Foods and substances influencing (lucid) dreams

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Summary. Research on how substances and foods influence dreams and lucid dreams (i.e. the dreamer knows that they are dreaming while dreaming) is still scarce. For the present study, 436 participants, mainly collected from communities with interest in dreaming and lucid dreams, completed an online questionnaire and answered questions about consumption of some daily foods and substances alongside with dream recall, lucid dream frequency and other dream-related items. For possible interactions, demographics and Big Five personality factors were also collected and partial correlations were calculated. Prominent findings of this mostly explorative study were: when corrected for openness to experiences as an interactive variable, vitamin intake still correlated significantly with lucid dream frequency, ($p = 0.013$, $r = 0.121$), but not with dream recall ($p = 0.112$, $r = 0.078$); However, when instead corrected for dream recall and age, vitamin intake did not significantly correlate with lucid dream frequency ($p = 0.066$, $r = 0.090$); this suggests, vitamin intake influences either dream recall or lucid dream frequency. Also, consumption of fruits correlated with dream recall ($p = 0.10$, $r = 0.124$), which might be due to vitamins. Eating fish correlated significantly with lucid dream frequency, after controlling for extraversion and age ($p = 0.012$, $r = 0.121$), which is discussed to occur probably due to effects of omega-3 fatty acids. Consumption of chili correlated significantly with recall of hypnagogia, when controlled for age and openness to experiences ($p = 0.002$, $r = 0.154$), which is discussed to occur probably due to effects of capsaicin. Smoking correlated significantly with nightmares, after controlling for sleep paralysis ($p = 0.049$, $r = 0.096$). Use of antidepressants correlated significantly with lucid dream frequency ($p = 0.012$, $r = 0.122$), but also with nightmare frequency, even after controlling for neuroticism ($p = 0.000$, $r = 0.197$), which could not be explained by lucid dream frequency. Other hypotheses about certain foods or substances influencing dream variables could not be confirmed or provided less evident results. Further research is suggested for testing more detailed hypotheses based on these findings.

Keywords: Lucid dreams, dream recall, substances, foods, nutrients, supplements, hypnagogia, sleep paralysis, nightmares, dream contents, omega-3 fatty acids, capsaicin, vitamins.

1. Introduction

Most of past research on substances and sleep has been done regarding possible effects on sleep stages, sleep quality or parasomnia like nightmares and sleep paralysis, as is shown below. However, not many studies considering substances and foods were concerned with general dream recall, dream contents other than nightmares or with the experience of hypnagogia (i.e. hallucinated impressions that occur during sleep onset stage N1). Also, of the many theorized effects that substances might have on lucid dreams, only few have been researched by now (Bazzari, 2018). This study aims to test previous findings and to develop new hypotheses about how everyday foods and substance intake might influence dream recall, lucid dreaming, sleep paralysis, hypnagogic experiences, nightmares, pleasant dreams and surreal dreams.

In principle, all substances and nutrients affecting REM-sleep could have an impact on dream recall, sleep paralysis, lucid dreams and dream contents. Alcohol, for example, suppressed REM-sleep and was linked to a fragmentation of sleep according to some studies (Munezawa et al., 2011). It also has been associated with an increase of sleep paralysis and nightmares (Munezawa et al., 2011; Wang, 2012), although others did not find significant correlations here (Watson et al., 2015; Rek et al., 2017). Even a decrease of dream recall has been found for alcohol consumption (Stieger & Kuhlmann, 2018), but research is still scarce and for lucid dreaming, no alcohol-related studies have been done yet.

For smoking cigarettes, a decrease in sleep quality and a promotion of nightmares has been found, which has been speculated to be due to an increased fragmentation of sleep, e.g. because of cough and withdrawal symptoms during the night (Wetter et al., 1994; Bazzari, 2018). On the other hand, nicotine patches worn during the night were associated with an increase in dream recall (Page et al., 2006) and some oneironauts (i.e. people exploring their dreams, especially by lucid dreaming) use them for the purpose of increasing lucid dream frequency (Bazzari, 2018), but an effect of nicotine on lucid dreams has not been researched until now.

REM-sleep has also been found to be decreased by some antidepressants (Bazzari, 2018). An increase of REM-sleep and of dream recall was found for vitamin B6 (Aspy et al., 2018). Vitamin B6 is being used as a lucid dream supplement by oneironauts, without any research existing for this application yet (Bazzari, 2018). Vitamin B generally has been used for sleep-related problems (Sanlier & Sabuncular, 2020) and different vitamins have been found to be important for cognitive functioning (Misuraca et al., 2017). So they might in general be candidates for dream-related effects, because they might enhance memory, which is important for recalling

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dreams and hypnagogia. Principally, an improved cognitive functioning might be a key to lucid dreaming, too.

Lucid dreaming has been linked to increased prefrontal cortex activity during sleep – which is decreased for non-lucid dreams (Dresler et al., 2012) and past studies showed robust results on increased lucid dream frequency for Galantamine, which is being used for Alzheimer disease (Bazzari, 2018). On the other hand, no effect of alpha-GPC on lucid dreams has been found by a study (Kern et al., 2017). So, a possible linkage between substances with positive cognitive effects and lucid dream frequency remains to be further tested. This could also include substances like nicotine or vitamins. Caffeine, which is sometimes being used by oneironauts during the night to induce lucid dreams, might be a candidate as well. In fact, some studies suggested that caffeine improves cognitive abilities (Misuraca et al., 2017; Dodd et al., 2015), although others found no such effects (Harvanko et al., 2015).

