# Analysis of taste in dreams: A defined and large-scale investigation of dreamt gustatory experiences

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*Summary*. For all the sensation and perception research performed, and even for all the dream research performed, little is known about sensation and perception in dreams. Basic facts about human oneiric sensory modalities have been established over the decades, including rough percentages of sensory occurrences in dreams. However, few studies have thoroughly investigated dreamt sensation and perception, despite their potential utility in understanding waking counterparts. This study uses over 28,000 dreams from the DreamBank database (Schneider & Domhoff, 1999) to focus specifically on gustatory experiences in dreams. About 200 dreams (0.7%) were found to contain taste experiences, and this number reflects an analysis combining optimized regex word-strings with human verification. Tastes were coded by valence (good, bad, neutral/undefined) and class (specific flavor). Numerous analyses were performed, though even such a substantial sample size seems insufficient for the deepest measures, given the apparent rarity of taste dreams. A few notable findings include: 1) good tastes appear more frequently than bad tastes; 2) sweet tastes appear to outnumber all other classes; 3) people are better at recording valence than class/flavor, but are generally quite ineffective at offering salient sensory and perceptual details via dream reports; 4) a few non-significant sex differences were observed, but these measures suffer from inadequate sample size; 5) future analyses of dreamt sensation and perception, especially rare modalities, may warrant methodological consideration; 6) a surprising gulf exists between eating and tasting dreams; and 7) dreamt gustation can be as varied, rich, and surprising as waking gustation. The core of this investigation is to be found in the particularities of each analysis.

*Keywords:* Dream, taste, gustation, sensation, perception

## 1. Introduction

Little is known about sensation and perception in dreams, perhaps by virtue of knowing little about dreams themselves. The research performed on waking sensory modalities—even those as overlooked as gustation or olfaction—completely dwarfs all investigation of their dreamt counterparts. Increasingly, however, as scientific and statistical dream research becomes both more accepted and undertaken, analysis of sensation and perception in dreams has become a significant avenue of inquiry. While analysis of the five major sensory modalities is not uncommon to perform on a dream series or across dream series, relatively few in-depth investigations of particular modalities have been undertaken. Some exceptions include Michael Schredl's notable papers on dreamt thermoception (2016) and olfaction (2019); an analysis of audition, olfaction, and gustation by Zadra, Nielsen, and Donderi (1998); an analysis of olfaction by Weitz et al. (2010); and even anomalous sensory phenomena such as an investigation of dreamt phantom limb syndrome by Frank and Lorenzoni (1989). Reports such as Bulkeley and Domhoff's (2010) in-depth investigation of a dream series and its predictive power analyzes sensory modalities alongside traditional Hall/Van de Castle criteria.

The importance of understanding dreams is typically construed in the context of their ability to aid waking cognition (Schredl, 2000) and their biological and evolutionary significance (Revonsuo, 2000). While the continuity hypothesis—the effect of waking-life experiences on the content of dreams—has been extensively examined (see Domhoff, 2017), the reverse of this—"countercontinuity" perhaps: the effect of dreams on waking life—is certainly understudied (though see Schredl, 2000; Schredl & Erlacher, 2007). Perhaps this extends scientifically, as well: what might we learn about our capacity for sensation and perception in the objective world if we can understand its counterpart in the mental world?

This study investigates gustatory dream experiences, using sixty-four dream series of 28,003 dreams in total, accessed from DreamBank, a reliable database hosted by the University of California, Santa Cruz and maintained by G. William Domhoff and Adam Schneider (Schneider & Domhoff, 1999; see also Domhoff & Schneider, 2008b). A few preliminary hypotheses were central to this investigation:

1) Dreams will contain more negatively valenced or "bad" tastes than positively valenced or "good" tastes.

This was originally hypothesized in the context of Revonsuo's evolutionary threat simulation theory (2000), whereby general threat simulation might predict a gustatory analogue. However, analogues in other modalities (such as vision, audition, equilibrioception) seem difficult to propose. Additionally, the evolutionary function of human taste serves

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both to orient us away from toxic foods, and toward nutritional and energy-dense foods (Breslin, 2013).

