD, and OBE often occurs during these attempts [26,32]. This fact indicates that OBE and LD are likely the same phenomena, at least in some cases. OBE frequency is relatively common among the population, as it ranges from 5% to 35% [33,34].

FA is another LD-like dissociative phenomenon. FA is said to occur when people wake up and start to perform daily routines before falling back asleep, fully waking up, or understanding that they are still in a dream. Like other PS phenomena, FA probably happens during REM sleep; this supposition is based on the empirical evidence that shows a strong correlation between LD and FA, which often transform into each other [35]. The only notable difference between FA and LD is that, during an LD, the dreamer has a logical understanding of the situation, whereas this is not the case during FA. From the point of view of an LD practitioner, once a person becomes aware that he is experiencing FA, he or she wakes up or starts an LD [26].

Though FA is quite well-known through culture (from movies and literature, for example), its prevalence among the general population has been almost entirely ignored by the scientific community. Only one online survey among LD practitioners showed a relatively high FA frequency, with 41% of respondents experiencing FA monthly and 71% experiencing it within one month prior to taking the survey [36]. This survey cannot represent actual FA prevalence, because LD practitioners may deal with FA more often than the average person. We included questions related to FA in our questionnaire so that we can better understand other PS phenomena.

Because LD, SP, OBE, and FA are related, it is troublesome that research on the prevalence of these PS forms among the human population is disjointed. We can find surveys on LD, SP, OBE, and FA, but there are no studies that examine all of these phenomena together. We propose that the simultaneous study and comparisons of these phenomena will lead to better understandings of each of them.

The result cannot be the same for all regions and countries, but it is possible to obtain statistics for at least one city. We chose to ask ordinary passersby in the streets of Moscow, Russia, to answer a few questions regarding our study. In the future, the same surveys could take place in other countries and cities so that the outcomes can be compared.

Hypothesis

The primary hypothesis of our study is that the different forms of PS are closely correlated in terms of how often they occur. Furthermore, they may be linked not only to each other but also to sleep duration (SD), dream recall frequency (DRF), and to awareness of PS related practices (AW). Another hypothesis is that PS occurs often for ordinary people.

The idea of cross-correlations between PS forms looks obvious, as all these phenomena originates from REM sleep, but it has never been revealed by actual data. Support for our hypotheses would indicate a need for more research on PS, as such research could provide information about an unknown, yet potentially profound, aspect of humanity. If PS is correlated with SD and DRF, knowing this could help us to better understand the nature of PS and why it happens. The results of the study could provide knowledge about the sleep process, REM sleep, and consciousness in general. The results also might reveal essential patterns in people's sleep regimes. Therefore, this study will be useful for LD practitioners and scholars who want to further explore the phenomena of interest.

Methods

Survey

The study took place on March 16th and 17th, 2019 in the form of a live survey on the streets of Moscow, Russia. A group of nine assistants was instructed to ask passersby a list of specific questions regarding our study. All the assistants were familiar with LD and were paid a fixed sum in rubles. They asked every passerby to stop for a minute and answer a few questions. If a person agreed, the assistants asked the questions and recorded the participant's answers. Since this study was a voluntary, non-experimental survey, no ethical approval was needed.

We decided to perform a live survey because it allowed us to ask questions to random people and to clarify questions if needed. People who have experienced some forms of PS might not be familiar with specific terms, or they might doubt whether their experience qualifies as PS. Moreover, if we had performed an online survey, people with an interest in LD or OBE might have made a disproportionately large contribution to the results. The inability of respondents to ask questions is a significant drawback of online surveys, and this drawback could have a crucial impact in the case of complicated topics like PS.

Questions and personal data

The questionnaire contained seven questions, which allowed respondents to provide information about the following: 1 – SD, measured in average number of hours for all days per week. 2 – DRF frequency, with the options of 'never,' 'sometimes,' 'often,' and 'cannot answer.' 3 – LD frequency, with the options of 'never,' 'once,' 'sometimes,' 'often,' and 'cannot answer.' 4 – FA frequency, with the same options that were given for the third question. 5 – SP frequency, with the same options that were given for the third question. 6 – OBE frequency, with the same options that were given for the third question. 7 – overall awareness (AW) about practices like lucid dreaming, astral projecting, or OBE, with the options of 'no,' 'yes,' and 'cannot answer.' Four more questions were asked to obtain respondents' personal information (age, name, gender, and phone number).

All the filled-out questionnaires were saved in their original physical form, as scanned copies, and as part of an overall data file.

Statistical analysis

The data analysis was performed using chi-square and contingency tables in JASP (Version 0.11.1). The analysis included all criteria (gender, age, SD, DRF, LD, SP, OBE, FA, PS, and AW), as well as their pairings and correlations to each other. An alpha = 0.05 significance level was employed, and Bonferroni corrections were used for post-hoc tests.