For effects of typical foods on dreams, research is even more scarce. In one study, participants subjectively assessed the causes of dream contents in their eating behavior (Nielsen & Powell, 2015). There, disturbing dreams were most often associated by the participants with dairy products, also with spicy food, starchy food and meat, while bizarre dreams were associated mostly with dairy products and sugary foods. Whether these subjective assessments were done due to effects of the nutrients themselves is questionable, though, because other explanations like misattribution due to cultural reasons are possible.

Thus, in the present study, most possible effects of foods on dreams were assessed in an exploratory manner, while some were bound to the aforementioned hypotheses surrounding REM-alteration, memory and cognitive effects. Of the many possible candidates, some substances and foods, which are relatively easy to assess in a cross-section designed study and which are assumed to be relatively common in the every-day of western people, have been chosen to assess their potential influence on dreams. Because not only demographics but also personality might influence eating habits as well as dreams, this study also assessed personality traits of the Big Five Inventory (Costa et al., 1987; Schmitt et al., 2007) for possible partial correlations.

2. Method

2.1. Participants

From June 2015 to January 2018, an online-questionnaire about sleep, dreams, lucid dreams and different facets of daily life was presented in German and English language. Participants were mostly recruited in lucid dreaming communities and channels on social media and internet forums, as well as on the website klartraum.de. It was to be expected that most participants were interested mildly to strongly in dreams and lucid dreaming because of this selection of the sample.

Incomplete or invalid results (i.e. when “not applicable” or the highest or lowest possible answers were given in every item) were dropped, leaving 436 valid results in total. For each individual item, “not applicable” was always an option to avoid forced false results, leading to a slightly lower number of valid answers in individual items as is shown in the tables 1-13.

Participants were aged 12-67 (mean 25.3 ± 12.1) years, which leaves younger children and elderly people unrepresented. 45.7% were female, 52.9% male and 1.4% had other or no gender identities. Although this seems representative of the overall distribution, “other gender” identities were too small and diverse a group for statistical considerations. Of the participants, 71.5% lived in Germany, 7.4% in the US, 5.6% in Austria, 2.8% in the UK, 2.6% in Switzerland, 1.4% in Canada and the remaining 8.8% in other countries. Only ten people (2.4%) lived outside of Europe or North America, which made this sample highly westernized and it mostly represents German-speaking culture. Overall, 3.1% were without formal education, 4.1% attended or completed a lower education than middle school/Mittlere Reife or equivalent, 17.7% attended or completed middle school/Mittlere Reife or equivalent, 41.9% attended or completed high school/Abitur or equivalent, 29.3% studied or completed Bachelor/Master or equivalent and 3.9% worked on or completed a PhD or equivalent.

2.2. Study design and analysis

Before conducting the survey, five volunteers performed tests and helped improve the items with their feedback. Participants were prompted to answer for a time period of the last three months in the foods- and dream-variables and to estimate their general situation in the personality-questionnaire. In the questionnaire, different items regarding dreams, sleep and the way of life were assessed (i.e. social, cultural, psychological or behavioral items). Not all items of the questionnaire have been analyzed in the present study. Instead, different sets of items are to be analyzed in separate studies, because they approach different topics.

The results were analyzed using IBM SPSS Statistics version 23. For descriptive analysis, some of the rating scaled items were metrified by calculating the mean of the given class as shown below. For correlation testing, spearman correlation tests were performed and in case of probable interactions of other variables, partial spearman correlations were calculated. Significance levels of $\alpha < .05$ were considered significant. Effects with $r < .2$ were considered weak, r between .2 and .6 were considered moderate and $r > .6$ were considered strong. With a maximum of 436 valid answers in a given test, a minimum effect size of $r = 0.134$ would be needed to detect a significant result with a statistical power of .8.

2.3. Variables observed

Dream characteristics: Additionally to the demographic data given above and to the variables that were not analyzed in the present study, participants were asked the following questions about their dreams and parasomnia: ‘How often could you remember your dreams?‘, ‘How often did you realize that you were dreaming, while dreaming (lucid dream)? (Definition: In a lucid dream, one is aware that one is dreaming during the dream. Thus it is possible to wake up deliberately, or to influence the action of the dream actively, or to observe the course of the dream passively.)’, ‘How often did you remember hypnagogia? (Definition: Hypnagogic hallucinations, like voices or visual impressions, can appear in deep relaxation, i.e. when falling asleep or waking up.)’, ‘How often did you experience sleep paralysis? (Definition: Sleep paralysis is a natural phenomenon of REM-sleep. It stops the body from acting out dreamed movements. Sometimes, this paralysis is experienced consciously during awakening or when falling asleep.)’

Those questions could be answered by 8-point rating scales: 0, 'Never' (0), 1, 'Less than once a month' (0.12 per week), 2, 'About once a month' (0,23 p.w.), 3, 'About 2-3 times a month' (0.58 p.w.), 4, 'About once a week' (1 p.w.), 5, 'Several times per week' (3.5 p.w.), 6, 'About every night/day' (7 p.w.), 7, 'Several times per night/day' (14 p.w.)). This scale is an adaptation of the one developed by Schredl (2004) for dream recall, with the addition of the last class, because it was to be expected that many advanced dreamers would participate in the study and that the original highest class needed to be further granulated.

Contents of dreams were assessed by the following three items: 'Frightening, depressing dreams, nightmares', 'Euphoric or very pleasant dreams', 'Dreams of fantastic, fictional or absurd worlds, beings or constructs'. Those could be answered by 4-point scales: 0, 'Never' (0), 1, 'Less than once a month' (0.12 p.w.), 2, 'About once a month to once a week' (0.63 p.w.), 3, 'Several times a week to daily' (4.5 p.w.).