2) Bad flavors will appear more commonly than good flavors.

As above, bitter or unpleasant tastes were originally hypothesized to prevail in dreams, though a broader review of the literature would not predict this.

3) The percent of dreams including gustatory experiences will be slightly lower than 1%.

Gustatory dreams have generally been found to occur in 1% or a little lower of all recorded dreams (Bulkeley & Domhoff, 2010; Zadra et al., 1998), though the methods used in these cited works were different from the methods used herein, and it is expected that fewer dreams actually include gustatory phenomena experienced by the dreamer him/herself (see the Methods for further details on this).

4) There will be sex differences observed in dream gustation that reflect sex differences found in other dream content and in waking taste and food preferences.

Some sex differences are known to exist in dream content (Domhoff & Schneider, 2008a; Schredl & Reinhard, 2008), as well as in waking taste and food preferences (Lombardo et al., 2019). Specifics are examined in the Discussion.

5) Dream gustation will be as rich and varied as waking-life gustation.

There is no reason to doubt that dreamt sensations and perceptions can be as intense, varied, bizarre, and rich as waking counterparts, and this will likely extend to taste as well. Similarity between the waking and dreaming mind has been principally explored through the continuity hypothesis (see Kahan and LaBerge, 2011 [particularly Study 2]; Nir and Tononi, 2010 also give an overview).

## 2. Method

### 2.1. Participants/Dreamers

All 64 English-language dream series publicly available on DreamBank as of this study were used in the analysis. Some of these series represent the dreams of single individuals over a period of weeks to years (e.g., Izzy), and others represent collective samples of groups of individuals' dreams (e.g., Peruvian Men). 29 dream series (8,833 dreams) are from male dreamers and 35 dream series (19,170 dreams) are from female dreamers. Dream series contain between 16 and 4,352 dreams per series ($M$ = 438, $SD$ = 808), with an average length of 171 words per dream report ($SD$ = 185; all dreams were included irrespective of length, as taste experience theoretically could occur in very brief dream reports). The series contain 28,003 dreams in total. For dream series broken into parts, all parts were used (ensuring no redundancies of dreams). Information is known about some of the dreamers (provided via DreamBank), which indicates that the dreams in this study come from people of various ages (7-74), occupations, countries, and time periods (1897-2017), and there is at least some variation in ability (three series of blind dreamers), sexual orientation, personality, and method of recording (Jasmine tape-recorded her dreams, rather than writing them down); though some series have meager or no information about them. Little else is known about the precise demographics of the dreamers, but it is necessarily assumed that the volume of dreams used produces a sufficiently representative sample for the purposes of this study.

### 2.2. Search Methodology

Each of the 64 English-language dream series on DreamBank was searched with DreamBank's built-in regex (regular expression) function to isolate those potentially relating to experiences of taste. The regex search string was carefully constructed over a trial period of looking through random large series to gauge the precision and efficiency of the string. After testing, the final string was used to search all series. (In practice, the string was updated once after some initial data collection, to ensure as few relevant dreams were overlooked as possible; the updated string was then used to re-search the few series that had already been looked at.) The exact string and an explanation of its construction can be found in Appendix A.

Using the regex string in DreamBank's "Dream Search: frames version", a few hundred dreams were examined. This process was expedited by DreamBank highlighting the relevant words found from the regex query, which enabled a rapid review of the surrounding context of the dream and either an acceptance or rejection of the search result. For the sake of precision and thoroughness, desiring to miss as little data as possible, a relatively large number of false hits occurred. Regardless, due to the small percentage of dreams containing taste experiences, this task was able to be completed relatively quickly, with higher accuracy than simply performing string searches without confirming the accuracy of regex results. Additionally, the search results were reviewed to weed out taste experiences that were simply mentioned and not genuinely experienced by the dreamer. (This was typically very clear when reviewing search results; instances of uncertainty that could not be elucidated by context were either discarded if particularly dubious [3 times] or scored only in the hypothetical coding and not included in the conservative coding [9 times], as explained below.) This is an important distinction from some studies of dream sensation and perception: the present study focuses on the experiences of the dreamer him/herself, and excludes mere mentions of taste or tastes experienced by dream "characters".