Though there were fixed options in the questionnaire, people sometimes gave simple answers like 'yes' or 'no.' For this reason, we put these options into the data file, as they contain general information regarding the questions. If an answer was unclear or if a person could not give an answer, we marked the response as 'n/a' to unite all uncertain results.

During the analysis, many alternative data fields were created through which the obtained data were either divided into groups or united as general outcomes. To analyze SD, we divided its data into 4 categories: < 6 h, 6–9 h, > 9 h, and n/a. It was based on the National Sleep Foundation recommendations for optimal sleep durations. It suggests 8 to 10 h for teenagers, 7 to 9 h for adults, and 7 to 8 h for people over 65 y/o [37]. Considering possible personal and age variations, we chose 6 to 9 h as most popular actual SD, which was common for ¾ of our data (76%).

Table 1
Gender Distribution of Lucid Dream Frequency (LD).

LD frequency	Gender			Total (N = 974)
	Male (N = 438)	N/a (N = 8)	Female (N = 528)	
No	128 (29%)	1 (13%)	143 (28%)	272 (28%)
Once	32 (7%)	0 (0%)	26 (5%)	58 (6%)
Yes	8 (2%)	0 (0%)	10 (2%)	18 (2%)
Sometimes	182 (42%)	4 (50%)	209 (40%)	395 (41%)
Often	84 (19%)	3 (38%)	135 (26%)	222 (23%)
N/a	4 (1%)	0 (0%)	5 (1%)	9 (1%)

Note: No = no one LD in life; Once = one LD in life; Yes = one or more LD in life; Sometimes = LD happen sometimes; Often = LD happen often; N/a = unclear or undefined answer.

To create PS data we united LD, OBE, FA, and SP data. If there were at least two 'yes' or 'once', it was counted as 'sometimes' for PS. If there were at least three answers 'sometimes', it was counted as 'often' for PS. If there were at least one 'often', it was counted as 'often' for PS.

Results

Our data are obtained from 974 passersby aged between 10 and 87 (M = 29, SD = 15) who took part on the study. Of the participants, 528 (54%) were female (10–83 years old), 438 (45%) were male (11–87 years old), and eight (1%) identified themselves as neither male nor female (16–33 years old).

Lucid dreaming statistics

Of the respondents, 71% reported having experienced at least one LD, with 6% having experienced exactly one LD, 41% experiencing LD sometimes, and 23% experiencing LD often (nLD). 26% of women reported experiencing nLD and 19% of men, but the χ2-test didn't show a statistically significant difference between genders (Table 1).

Respondents who sleep less than six hours or more than nine hours experience nLD in 29% and 31%, when other respondents in 21%, but the χ2-test didn't show a statistically significant difference between LD and SD (Fig. 1).

Respondents with nLD often remember their dreams (nDRF) more regularly (66%) than those who don't experience LD (39%). Respondents with nLD have no DRF less regularly (3%) than those who don't experience LD (14%). The χ2-test confirmed a statistically significant relationship between LD and DRF (χ2 (20, N = 974) = 264.947, P < .001). Post-hoc tests showed an equal significant difference between the nDRF / no DRF and LD pairs ($P_{bonferroni}$ < 0.005).

Respondents with nLD often endure FA (nFA) more regularly (15%) than those who don't experience LD (4%). Respondents with nLD have no FA less regularly (43%) than those who don't experience LD (67%). The χ2-test confirmed a statistically significant relationship between LD and FA (χ2 (25, N = 974) = 314.934, P < .001). Post-hoc tests showed an equal significant difference between nFA / no FA and LD ($P_{bonferroni}$ < 0.006).

Respondents with nLD often endure SP (nSP) more regularly (5%) than those who don't experience LD (1%). Respondents with nLD have no SP less regularly (70%) than those who don't experience LD (83%). The χ2-test confirmed a statistically significant relationship between LD and SP (χ2 (25, N = 974) = 126.767, P < .001). Post-hoc tests showed an equal significant difference between nSP / no SP and LD ($P_{bonferroni}$ < 0.006).

Respondents with nLD often have OBE (nOBE) more regularly (24%) than those who don't experience LD (10%). Respondents with nLD have no OBE less regularly (41%) than those who don't experience LD (64%). The χ2-test confirmed a statistically significant relationship between LD and OBE (χ2 (25, N = 974) = 285.996, P < .001). Post-hoc tests showed an equal significant difference between nOBE / no OBE and LD ($P_{bonferroni}$ < 0.006).