Foods and substances: The following consumption of foods and substances was assessed: 'Cereal products (pastry, pasta, rice, ...)', mainly for possible effects of starch on dreams; 'Dairy products (milk, cheese, yoghurt, dough with milk, ...)', because they have been attributed to affect dreams as mentioned before in previous studies; 'Meat' and 'Fish', to assess possible differences in omnivore, pescetarian and vegetarian diet; 'Fruit', mainly to assess possible effects of fructose; 'Other foods containing sugar (candy, sugary drinks, ...)' to assess general effects of sugars on dreams; 'Protein supplements' to assess possible effects that high amounts of proteins might have on dreams, 'Vitamin supplements' to test the above mentioned findings and hypotheses about vitamins and dreams; 'Chili', because spicy food has been attributed to influence dreams as mentioned before; the common substances 'Caffeine/Theine'; 'Alcohol' and 'Nicotine' were assessed, because they have been found to influence REM-sleep already; and 'Antidepressants', which might as well influence dreams. For each of these items, a 6-point rating scale was used: 0, 'Never' (0), 1, 'Once a month or less' (0.12 times per Week), 2, 'A few times a month' (0.7 t.p.W.), 3, 'A few times a week' (3.5 t.p.W.), 4, 'Once daily' (7 t.p.W.), 5, 'Several times a day' (14 t.p.W.)

Personality: The NEO-FFI, a short version with 60 items of the Big Five Personality Inventory was used to assess general personality dimensions, i.e. 12 items per personality trait (Costa & McCrae, 1989; Borkenau & Ostendorf, 1993). Factors lay on a Likert scale between 0 and 4, consisting of the means between all the items belonging to a given factor. '0' then means the opposite of a given factor (i.e. not agreeable at all), '2' means a medium (i.e. between agreeable and not agreeable) and '4' means an extreme manifestation of a given factor (i.e. extremely agreeable).

3. Results

3.1. Descriptive Data

Dreams: In table 1, means and correlations for every dream-related variable are listed. On average, participants reported a dream recall of almost every night (6.44 ± 4.5 per week), lucid dreams about once a week (1.19 ± 2.38 per week), hypnagogic hallucinations about twice a week (1.93 ± 3.12 per week) and experiences of sleep paralysis about every two weeks (0.40 ± 1.35 per week). They furthermore reported to have recalled about two nightmares in three weeks (0.75 ± 1.38 per week), one pleasant dream in a week (1.13 ± 1.58 per week) and three surreal dreams in two weeks (1.62 ± 1.95 per week). Thus, on average, 45.28% (± 29.735%) of participant's recalled dreams were reported to be lucid dreams.

These distributions were quite high. For example, Snyder & Gackenbach estimated an incidence of "frequent" lucid dreamers (i.e. once a month or more) for about 21% of the population (Snyder & Gackenbach, 1988). In my study, 53.7% of the participants had lucid dreams once a month or more. For general dream recall, 51.3% of the participants reported a dream recall of one dream per night or more. This confirms the assumption that the sample consisted to a high degree of people strongly interested in dreams and lucid dreams. The rather high average percentage of lucid dreams might stem from a high amount of native lucid dreamers or well-trained lucid dreamers included in the study, although it was not evaluated if participants had their lucid dreams natively or through training. Yet, the data still included participants with lower frequencies and was thus still suited for statistical analysis. Also, almost all variables for dreams correlated with each other, confirming especially the need of controlling for dream recall frequency in correlation tests, as it has been sometimes done in previous studies (e.g. in Hess et al., 2016).

Foods and substances: Consumption of different foods and substances were distributed and correlated with each other as is shown in table 2. On average, participants re-

Table 1. Means, standard deviations and Spearman correlations for dream variables.

Variable	DRF	LDF	SPF	HRF	NF	PDF	SDF
DRF		.374***	.132**	.304***	.219***	.303***	.308***
LDF			.276***	.278***	.115*	.304***	.202***
SPF				.170***	.120*	.150**	.063
HRF					.161***	.232***	.245***
NF						.157**	.181***
PDF							.218***
M	6.44	1.19	0.40	1.93	0.75	1.13	1.62
SD	4.50	2.38	1.35	3.12	1.38	1.58	1.95

Note. Abbreviations: DRF = Dream Recall Frequency, LDF = Lucid Dream Frequency, SPF = Sleep Paralysis Frequency, HRF = Hypnagogia Recall Frequency, NF = Nightmare Frequency, PDF = Pleasant Dream Frequency, SDF = Surreal Dream Frequency. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed), *** $p < 0.001$ (2-tailed).

Table 2. Means, standard deviations and Spearman correlations for substances.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1		.266***	.044	.033	.164***	.148**	-.082	-.007	.087	-.002	-.030	-.079	-.095
2			.205***	.179***	.085	.286***	-.006	-.104*	.035	.058	.045	-.072	-.041
3				.460***	-.029	.139**	-.030	-.070	-.017	-.014	.046	-.008	-.007
4					.072	-.043	.055	.079	.002	.129**	.115*	.066	-.052
5						.020	-.036	.034	.093	.004	-.028	-.122*	-.060
6							-.083	-.097*	-.034	.052	-.103*	-.016	.033
7								.283***	.081	.182***	.017	.081	.059
8									.104*	.188***	.084	.066	.074
9										.204***	.137**	.055	.019
10											.276***	.273***	.073
11												.332***	.008
12													.014
M	7.43	7.75	4.83	1.21	6.13	6.74	0.77	1.40	1.02	5.56	0.81	2.05	0.44
SD	4.70	4.64	4.27	1.83	4.52	4.71	2.52	2.99	2.27	5.55	1.57	4.76	1.75

Note. Key: 1 = Cereal Products, 2 = Dairy Products, 3 = Meat, 4 = Fish, 5 = Fruit, 6 = Other Sugary Foods, 7 = Protein Supplements, 8 = Vitamin Supplements, 9 = Chili, 10 = Caffeine/Theine, 11 = Alcohol, 12 = Nicotine, 13 = Antidepressants. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed), *** $p < 0.001$ (2-tailed).

ported to consume cereal products about once a day, dairy products about once a day, meat about five times a week, fish about once a week, fruit almost once a day, other sugary foods about once a day, protein supplements about once a week, vitamin supplements more than once a week, chili once a week, caffeine more than five times a week, alcohol about once a week, nicotine twice a week and antidepressants about once in two weeks. For meat, fish, vitamin and protein supplements, alcohol, nicotine and antidepressants, the distributions had low and high peaks because of a high number of non-consumers.