Random testing demonstrated that a combination of a scrutinizing regex string and human verification produced accurate data. These preliminary tests were performed on random excerpts of large series such as Izzy, Barb Sanders, and Kenneth, iteratively adjusting the regex string until it found no false negatives when compared to human read-throughs. Given that this was only an excerpt, it is certainly possible that some taste experiences were missed altogether by the regex (some dreamers have idiosyncratic ways of writing), but this number is believed to be very low. More information can be found in Appendix A. (For the cursory comparative analysis of the occurrences of eating in dreams, a separate regex string was used, and these results were not verified for accuracy by a human being; see Discussion for more.)

### 2.3. Data Collection and Dream Coding

Each relevant dream was recorded in a spreadsheet with information on the dream series, sex of dreamer, dream identifier/number, a brief quotation from the text of the dream describing the taste experience, two different codings of the taste, and sometimes additional notes (this raw data can be found in Appendix C). For each series, the number of taste dreams and the number of total dreams were recorded, and a percentage of taste dreams for each dream series was calculated.

Two coding systems were used: 1) a conservative coding, which assumed nothing about the taste experience and relied purely on the text of the dream (with as much or as little information as it provided); and 2) a hypothetical coding, which made judicious estimations about the nature of the taste based on surrounding dream context (sometimes a taste was described, followed by an experience of distress, vomiting, or the like; these were assumed to imply a bad taste in the hypothetical coding, when it was unclear) and the normative function of taste in daily life (sometimes a taste was described as being very good, and a food was described, such as honey, but no other information was given; this was assumed to imply a sweet taste in the hypothetical coding). The necessity of these two systems arose from the observation that oftentimes very little definitive information is provided about a taste experience (and perhaps this is not too surprising—the dreamer is typically more concerned with other events, and precise tastes may seem trivial; after all, none of the dreamers knew their dreams would ever be analyzed in this way). In other words, the conservative coding assumed nothing, while the hypothetical encoding simply acknowledged that writers sometimes imply things indirectly. Separating the data into that which can be textually verified and that which can be sensibly estimated allowed for a breadth of analysis. The dual coding system is also thought to address any individual biases in analysis and coding, which, due to non-ideal limitations, was performed by a single rater and reviewed for internal consistency.

The coding of each taste experience was twofold: valence and class. The valence of a taste experience defines

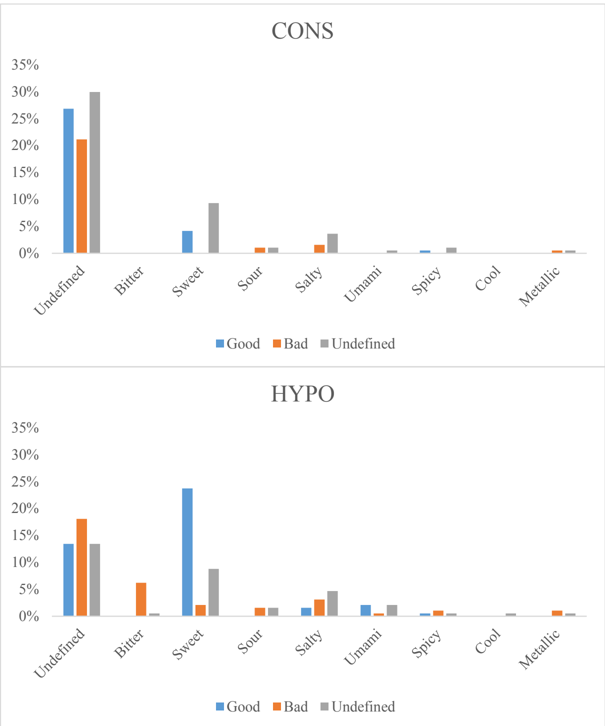


*Figure 1*. Class and Valence Data. These taste experiences are expressed as percentages of taste dreams, first for the conservative (cons) coding method and then for the hypothetical (hypo).