Respondents of the 51–60 and > 60 age groups less often experience nLD (14% and 20%) than the 11–20, 21–30, 31–40, and 41–50 age groups (24%, 24%, 19%, and 28%). Respondents of the 51–60 and > 60 age groups more regularly don't experience LD (48% and 45%) than the 11–20, 21–30, 31–40, and 41–50 age groups (24%, 28%, 27%, and 28%). The χ2-test confirmed a statistically significant relationship between LD and age groups (χ2 (30, N = 974) = 58.561, P = .001). Post-hoc tests showed an equal significant difference between nLD / no LD and age groups ($P_{bonferroni}$ < 0.007).

Respondents with nLD have positive awareness about PS related practices (AW) in 68% when those who don't experience LD in 58%. Respondents with nLD have negative AW in 27% when those who don't experience LD in 39%. The χ2-test didn't confirm a statistically significant relationship between LD and AW.

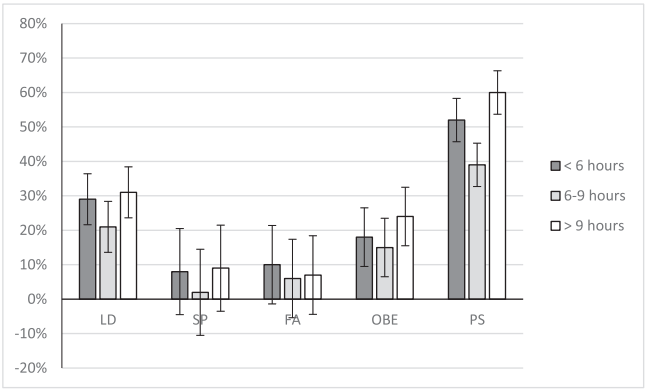

Fig. 1. nPS and its forms distribution in sleep hours group.

Sleep paralysis statistics

Of the respondents, 24% reported having experienced SP at least once. 9% of participants have experienced only one SP episode, 10% experience SP sometimes, and 3% often experience SP (nSP). 4% of women experience nSP and 3% of men, but the χ2-test didn't show a statistically significant difference between genders (Table 2).

Respondents who sleep less than six hours or more than nine hours experience nSP more regularly than the other respondents (8% and 9% vs. 2%, respectively) (Fig. 1). The χ^2-test confirms a statistically significant relationship between SP and SD (χ^2 (15, N = 974) = 32.882, P = .005). Post-hoc tests showed an equal significant difference between < 6 / 6–9 / > 9 h groups and SP ($P_{bonferroni}$ < 0.004).

Respondents with nSP experience nDRF more regularly (55%) than those who don't experience SP (48%). Respondents with nSP have no

Table 2
Gender Distribution of Sleep Paralysis Frequency (SP).

SP frequency	Gender			Total (N = 974)
	Male (N = 438)	N/a (N = 8)	Female (N = 528)	
No	335 (77%)	6 (75%)	393 (74%)	734 (75%)
Once	40 (9%)	1 (13%)	49 (9%)	90 (9%)
Yes	5 (1%)	0 (0%)	4 (1%)	9 (1%)
Sometimes	40 (9%)	0 (0%)	57 (11%)	97 (10%)
Often	11 (3%)	1 (13%)	21 (4%)	33 (3%)
N/a	7 (2%)	0 (0%)	4 (1%)	11 (1%)

Note: No = no one SP in life; Once = one SP in life; Yes = one or more SP in life; Sometimes = SP happen sometimes; Often = SP happen often; N/a = unclear or undefined answer.

DRF more regularly (12%) than those who don't experience SP (6%). The χ2-test confirmed a statistically significant relationship between SP and DRF (χ2 (20, N = 974) = 77.673, P < .001). Post-hoc tests showed an equal significant difference between nDRF / no DRF and SP ($P_{bonferroni}$ < 0.005).

Respondents with nSP experience nFA more regularly (24%) than those who don't experience SP (6%). Respondents with nSP have no FA less regularly (42%) than those who don't experience SP (58%). The χ2-test confirmed a statistically significant relationship between SP and FA (χ2 (25, N = 974) = 188.103, P < .001). Post-hoc tests showed an equal significant difference between nFA / no FA and SP ($P_{bonferroni}$ < 0.006).

Respondents with nSP experience nOBE more regularly (36%) than those who don't experience SP (15%). Respondents with nSP have no OBE less regularly (39%) than those who don't experience SP (52%). The χ2-test confirmed a statistically significant relationship between SP and OBE (χ2 (25, N = 974) = 44.652, P = .009); post-hoc tests showed a significant difference between the nOBE / no OBE and SP pairs ($P_{bonferroni}$ < 0.054).

Respondents of the 41–50, 51–60, and > 60 age groups less often experience nSP (2%, 0%, and 2%) than the 11–20, 21–30, and 31–40 age groups (4%, 3%, and 4%). Respondents of the 51–60 and > 60 age groups more regularly don't experience SP (80% and 90%) than the 11–20, 21–30, 31–40, and 41–50 age groups (74%, 73%, 78%, and 72%). The χ2-test didn't confirm statistically significant relationship between SP and age groups.