Big Five Personality traits: Distribution and correlations of personality traits as well as demography are shown in table 3. Chronbach's Alpha for the five personality factors were: Openness to experiences: $\alpha = 0.720$, Conscientiousness: $\alpha = 0.822$, Extraversion: $\alpha = 0.765$, Agreeableness: $\alpha = 0.805$, Neuroticism: $\alpha = 0.876$. For the average participant, Neuroticism was almost balanced, Extraversion was balanced while a little tending towards Introversion, Openness to experiences was quite high, Agreeableness was also higher than balanced and Conscientiousness a little higher than balanced.

3.2. Correlations

In table 4, all correlations between dream variables and foods/substances are shown. Significant correlations were:

Dream recall frequency correlated positively with consumption of fruit and vitamin supplements and negatively with smoking. Lucid dreaming frequency correlated positively with consumption of fish, fruit, antidepressants, chili and vitamin supplements. Sleep paralysis frequency correlated negatively with other sugary foods and positively with alcohol and smoking. For hypnagogia recall frequency, positive correlations were found for chili, caffeine and vitamin supplement intake. Nightmare frequency correlated positively with the consumption of other sugary foods, antidepressants and nicotine. Pleasant dream frequency correlated negatively with eating cereal products and positively with eating fruit. Surreal dream frequency correlated positively with a consumption of chili.

All effect sizes were weak, except for the correlation of antidepressants with nightmares, which was medium in size. Possible candidates for partial correlations can be found in tables 1, 2 and 3, as well as in the additional tables 5 and 6, the latter two showing correlations between dreams with demographics and personality traits, as well as correlations

Table 3. Means, standard deviations and Spearman correlations for personality and demographics.

Variable	O	C	E	A	N	Age	Gender[a]
O		.030	.046	.027	.013	.241***	-.141**
C			.231***	.200***	-.320***	.170***	-.035
E				.337***	-.400***	.022	-.043
A					-.276***	.179***	-.128**
N						-.190***	-.226***
Age							-.033
M	2.84	2.31	1.87	2.61	1.94	25.27	1.56
SD	0.55	0.64	0.58	0.62	0.81	12.07	0.53

Note. Abbreviations: O = Openness to experiences, C = Conscientiousness, E = Extraversion, A = Agreeableness, N = Neuroticism. [a] Negative numbers correspond to female, positive to male gender. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed), *** $p < 0.001$ (2-tailed).

Table 4. Spearman correlations for substances and dreams.

		DRF	LDF	SPF	HRF	NF	PDF	SDF
Cereal Products	r	.004	-.050	-.071	.074	-.003	-.095*	.018
	p	.933	.298	.145	.129	.942	.050	.706
	N	431	428	421	426	430	430	431
Dairy Products	r	0.86	.020	-.053	-.036	.059	-.005	.041
	p	0.75	.674	.276	.460	.224	.919	.398
	N	431	428	421	426	430	430	431
Meat	r	-.050	.032	-.062	-.057	-.012	.001	.086
	p	.297	.511	.202	.241	.809	.985	.075
	N	430	427	420	425	429	429	430
Fish	r	-.028	.155**	.080	-.011	-.061	.043	.048
	p	.561	.001	.101	.824	.205	.377	.322
	N	430	428	420	425	429	429	430
Fruit	r	.124*	.102*	.073	.082	.044	.122*	.067
	p	.010	.035	.134	.091	.367	.011	.168
	N	431	428	421	426	430	430	431
Other Sugary Foods	r	.002	-.021	-.126**	-.022	.100*	.006	.059
	p	.966	.659	.010	.657	.039	.907	.220
	N	431	428	421	426	430	430	431
Protein Supplements	r	.031	.010	.026	.069	.042	-.023	.013
	p	.523	.843	.595	.156	.391	.640	.788
	N	427	424	417	422	426	426	427
Vitamin Supplements	r	.100*	.144**	.087	.100*	.091	-.004	.070
	p	.038	.003	.074	.040	.060	.929	.146
	N	429	426	419	424	428	428	429
Chili	r	.074	.123*	-.020	.195***	-.047	.035	.110*
	p	.124	.011	.682	.000	.333	.466	.022
	N	431	428	422	426	430	430	431
Caffeine	r	.013	.076	.090	.155**	.048	-.032	.048
	p	.794	.114	.064	.001	.320	.510	.324
	N	432	429	422	427	431	431	432
Alcohol	r	.017	.086	.116*	.017	.033	.067	-.019
	p	.728	.076	.017	.732	.499	.167	.696
	N	431	428	421	426	430	430	431
Nicotine	r	-.109*	.014	.132**	.081	.110*	.032	-.069
	p	.023	.777	.007	.094	.022	.513	.154
	N	430	427	420	425	429	429	430
Antidepressants	r	-.009	.122*	.025	.036	.265***	-.015	.066
	p	.851	.012	.606	.464	.000	.761	.172
	N	429	426	419	424	428	428	429

Note. . Abbreviations: DRF = Dream Recall Frequency, LDF = Lucid Dream Frequency, SPF = Sleep Paralysis Frequency, HRF = Hypnagogia Recall Frequency, NF = Nightmare Frequency, PDF = Pleasant Dream Frequency, SDF = Surreal Dream Frequency. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed), *** $p < 0.001$ (2-tailed).

between foods/substances with demographics and personality traits.