whether it is characterized as good, bad or undefined/neutral. The class of a taste defines its flavor. In this analysis, nine classes were used: bitter, sour, sweet, salty, umami, spicy, cool, metallic, and undefined. These classes cover the five basic tastants while also allowing for commonly experienced composite and trigeminal flavors/tastes (Gravina et al., 2013; see Omür-Özbek et al., 2012 for explanation of metallic tastes). This collection of flavors was determined during the initial regex trial period and designed to sufficiently cover the spectrum of dreamt tastes without having too many or too unwieldy categories. With the conservative coding, 197 taste experiences in 194 dreams were discovered. With the hypothetical coding, 208 taste experiences in 205 dreams were discovered. (A few dreams had more than one experience of taste in a single dream. The difference between the conservative and hypothetical numbers is due to some cases of uncertainty over whether a taste was actually perceived. Uncertainties were evaluated on an individual basis; this is elaborated on in the Discussion of Methodology and Uncertainty.)

## 2.4. Data Analysis

A number of analyses were conducted on the data collected (roughly 200 taste experiences in dreams), performed mostly in Excel 2016 version 16.0.6001.1054 for Windows, and partly in RStudio 2022.02.3+492 for Windows. Chi-square and Fisher's exact tests were performed in R; all other analysis was performed in Excel.

# 3. Results

Of the 28,003 dreams in this study, a conservative (cons) coding procedure found 197 taste experiences ("tastes") in 194 dreams, and a hypothetical (hypo) coding procedure found 208 taste experiences in 205 dreams. (See Methods for why these numbers differ.) That is, between 0.69% of dreams (cons) and 0.73% of dreams (hypo) seem to have tastes experienced by the dreamer (and that make it into the report of their dream). Figure 1 displays tastes and valences per coding method as percentages of total taste dreams.

Contrary to hypothesis 1, good tastes appear to outnumber bad tastes in dreams, irrespective of coding method, though a considerable amount of uncertainty exists. The conservative approach found 7.11 percentage points more good (30.96%) than bad (23.86%) tastes, though with a considerable number of undefined/neutral (45.18%; any distinctions between undefined or neutral tastes were indistinguishable in the dream reports). The hypothetical approach found similar data, with 7.21 percentage points more good than bad, of course reducing the number of undefined, but not by any considerable margin (good = 38.46%, bad = 31.25%, undefined = 30.29%; Figure 2). Contrary to hypothesis 2, sweet dreams appear to outnumber all other classes/flavors (13.20% of classes cons; 32.21% hypo), more than all the other classes combined (barring undefined) for both cons and hypo; though again, considerable uncertainty exists, even more than with valence (Figure 3).

More uncertainty exists in class definitions than valence definitions, as summarized in Figure 4. It can be seen that certainty of valence supersedes that of class regardless of coding method, but to a lesser extent with hypo than cons (31% valence-class difference for cons; 12% valence-class difference for hypo); that class certainty is boosted more than valence certainty between methods (15% valence;

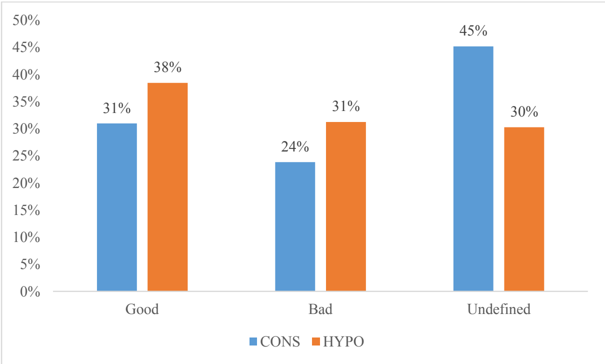


*Figure 2*. Taste Experiences by Valence. Expressed as percentage of taste dreams, for both cons and hypo coding methods.

35% class); and that uncertainty is diminished (unsurprisingly) with hypo.