Respondents with nSP have positive AW in 67% when those who don't experience SP in 64%. Respondents with nSP have negative AW in 30% when those who don't experience SP in 32%. The χ2-test didn't confirm a statistically significant relationship between SP and AW.

False awakening statistics

Of the respondents, 45% reported having experienced at least one FA episode, with 8% having experienced exactly one FA episode, 28% experiencing FA sometimes, and 7% experiencing nFA (Table 3).

Respondents who sleep less than six hours per day experience nFA more regularly than other respondents (10% versus 6% for 6–9 h SD and 7% for > 9 h SD) (Fig. 1). The χ^2-test confirmed a statistically significant relationship between FA and SD (χ^2 (15, N = 974) = 85.164, P < .001). Post-hoc tests showed an equal significant difference between < 6 / 6–9 / > 9 h groups and FA ($P_{bonferroni}$ < 0.004).

Respondents with nFA experience nDRF more regularly (53%) than those who don't experience FA (46%). Respondents with nFA have no DRF less regularly (3%) than those who don't experience FA (8%). The χ2-test confirmed a statistically significant relationship between FA and DRF (χ^2 (20, N = 974) = 144.032, P < .001). Post-hoc tests showed an equal significant difference between nDRF / no DRF and FA ($P_{bonferroni}$ < 0.005).

Respondents with nFA experience nOBE more regularly (32%) than those who don't experience FA (12%). Respondents with nFA have no OBE less regularly (40%) than those who don't experience FA (53%). The χ2-test confirmed a statistically significant relationship between FA and OBE (χ2 (25, N = 974) = 194.547, P < .001). Post-hoc tests showed an equal significant difference between nOBE / no OBE and FA ($P_{bonferroni}$ < 0.006).

Respondents of the 51–60 and > 60 age groups less often experience nFA (4% and 3%) than the 11–20, 21–30, 31–40, and 41–50 age groups (8%, 9%, 5%, and 8%). Respondents of the 51–60 and > 60 age groups more regularly don't experience FA (78% and 74%) than the 11–20, 21–30, 31–40, and 41–50 age groups (46%, 49%, 60%, and 55%). The χ2-test confirmed a statistically significant relationship between FA and age groups (χ2 (30, N = 974) = 75.584, P < .001). Post-hoc tests showed an equal significant difference between nFA / no FA and age groups ($P_{bonferroni}$ < 0.007).

Respondents with nFA have positive AW more regularly (76%) than those who don't experience FA (59%). Respondents with nFA have negative AW less regularly (22%) than those who don't experience FA (37%). The χ2-test confirmed a statistically significant relationship between FA and AW (χ2 (10, N = 974) = 23.159, P = .010). Post-hoc tests showed an equal significant difference between positive / negative AW and FA ($P_{bonferroni}$ < 0.003).

Out-of-body experience statistics

Of the respondents, 48% reported having experienced an OBE at least once, with 7% having experienced exactly one OBE, 24% experiencing OBE sometimes, and 16% experiencing OBE often (nOBE). Women more often than men experience nOBE (18% versus 14%), but the χ2-test didn't show a statistically significant relationship between OBE and gender (Table 4).

Respondents who sleep more than nine hours per day experience nOBE in 24% when 15% for 6–9 h SD and 18% for < 6 h SD. The χ2-test didn't show a statistically significant relationship between OBE and SD (Fig. 1).

Respondents with nOBE experience nDRF more regularly (58%) than those who don't experience OBE (45%). Respondents with nOBE have no DRF less regularly (5%) than those who don't experience OBE (7%). The χ2-test confirmed a statistically significant relationship between OBE and DRF (χ2 (20, N = 974) = 86.787, P < .001). Post-hoc tests showed an equal significant difference between nDRF / no DRF and OBE ($P_{bonferroni}$ < 0.005).

Respondents of the 31–40, 51–60, and > 60 age groups less often experience nOBE (10%, 8%, and 10%) than the 11–20, 21–30, and 41–50 age groups (23%, 14%, and 16%). Respondents of the 31–40, 51–60, and > 60 age groups more regularly don't experience OBE (42%, 48%, and 50%) than the 11–20, 21–30, and 41–50 age groups (23%, 14%, and 16%)The χ2-test confirmed a statistically significant relationship between OBE and age groups (χ2 (30, N = 974) = 56.815,

Table 3
Gender Distribution of False Awakening Frequency (FA).