3.3. Partial correlations

3.3.1 Dream recall

The partial correlation is depicted in table 7. Dream recall correlated with openness to experiences, as well as intake of vitamin supplements. After partialling out openness to experiences, dream recall did not correlate significantly with vitamin supplements anymore. For correlations with eating fruit and with nicotine, no candidates for partial correlations were found, so none were calculated.

3.3.2 Lucid dreams

Partial correlations are depicted in table 8. The consumption of fruit also correlated with dream recall, so after partial correlation, no significant effect on lucid dream frequency remained. For vitamin supplements, dream recall did not correlate significantly after partialling out openness to experiences, as is shown above. Thus, for lucid dream frequency, when partialling out openness to experiences instead of dream recall, the correlation between lucid dreaming and vitamin supplements still remained significant. However, when partialling out dream recall and age, instead of openness to experiences, the relationship between vitamin supplements and lucid dreams was not significant anymore.

Fish consumption correlated with age and extraversion – both of which also correlated with lucid dream frequency in the present sample. Yet, after partialling out these, eating fish still correlated significantly with lucid dream frequency.

Chili consumption was linked to openness to experiences, which also correlated to lucid dream frequency. After partialling out openness to experiences, the correlation between lucid dream frequency and chili intake was not significant anymore.

Table 5. Spearman correlations for demographics, personality and dreams.

Variable	O	C	E	A	N	Age	Gender[a]
DRF	.171***	.075	.017	.016	-.085	.034	-.079
LDF	.185***	.069	.143**	-.021	-.104*	.140**	-.036
SPF	.102*	.016	.123*	.026	-.084	.171***	-.067
HRF	.240***	-.005	.077	.007	-.006	.132**	-.054
NF	.137**	-.027	-.135**	-.066	.321***	.066	-.283***
PDF	.091	.006	.179***	.038	-.116*	-.001	-.037
SDF	.242***	-.017	.052	-.060	.008	-.038	-.027

Note. Abbreviations: DRF = Dream Recall Frequency, LDF = Lucid Dream Frequency, SPF = Sleep Paralysis Frequency, HRF = Hypnagogia Recall Frequency, NF = Nightmare Frequency, PDF = Pleasant Dream Frequency, SDF = Surreal Dream Frequency, O = Openness to experiences, C = Conscientiousness, E = Extraversion, A = Agreeableness, N = Neuroticism. [a] Negative numbers correspond to female, positive to male gender. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed), *** $p < 0.001$ (2-tailed).

Antidepressants: Unlike in previous studies, no correlation between nightmares or neuroticism and lucid dreaming occurred, so they could not mediate the correlation of antidepressants and lucid dreaming, hence no partial correlations were calculated.

3.3.3 *Sleep paralysis*

Partial correlations are depicted in table 9. For other sugary foods, no variable could be partialled out. Alcohol and nicotine consumption, though, correlated with age, as well as experience of sleep paralysis. So after partialling out age, these correlations were not significant anymore.

3.3.4 *Hypnagogia recall*

Partial correlations are depicted in table 10. Since hypnagogia recall correlated both with age and openness to experiences, these variables could be mediators for the correlations between hypnagogia and chili, caffeine, and vitamin intake, because these correlated with age and openness as well. In fact, after calculating partial correlations, only chili intake still correlated significantly with hypnagogia recall.

3.3.5 *Nightmares*

Partial correlations are depicted in table 11. Nightmares correlated with neuroticism, which also correlated with eating other sugary foods and with consumption of antidepressants. After partialling out neuroticism, the correlation between nightmares and sugary foods was not significant anymore, but the one with antidepressants still was. Nicotine and nightmares had a shared correlation with sleep paralysis, which might cause nightmares. After partialling out sleep paralysis, the significance decreased, yet remained significant.

3.3.6 *Pleasant dreams*

Partial correlations are depicted in table 12. For cereal products, neuroticism was a shared negative correlation and a candidate for mediating the negative correlation with pleasant dreams. After partialling out neuroticism, the correlation between pleasant dreams and cereal products was not significant anymore. For fruit, dream recall could mediate the correlation to pleasant dreams. Indeed, after calculating a partial correlation, significance vanished.

3.3.7 *Surreal dreams*

Partial correlations are shown in table 13. Chili correlated with hypnagogia recall, as well as with surreal dream recall. Since the correlation with hypnagogia recall frequency is higher and more significant, a partial correlation controlling

Table 6. Spearman correlations for substances, demographics and personality.

Variable	O	C	E	A	N	Age	Gender[a]
Cereal Products	.131**	-.016	.013	.064	.097*	.007	-.033
Dairy Products	-.008	-.024	.019	.014	.048	-.008	.042
Meat	-.060	.039	.147**	-.080	.032	-.080	.148**
Fish	.056	.041	.159**	-.022	-.065	.118*	.125*
Fruit	.084	.044	.077	.068	-.047	-.087	-.146**
Other Sugary Foods	.030	-.008	-.085	-.011	.194***	-.090	-.058
Protein Supplements	.015	.015	.001	-.041	-.045	.130**	.067
Vitamin Supplements	.142**	.034	.035	-.012	.032	.209***	-.125*
Chili	.180***	-.067	-.008	-.022	-.033	.114*	.095
Caffeine	.172***	.171***	-.032	.045	-.072	.488***	-.092
Alcohol	.172***	-.033	.105*	.072	-.075	.397***	-.014
Nicotine	.064	-.066	.041	.003	.007	.258***	.009
Antidepressants	.075	-.017	-.190***	-.090	.264***	.081	-.115*

Note. . Abbreviations: O = Openness to experiences, C = Conscientiousness, E = Extraversion, A = Agreeableness, N = Neuroticism. [a] Negative numbers correspond to female, positive to male gender. * $p < 0.05$ (2-tailed), ** $p < 0.01$ (2-tailed), *** $p < 0.001$ (2-tailed).