A comparison of the conservative and hypothetical coding approaches found the largest differences between cons and hypo codings involving sweet and bitter tastes (19.01% sweet, 6.25% bitter, 3.82% umami, 3.58% salty, 0.85% sour, 0.48% cool, 0.43% metallic, 0.40% spicy, -34.82% undefined). Valence differed evenly from cons to hypo (7.50% bad; 7.39% good; 14.89% undefined). A strong positive correlation was found, as expected, between the prevalence of a class/flavor across dream reports (using cons) and its percent difference between coding methods ($r$ = 0.93 if undefined is included; $r$ = 0.87 if undefined is not included).

A comparison of dream series was also conducted, and is illustrated in Figure 5 (the data for the hypothetical coding is virtually identical, and therefore not illustrated). Many dream series fell significantly above or below the mean for dreams with taste experiences (0.69% cons; 0.73% hypo).

The same analysis was repeated after removing all dream series with fewer than 400 dreams (thus removing 48 series and retaining 16 [25%]; again, the data for the hypothetical coding is virtually identical; Figure 6), to reduce the effect of outliers. This found only four dream series to fall within the confidence interval of the mean (Pegasus, Barb Sanders, Dorothea, Izzy); four series were significantly above the mean (Jasmine, Madeline, Kenneth, Alta), and eight were significantly below (Norman, Vietnam Vet, Phil, H/VdC norms F, Emma, Elizabeth, H/VdC norms M, and College women late 1940s), irrespective of coding method. Again, substantial variation appears to exist between dreamers and groups of dreamers.

Females had more taste dreams (0.75%, $SD$ = 1.24% for cons; 0.78%, $SD$ = 1.23% for hypo) than males (0.58%, $SD$ = 1.03% for cons; 0.63%, $SD$ = 1.04% for hypo) irrespective of coding method (Figure 7). A chi-square analysis found no significant difference ($\chi^2$ = 2.50, p = 0.114, φ = 0.009 for cons; $\chi^2$ = 1.68, p = 0.195, φ = 0.008 for hypo). Females also had on average more dreams in their dream series ($M$ = 548, $SD$ = 1010) than males did in their dream series ($M$ = 305, $SD$ = 444; keep in mind that some series are of individuals and others are of groups). A t-test found no significant difference ($t$ = 1.28, $p$ = 0.206, Cohen's $d$ = 0.31).

The data for sex differences between males' and females' valences of taste can be seen in Figure 8. A chi-square test found no significant difference between males' and females' valences of taste dreams irrespective of coding method ($\chi^2$ = 2.75, p = 0.253, Cramer's $V$ = 0.12 for cons; $\chi^2$ = 1.21, $p$ = 0.547, Cramer's $V$ = 0.08 for hypo).

The data for sex differences between males' and females' classes/flavors of tastes can be seen in Figure 9. A Fisher's exact test found no significant difference between males' and females' classes of taste dreams irrespective of coding method ($p$ = 0.102, Cramer's $V$ = 0.11 for cons; $p$ = 0.122, Cramer's $V$ = 0.13 for hypo). (Fisher's exact test was necessitated by the paucity of data in certain class categories.)