FA frequency	Gender			Total (N = 974)
	Male (N = 438)	N/a (N = 8)	Female (N = 528)	
No	242 (55%)	5 (63%)	272 (52%)	519 (53%)
Once	48 (11%)	1 (13%)	31 (6%)	80 (8%)
Yes	5 (1%)	0 (0%)	14 (3%)	19 (2%)
Sometimes	107 (24%)	2 (25%)	165 (31%)	274 (28%)
Often	30 (7%)	0 (0%)	38 (7%)	68 (7%)
N/a	6 (1%)	0 (0%)	8 (2%)	14 (1%)

Note: No = no one FA in life; Once = one FA in life; Yes = one or more FA in life; Sometimes = FA happen sometimes; Often = FA happen often; N/a = unclear or undefined answer.

Table 4
Gender Distribution of Out-of-Body Experience Frequency (OBE).

OBE frequency	Gender			Total (N = 974)
	Male (N = 438)	N/a (N = 8)	Female (N = 528)	
No	211 (48%)	6 (75%)	263 (50%)	480 (49%)
Once	39 (9%)	0 (0%)	27 (5%)	66 (7%)
Yes	7 (2%)	0 (0%)	9 (2%)	16 (2%)
Sometimes	108 (25%)	1 (13%)	124 (23%)	233 (24%)
Often	61 (14%)	1 (13%)	95 (18%)	157 (16%)
N/a	12 (3%)	0 (0%)	10 (2%)	22 (2%)

Note: No = no one OBE in life; Once = one OBE in life; Yes = one or more OBE in life; Sometimes = OBE happen sometimes; Often = OBE happen often; N/a = unclear or undefined answer.

Table 5
Gender Distribution of the Phase State (PS).

PS frequency	Gender			Total (N = 974)
	Male (N = 438)	N/a (N = 8)	Female (N = 528)	
No	48 (11%)	0 (0%)	52 (10%)	100 (10%)
Once	32 (7%)	1 (13%)	14 (3%)	47 (5%)
Yes	4 (1%)	0 (0%)	5 (1%)	9 (1%)
Sometimes	178 (41%)	2 (25%)	206 (39%)	386 (40%)
Often	169 (39%)	5 (63%)	242 (46%)	416 (43%)
N/a	7 (2%)	0 (0%)	9 (2%)	16 (2%)

Note: No = no one PS in life; Once = one PS in life; Yes = one or more PS in life; Sometimes = PS happen sometimes; Often = PS happen often; N/a = unclear or undefined answer.

P = .002). Post-hoc tests showed an equal significant difference between nOBE / no OBE and age groups ($P_{bonferroni}$ < 0.007).

Respondents with nOBE have positive AW more regularly (72%) than those who don't experience OBE (58%). Respondents with nOBE have negative AW less regularly (22%) than those who don't experience OBE (38%). The χ2-test confirmed a statistically significant relationship between OBE and knowledge about PS related practices (χ2 (10, N = 974) = 25.494, P = .004). Post-hoc tests showed an equal significant difference between positive / negative AW and OBE ($P_{bonferroni}$ < 0.003).

Phase state statistics

Of the respondents, 88% have experienced at least one PS, with 5% having experienced exactly one PS, 40% experiencing PS sometimes, and 43% experiencing PS often (nPS) (Table 5). Women experience nPS more often than men do (46% versus 39%). but the χ2-test didn't show a statistically significant relationship between PS and gender (Fig. 2). 33% have experienced only one nPS form, 8% two forms, 2% three forms, and only one respondent has reported four nPS forms.

Respondents who sleep less than six hours or more than nine hours per day are more likely to experience nPS than those who sleep 6–9 h (52% and 60% versus 39%, respectively) (Fig. 1). 64% of respondents who sleep for > 10 h per day experience nPS and 56% of respondents who sleep for < 5 h experience nPS. The χ^2-test confirmed a statistically significant relationship between PS and the three SD group (χ^2 (15, N = 974) = 27.639, P = .024). Post-hoc tests showed an equal significant difference between < 6 / 6–9 / > 9 h groups and PS ($P_{bonferroni}$ < 0.006).

Respondents with nPS experience nDRF more regularly (60%) than those who don't experience PS (34%). Respondents with nPS have no DRF less regularly (3%) than those who don't experience PS (16%) (Fig. 3). The χ2-test confirmed a statistically significant relationship between PS and DRF (χ2 (20, N = 974) = 96.371, P < .001). Post-hoc tests showed a significant difference between nDRF and PS ($P_{bonferroni}$ < 0.005), but didn't show difference between no DRF and PS ($P_{bonferroni}$ = 0.07).

Respondents in the 11–20 (51%), 21–30 (43%), and 41–50 (45%) age groups experience nPS more regularly than those in the 31–40 (30%), 51–60 (28%), and > 60 (29%) age groups. The χ^2-test confirmed a statistically significant relationship between PS and age (χ^2 (30, N = 974) = 92.730, P < .001). Post-hoc tests showed a significant difference between nPS and age groups ($P_{bonferroni}$ < 0.007), but didn't show difference between no PS and age groups ($P_{bonferroni}$ = 0.084). (Fig. 3).