Table 7. Partial Spearman correlation for Dream Recall Frequency.

Correlations	DRF & Vitamin Supplements
Partialled by	O
r	.078
p	.112
N	418

Note. Abbreviations: DRF = Dream Recall Frequency, O = Openness to experiences.

for hypnagogia recall frequency was calculated. According to this calculation, correlation of chili with surreal dream frequency is not significant anymore.

4. Discussion

4.1. Dream recall

Eating fruit correlated with dream recall, which might be explained by the effect of vitamins – especially those that are abundant in common fruit. This goes in line with previous findings of vitamin B6 effects on dream recall (Aspy et al., 2018) and other vitamins being important for cognitive functioning (Misuraca et al., 2017). On the other hand, no direct correlation for vitamin supplements on dream recall has been found in the present study, as the ones found initially could be better explained by a higher openness to experiences of the participants. This character trait could lead people into having more interest in dreams and, independently of that, being more willing to take supplements for their health. Yet, the results still suggest a need for further research for vitamins or vitamin-rich foods like fruit and their possible effects on dream recall on a more detailed basis.

While past studies showed an increase of dream recall for wearing nicotine patches during the night (Page et al., 2006), the present study, which rather measured smoking during the day, found a negative correlation with dream recall. This might have to do with negative impacts of smoking on sleep quality, as it has been found by past studies (Wetter et al., 1994).

A speculated negative effect of alcohol on dream recall because of REM-suppression could not be confirmed. While a negative effect might appear at first, rebound-effects on REM-sleep might cancel this out in the long run, at least for moderate alcohol consumption. This could further be researched in a longitudinal study.

Table 9. Partial Spearman correlations for Sleep Paralysis Frequency.

Correlations	SPF & Alcohol	SPF & Nicotine
Partialled by	Age	Age
r	.054	.092
p	.275	.059
N	416	416

Note. Abbreviations: SPF = Sleep Paralysis Frequency.

4.2. Lucid dreams

Results suggest that vitamin supplements might increase lucid dream frequency, because this effect could not be explained by openness to experiences. Although the effect might instead be explained by an increased dream recall and a higher age correlating with vitamin intake, this hypothesis conflicts with another result, suggesting that dream recall is not increased by vitamin supplements, but instead by openness to experiences. So, either vitamin supplements increase dream recall or lucid dream frequency; the data suggests the latter to be more probable or more pronounced, but this needs to be further researched, especially for different kinds of vitamins.

An unexpected correlation was found between eating fish and lucid dream frequency, which could not be explained by other mediating variables. A plausible explanation seems to be an effect of omega-3 fatty acids, which are abundant in common fish and have been suggested to be important for cognitive abilities in past studies (Martí & Fortique, 2019; Fotuhi et al., 2009). If this explanation is correct, other foods or supplements containing omega-3 might also improve lucid dream frequency. These findings are very promising, yet it should be kept in mind that the effect found was only weak and it could, for example, only work for people who at the same time do lucid dreaming training or who compensate for a deficiency of omega-3. These hypotheses should be researched in experimental studies.

Consumption of chili did not prove to be related to lucid dream frequency significantly after partial correlations were calculated, because this seems to be better explained by the character trait openness to experiences, which might at the same time increase motivation for lucid dreaming training as well as motivate to consume spicy foods.

A possible effect of antidepressants on lucid dream frequency has been found, which could not be explained by any of the other variables. For serotonergic antidepressants, REM-suppression has been observed in the past (Bazzari,

Table 8. Partial Spearman correlations for Lucid Dream Frequency.

Correlations	LDF & Vitamin Supplements	LDF & Vitamin Supplements	LDF & Chili	LDF & Fish	LDF & Fruit
Partialled by	.121	.090	.093	.121	.061
r	.013*	.066	.057	.012*	.212
p	418	422	419	421	425
N	418				

Note. Abbreviations: DRF = Dream Recall Frequency, LDF = Lucid Dream Frequency. Note. Abbreviations: O = Openness to experiences, E = Extraversion. * $p < 0.05$ (2-tailed).

Table 10. Partial Spearman correlations for Hypnagogia Recall Frequency.

Correlations	HRF & Chili	HRF & Vitamin Supplements	HRF & Caffeine
Partialled by	O & Age	O & Age	O & Age
r	.154	.055	.093
p	.002**	.260	.058
N	417	417	417

Note. Abbreviations: HRF = Hypnagogia Recall Frequency, O = Openness to experiences. ** p < 0.01 (2-tailed).

Table 11. Partial Spearman correlations for Nightmare Frequency.

Correlations	NF & Other Sugary Foods	NF & Antidepressants	NF & Nicotine
Partialled by	N	N	SPF
r	.040	.197	.096
p	.410	.000***	.049*
N	423	421	417

Note. Abbreviations: SPF = Sleep Paralysis Frequency, NF = Nightmare Frequency, N = Neuroticism. * p < 0.05 (2-tailed). *** p < 0.001 (2-tailed).