A cursory regex analysis (without human verification) of

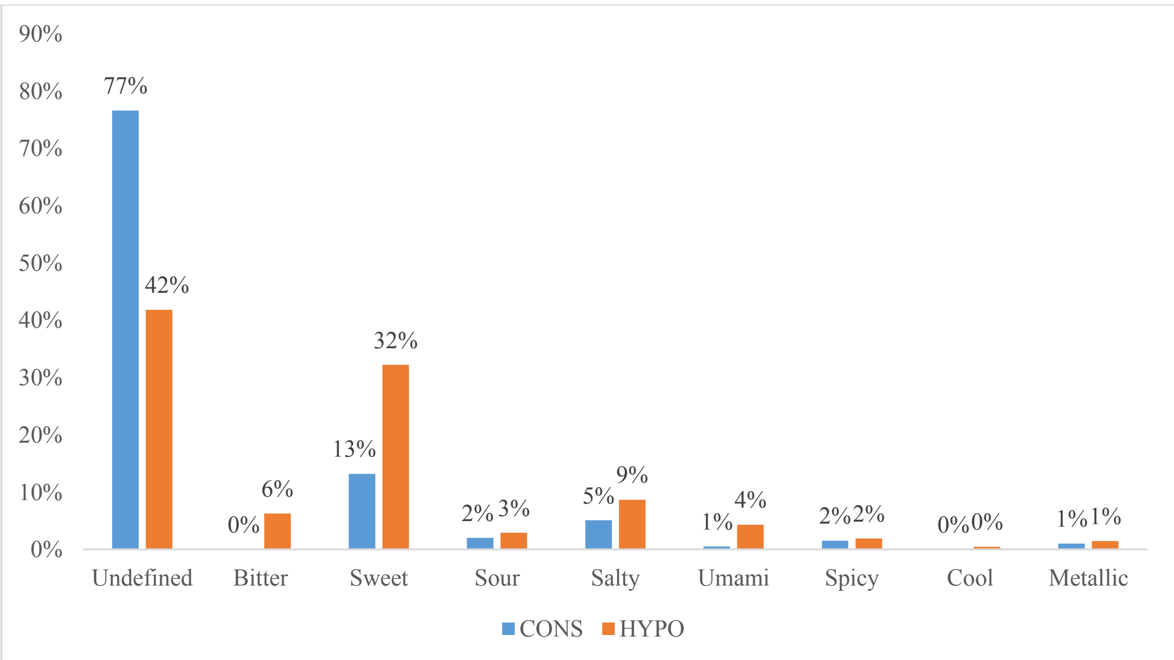


*Figure 3*. Taste Experiences by Class. Expressed as a percentage of taste dreams, for both cons and hypo coding methods.

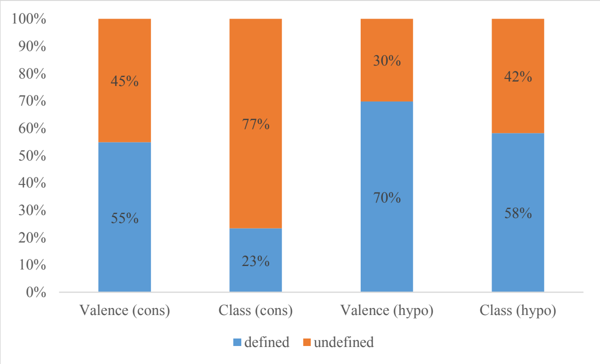


*Figure 4*. Uncertainty in Valence and Class. Here, defined valences are good plus bad, and defined classes are the sum of every class that is not undefined. Undefined refers to undefined valence and undefined class, respectively. Data is expressed as a percent of total valences or classes, respectively; that is, as percent of total taste experiences.

the occurrence of eating (opposed to taste) across all 64 English-language dream series found eating to be mentioned in 5.80% of dreams (*SD* = 3.61%).

Lastly, certain dreams have been excerpted in Appendix B that demonstrate particularly fascinating, unusual, or surprising taste experiences in dreams; more on this can be found in Appendix B and in the Discussion.

## 4. Discussion

### 4.1. General Discussion

As predicted, fewer taste experiences in dreams were discovered than previous literature of Hall/Van de Castle norms would suggest (0.69% cons, 0.73% hypo; compared to 1%; Bulkeley & Domhoff, 2010; though Zadra et al., 1998, found 0.86%, and notably used purely-human scoring methods, not regex). Using human verification for every word-string search result tends to be very time-intensive, especially if the regex is optimized to reduce false negatives (thereby maximizing false positives). However, because the current study examined only taste and spent time refining a single highly effective word-string, efficient human verification was possible, which eliminated false positives from the search results. Furthermore, some studies do not differentiate between experiences of the dreamer and those simply mentioned or experienced by a dream character; doing so with purely word-string searches (without human verification) is likely impossible.