Respondents with nPS gave positive AW more regularly (70%) than those who don't experience PS (53%). Respondents with nPS have negative AW less regularly (25%) than those who don't experience PS (46%). The χ2-test confirmed a statistically significant relationship between PS and knowledge about PS related practices (χ2 (10, N = 974) = 24.936, P = .005). Post-hoc tests showed an equal significant difference between positive / negative AW and PS ($P_{bonferroni}$ < 0.003).

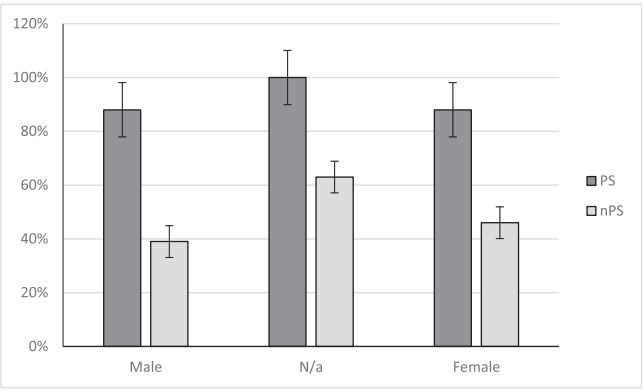

Fig. 2. Gender distribution of PS.

Discussion

We aimed to study the cross-correlations of similar psychophysiological phenomena that occur while people are conscious during REM sleep. To accomplish this goal, we conducted a live survey on the streets of Moscow. According to the primary hypothesis, PS forms are closely correlated in terms of how often they occur and their dependence on SD. DRF, and AW.

Hypotheses confirmation

The primary hypothesis stated that the different forms of PS are closely correlated in terms of how often they occur. This hypothesis was confirmed by the consistent correlations between LD, SP, FA, and OBE. In our analysis, all these phenomena were found to be related to each other. In other words, if a person has often experienced one form of PS, they are more likely than average to experience other forms of PS.

Another hypothesis of our study was that PS is widespread among the population; as such, we expected that most of the respondents would have had at least one LD / SP / FA / OBE experience. This hypothesis is confirmed by the data (Fig. 4). This result is unique, as the different PS forms have never been analyzed together in one study.

Advantages and limitations of the survey

The main problem of our study is that the questionnaire allowed respondents to give subjective answers (e.g., 'sometimes' and 'often') instead of using fixed, concrete ranges. As a result, one respondent might have answered 'sometimes' while another respondent with the same experience might have answered 'often.' We did not expect the difference between objective and subjective answers to be dramatic because we see considerable consistency regarding the correlations between almost every 'often' option and other data. To illustrate, the more 'often' responses we received for LD, the more 'often' responses we received for SP, FA, and OBE; such findings are very unlikely to be coincidental. The same respondents who used 'sometimes' or 'often' for one answer were likely to use it for other answers if they experience the two PSs in question at the same frequency.

If we consider the options 'sometimes' and 'often' as subjective data, we can objectively count them as positive answers for any given question. This means that the overall data could be more accurate if we were to analyze how many representatives encountered one phenomenon or another.

Another problem is that some respondents could misunderstand the concepts of questions in general or could be false self-acclaimed PS

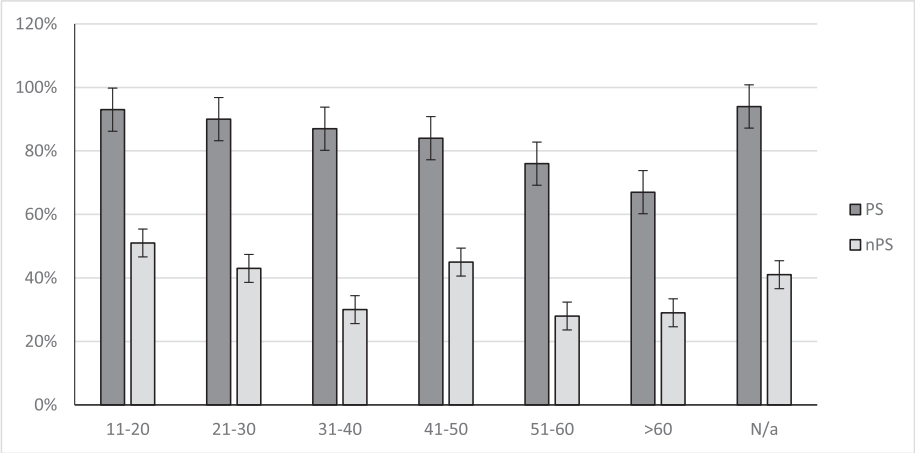

Fig. 3. Age groups distribution of PS.