2018), so a following REM-rebound might be possible as an explanation for increased lucid dream frequency.

While some have speculated that nicotine influences lucid dream frequency, this could not be confirmed, at least for smoking. A possible effect of nicotine patches worn during the night still should be researched, though. The same applies to caffeine, which, for general consumption during the day, did not prove to influence lucid dream frequency, but might as well do so in specific settings, e.g. when consumed in the night after some hours of sleep.

4.3. Sleep paralysis

Alcohol and smoking correlated with sleep paralysis frequency, but here again it is most plausible – and partial correlations confirmed this – that the actual cause for a more frequent sleep paralysis is higher age, which also corresponds to consumption of different drugs. Age correlating with sleep paralysis may be explained by a possible increase of sleep interruptions. It further seemed that sugary foods decrease the frequency of sleep paralysis, yet this finding still is in need for a plausible explanation.

4.4. Hypnagogia recall

Hypnagogia recall frequency, like other variables, was correlating with openness to experiences, which is plausible because an interest in such things, as well as a mind focused on inner perceptions, might increase the chance to experience hypnagogia. With this correlation, it was further possible to explain seeming correlations with caffeine and vitamin supplement intake, because those were increased with an openness to experiences as well. However, the correlation with chili could not be explained by this personality factor. This then leaves the possibility of capsaicin, an important substance of chili, having an effect on memory or on inner perceptions. This would be in line with previous findings of capsaicin playing a positive role in cognitive functioning (Liu et al., 2016). Hence, such an effect should be further investigated.

4.5. Nightmares

The personality trait neuroticism could explain a seeming correlation between nightmare frequency and eating other sugary foods. My assumption is that people with higher scores of neuroticism tend to self-medicate with sugary foods and, independently, have more nightmares. However, neuroticism could not fully explain a correlation between nightmare frequency and antidepressants. While this would be highly counterproductive from a therapeutic perspective, further research would be important to assess whether some antidepressants could indeed promote nightmares.
Smoking also correlated with nightmare frequency, which further underlines previous findings of smoking leading to a decrease of sleep quality and nightmares. However, what could not be confirmed was a linkage between nightmare frequency and consumption of alcohol.

4.6. Pleasant dreams

At first, cereal products seemed to correlate negatively with pleasant dream frequency, but this could be better explained by a negative correlation with neuroticism. Although a thorough explanation can not be provided, at least it is plausible that a low level of emotional stress is reflected in more pleasant dreams or that having frequent pleasant dreams could lighten up the general mood.

Eating fruit also seemed to correlate with pleasant dream frequency, but this could be explained by general dream recall, which probably is a prerequisite for any specific dream recall and which was enhanced by eating fruit as has been shown above.

Table 12. Partial Spearman correlations for Pleasant Dream Frequency.

Correlations	PDF & Fruit	PDF & Cereal Products
Partialled by	DRF	N
r	.090	-.084
p	.064	.083
N	427	423

Note. Abbreviations: DRF = Dream Recall Frequency, PDF = Pleasant Dream Frequency, N = Neuroticism.

Table 13. Partial Spearman correlations for Pleasant Dream Frequency.

Correlations	Chili & SDF
Partialled by	HRF
r	.066
p	.176
N	423

Note. Abbreviations: SDF = Surreal Dream Frequency, HRF = Hypnagogia Recall Frequency.

4.7. Surreal dreams

Surreal dream frequency correlated with the intake of chili, but not anymore when controlled for hypnagogia recall. However, it is not clear to me how these three variables interact. One possibility is that capsaicin could increase creative processes, which might in turn lead to more absurd and eccentric dream contents, especially in the hypnagogic state. At least, the hypnagogic state N1 was linked to increased creativity by a recent study (Lacaux et al., 2021). Although this explanation is highly speculative, possible relationships between capsaicin, hypnagogia and surreal dreams seem to be fruitful for further research, based on the present findings.

5. Limitations of this study

As this study is mostly explorative, one important limitation is the undetailed assessment of foods and substances, which need to be researched in better detail, preferably in longitudinal or even placebo-controlled studies. For a start, it might be fruitful to assess intake of foods as well as dream variables on a daily basis for some period of time to further test possible causal relationships, or to assess experimental versus control groups for some specific foods and substances. Also, assessment of different foods could be done on a broader scale, including other common foods and substances not being assessed in my study, like vegetables, legumes, or cannabis. Categories of foods could be assessed in a more systematic manner including categories like foods rich in sugar, rich in complex carbohydrates, rich in fats or rich in proteins.

Moreover, the time of food intake before going to sleep was not considered in this study, but it definitely has an influence on sleep and dreaming, i.e. foods rich on fats or proteins eaten shortly before going to sleep decreases sleep quality according to Nielsen et al. (2015). So this should be considered in upcoming studies.

Thus, some effects may not have been found in my study because they might not exist in a generalized way, but rather in specific contexts, i.e. for administration of substances during the night, shortly before sleep-onset, or right before REM-onset.

On the other hand, my study gives some impressions on general effects that substances and nutrients might have in the long run instead of effects that may only last for single nights or which only occur in certain settings, i.e. when consumed shortly before going to sleep.

Another limitation is the sample, which was not necessarily representative of all groups, i.e. of young children, elderly, or non-western cultures. Results may also be skewed to some degree by the fact that participants mostly seemed to have a strong interest in dreams and lucid dreaming, so it might be possible that the effects found only occur in combination with dream-related motivation and activities.

For the possible confounding variables, only demographics and Big 5 personality scores have been assessed. Thus, it is possible that other confounding variables exist but have been overlooked in my study. Those could be other personality facets, food combinations, the amount of foods, daily mood, cognitive abilities, eating and dream culture, general health, and also placebo effects in case of voluntary attempts to influence dreams, i.e. by use of vitamin supplements.