As a caveat, remember that these results represent only those tastes that made it into dream reports; it is currently impossible to know, given the personal nature of dreams, what is truly experienced by the dreamer in the moment of the dream, though reliable dream diaries are generally acknowledged as excellent sources of dreamt information (Domhoff, 2000). Additionally, there exist known differences in dream analysis (especially those related to emotion) depending on how the analysis was performed—i.e., self- vs. external-rating—as well as time of night, setting (home or lab), and potentially other factors (Sikka et al., 2017; 2018). However, it is worth noting that external-judgement is predicted to measure dreamt experiences as less positive than self-judgment, which is in the opposite direction of the present findings.

Contrary to the original hypothesis, good tastes outnumbered bad tastes by about 7 percentage points irrespective of coding method, though considerable uncertainty exists, given the vagueness of many dream reports (see Figure 2). This may suggest that a more powerful mechanism is at play behind dream gustation than the effect of dreams as a form of survival simulation, and/or that it is illogical to assume such a theory would select for bad tastes over good, given that the evolutionary function of human taste is both to orient us away from toxic foods as well as toward nutritious and energy-dense foods (Revonsuo, 2000; Breslin, 2013). An alternative mechanism may be the continuity hypothesis (see Domhoff, 2017), given that individuals are more likely to experience good tastes than bad in their waking life (as people tend to have a choice over what they eat and taste, and tend to avoid tastes they find unpleasant). The prevalence of sweet tastes (see Figure 3)—more

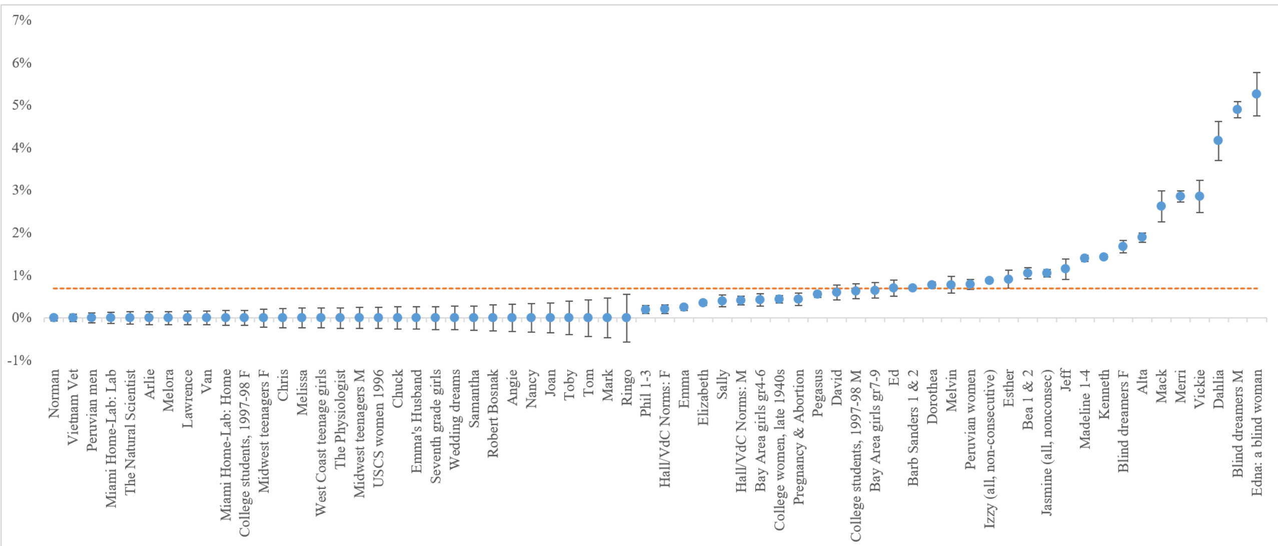


*Figure 5*. Percent Taste Across All Dream Series. This shows the percent of taste dreams for each series, using the conservative coding method (with 95% confidence intervals); the orange (or grey) dotted line represents the average percent of taste dreams (0.69%).