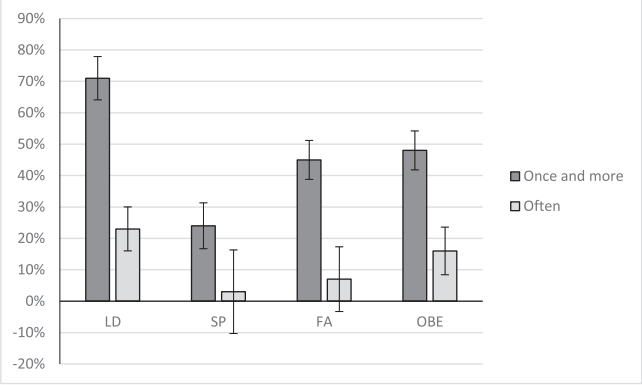

Fig. 4. PS forms distribution.

practitioners (due to popularity of the topic in social media, movies, etc.). It is possible that these issues could affect the overall data, but it less likely refers to the most important part of the study: the cross-correlation findings, which are statistically significant.

The main advantage of our study is that the survey was administered in person (as opposed to online or via printed questionnaires) by people who are familiar with the topic at hand. This allowed us to clarify all the questions and explain any details if doing so was needed. This could have a considerable impact on the results because many respondents couldn't understand all the questions without some help. This might be the primary reason that we obtained different results than other researchers have obtained.

Another advantage of our research is that it was conducted on the streets, using random passersby as participants. None of the respondents had any affiliation with our study, nor do they represent a specific, isolated group of people. We tried to post our questionnaire online, but we found that people with an interest in PS were much more likely than other people to fill it out. The same happened with our attempt to conduct the survey by phone.

Corrections of the results

Our study was made in the capital of the Russian Federation, and its results cannot be 100% relevant to other countries, or for other regions in Russia for that matter. We assume that the results of this study would be different – perhaps slightly or perhaps completely – were it to be carried out in other parts of the world due to differences in culture, education, climate, etc.

LD appears to be the most common form of PS, as 71% of participants reported experiencing at least one LD, with 23% claiming that they experience nLD. These percentages are larger than those that have been published in most previous surveys [8]. This could be explained by faults with the research, a greater LD predisposition among Moscow's inhabitants, or by an overall awareness of the phenomenon (64%) among Moscow's population. Another reason could be the strong familiarity that the survey distributors of this study have with LD practice, as they had the time and ability to clarify any aspect of any question if needed. As was expected, the frequency of LD is correlated with the frequencies of DRF, SP, FA, OBE, and age.

The SP frequency of our participants was within the range of what other studies have reported [27,28]. As was predicted, the frequency of SP is correlated with the frequencies of SD, DRF, LD, FA, and OBE. We found an unexpected connection between SP and DRF, as DRF had a negative correlation with nSP. There would be indeed such correlations between SP or DRF, or more research in this aspect is needed.

Forty-five percent of the participants reported having experienced FA at least once. It is difficult to compare our data with that of other studies, as there are almost no studies that have measured FA frequency. As predicted, the frequency of FA is correlated with the frequencies of SD, DRF, LD, SP, OBE, AW, and age. We expected the overall frequency of FA to be at least twice the value we obtained. We suspect that such a low value was obtained because people simply don't notice when they have experienced FA. This is because FA episodes can sometimes be very short or vague. Also, people can quickly forget about an occurrence of FA soon after it has happened. Thus, we believe that the results we obtained related to FA do not accurately represent reality.

Another unexpected result was related to the OBE frequencies (48% at least once and 16% often). We obtained values twice as large as expected and have no clear explanation of the situation. Perhaps there was a problem with the formulation of the question used to measure OBE despite our attempt to clarify every phenomenon that we asked participants about. Some respondents may not have understood precisely what is meant by the term OBE. However, we believe that our figures could be accurate because the assistants were familiar with the topic and could explain it better than might have been the case in other surveys. Moreover, OBE frequency is correlated to frequencies of DRF, LD, SP, FA, AW, and age. If the OBE data is inaccurate, it's highly improbable that a 100% correlation with all other PS aspects, as well as with AW and DRF, would have been achieved.