6. Conclusion

Research on possible effects of foods and substances on dream recall, lucid dreams and other dream related variables is still scarce as most of the research done in the past was focused on effects on sleep quality. In this mostly exploratory cross-section design study, some promising foods and substances for future research have been found. Some correlations to dream variables could not be explained by personality or demographics, as they remained significant in partial correlations. These include vitamins and vitamin rich foods, which might increase dream recall and lucid dreams; omega-3 rich foods or supplements, like fish, which probably increase lucid dream frequency; capsaicin, which probably increases recall of hypnagogia and surreal dreams; some antidepressants which might have an increasing effect on lucid dream frequency but seemingly on nightmare frequency as well; and smoking, which was linked to a decreased dream recall and more nightmares. Other substances and foods did not yield equally conclusive results, which might in part be due to the very broad cross-section design of this study. In principle, the findings are in line with the theory that such substances affect dreams most that also affect cognitive abilities, memory and REM-sleep. Hence, these findings suggest future dream related studies to focus on a more detailed analysis of the foods and substances researched here, preferrably in an experimental or longitudinal study design. Also, other substances, administration details and possible further intercorrelation effects which were not part of the present study should be taken into consideration in future research. If confirmed and elaborated by future studies, these findings could be utilized i.e. for setting the right conditions to produce better dream recall, ameliorate nightmares and to improve the effect of lucid dream induction techniques.

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Appendix

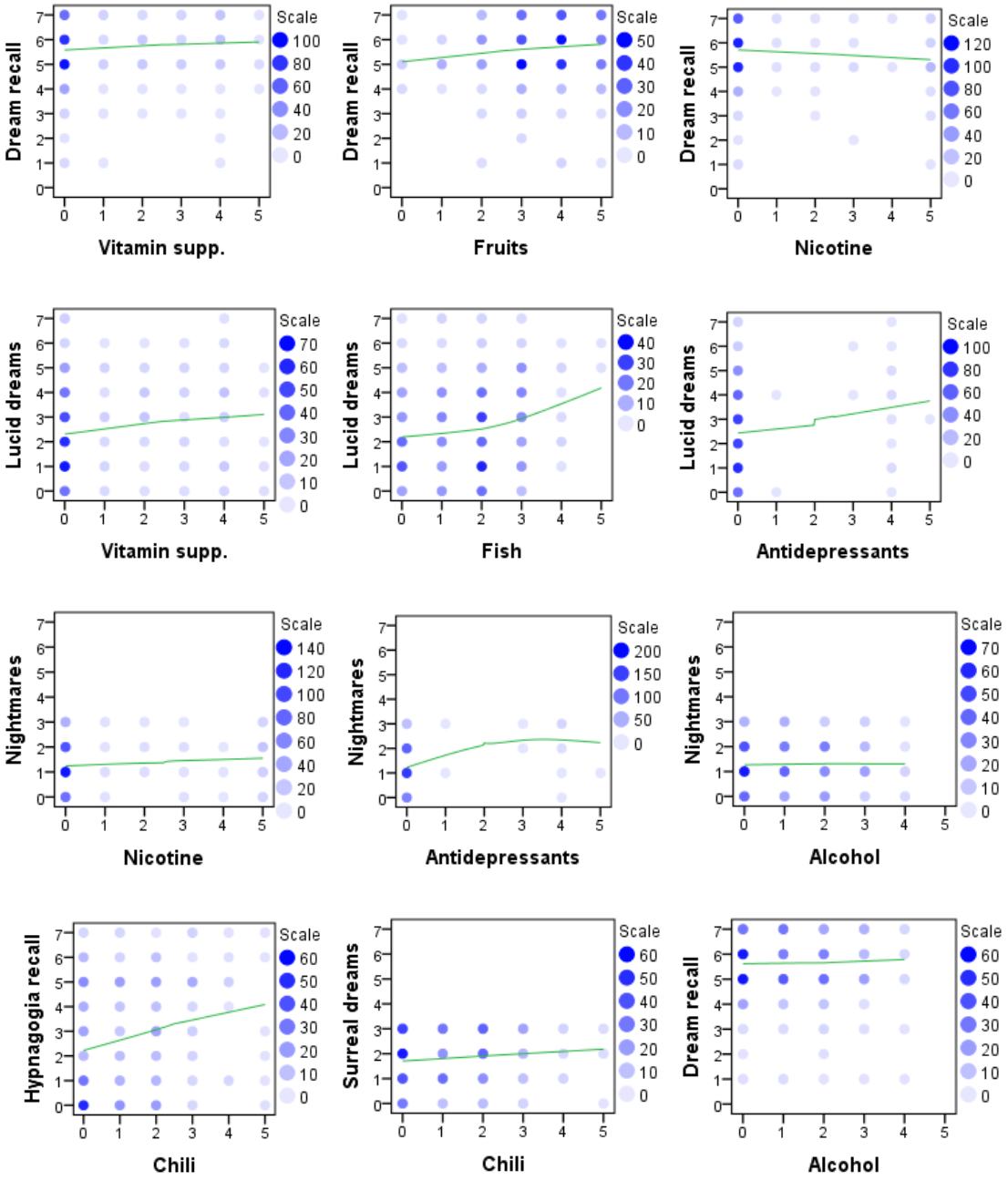

Figure 1. Scatterplots for selected dream variables and foods consumptions, including locally weighted scatterplot smoothing (LOESS) lines in green color. Blue color intensity signifies the numbers of cases. Numbers on axis correspond to ordinal ranks, i.e. lowest (0) = never, highest (y=7 resp. x=5) = several times per day.