Our data show that 88% of respondents have experienced at least one form of PS at least once and that 43% often encounter some form of PS. Though these results were predicted, it was unexpected that so many respondents would have experienced a form of PS often. Because different forms of PS are correlated with gender, SD, and DRF, it was not surprising to find correlations between PS, the abovementioned

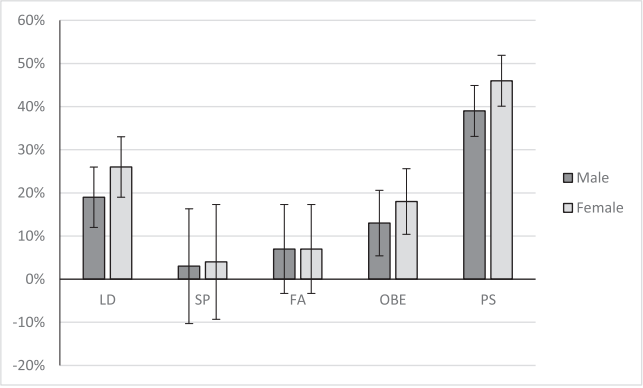

Fig. 5. nPS and its forms distribution.

factors, and age. Finding these correlations was one of the primary goals of the study. This is because finding such correlations uncovers information relevant to all dissociative phenomena that happen when people are falling asleep or just waking up. PS statistics may be considered as more accurate way to learn LD, SP, FA, and OBE, than studying them separately.

While our results show that 88% of respondents have experienced PS, there is a chance that up to 100% of them have had this kind of experience. The main reason to suppose so high PS frequency is that it's impossible for respondents to quickly recall all rare situations that they have encountered. If respondents would have been given more time and had been given more thorough explanations of the phenomena, more of them likely would have recalled experiencing PS forms.

Gender correlations

Our data shows that for PS in general, as well as for most specific forms of PS, women have stronger predispositions than men to experience them. At least by numerical difference, women more regularly than men experience nLD, nSP, nOBE, nPS (Fig. 5). We didn't find a correlation between gender and FA, though this could be a result of a mistake in the survey.

Sleep duration correlations

In all the correlations, PS and its forms were dependent on SD (at least by numerical difference). Respondents who sleep less than six hours or more than nine hours per day experience nLD, nSP, and nPS more regularly than those who get between six and nine hours of sleep per day. Those who sleep less than six hours are especially likely to experience nFA, while those who sleep more than nine are prone to nOBE (Fig. 1).

Dream recall correlations

For all correlations, at least by numerical difference, DRF influences PS and its distinct forms. Respondents with nDRF tend to experience PS more regularly than other respondents, while respondents with no DRF tend not to experience PS. The only condition that was more likely to occur for the no DRF group than the other DRF groups was nSP. It should be noted that people with better DRF are apparently more likely to recall any PS forms, because PS nature closely relative to dreaming processes.

Age correlations

The age of the respondents impacted all observed correlations. In general, younger respondents were more likely than older respondents to have experienced PS and its forms. The 11–20 age group had the highest predispositions for nSP, nOBE, and nPS. The 21–30 age group had the highest percentage of respondents who experience nFA. The 51–60 age group had the lowest percentage of respondents who reported experiencing nSP, nOBE, and nPS, while the > 60 age group had the lowest percentage of respondents experiencing nLD, nFA, and nPS.

No linear correlation was found between age and PS. Sometimes, the 31–40 or 41–50 age groups had almost the same – and sometimes had higher – predispositions than the younger groups. For example, the 41–50 group had the highest rate of nLD. Young groups did not have the lowest prevalence of any form of PS, whereas old groups did not have the highest incidence of any form of PS.

PS awareness

We found direct correlations, numerical or proved by the χ^2-test, between AW and frequencies of all PS forms. To clarify this outcome, more in-depth study is needed. We may suppose that unintentional PS encounters may rise probability of reading books / articles or watching videos related to this topic. At the same time, general interest in PS may lead to controllable PS practice (LD and OBE).

Narcolepsy symptoms

Some of the respondents often experience a few PS forms (8% for two forms, 2% for three forms, and one case for all four forms). This could be a symptom of narcolepsy, especially if it correlates with high SD [38,39]. This topic needs more research, but our survey could bring new insights on narcolepsy prevalence too.

Conclusions and future studies

The data provide a broader picture of the nature of dissociative phenomena like LD, SP, FA, and OBE. Once again, we see that all these states are very common among the human population, and they are strongly cross-correlated to each other. Most people experience PS in one form or another, and it could be that everybody has experienced PS, with some people simply forgetting about it. This indicates an aspect of the human brain that is still unexplored. Studies in this field may lead to new scientific discoveries about consciousness and the workings of the mind.

Because our results were obtained only in one region of one country, it would be worthwhile to conduct similar studies in other countries and cities. Not only would additional surveys of this nature help us to better understand our brain, but they would also identify how culture and climate affect PS.

Further PS studies may lead to new health treatments or new ways of enhancing human abilities. A solid understanding of PS and its forms may help us to better understand our culture, history, and daily lives and, in turn, to improve our lives. To achieve this, we need to keep researching and have the determination to meticulously explore this topic.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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As the author of '*Is there a relation among REM sleep dissociated phenomena, like lucid dreaming, sleep paralysis, out-of-body experiences, and false awakening?*', I have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria;

educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.mehy.2020.110169.

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