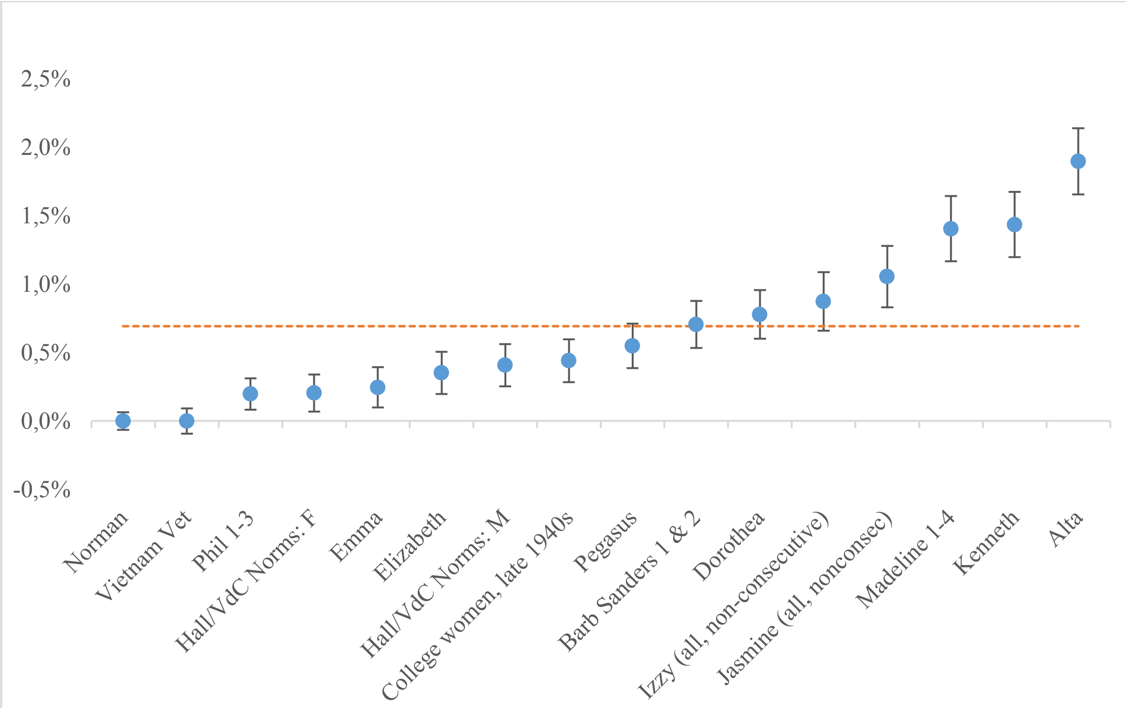


*Figure 6*. Percent Taste Across All Dream Series. This shows the percent of taste dreams for each series, using the conservative coding method (with 95% confidence intervals); the orange (or grey) dotted line represents the average percent of taste dreams (0.69%).

than any other and more than all others combined (barring undefined)—may also reflect the underlying human desire toward sweet tastes; however, to what extent our everyday experiences of taste match our dreamt experiences is unclear (e.g., while we may like sweet things, we don't always eat them for health reasons; with the exception of natural sugars, the majority of our taste intake is likely not sweet). A deeper investigation comparing the taste profiles of waking and dreaming individuals may be insightful.

Alternatively, the mechanism may not be the continuity hypothesis—it may be linguistic. Again, further study is required to investigate this relationship, but it does not seem unlikely that—given the baseline uncertainty of dream reports—individuals are either more likely to remember sweeter/better tastes and/or more likely to summon up that verbal taste descriptor when recollecting and recording their dreams. (E.g., is a person significantly more apt to recall and report a sweet or salty taste than a bitter or sour one? A linguistic and/or mnemonic pattern could be at play here.)

More uncertainty was seen to exist in class definitions than valence definitions, for both codings; in other words, people more confidently and decisively reported whether a taste was good or bad than what flavor would characterize that taste (Figure 4). This may be unsurprising, insofar as valence is a broader descriptive category than flavor/class, and would be in any context (e.g., valence of smell versus particular smell). Given that most dreamers are not overly concerned with the precise sensory and perceptual experiences of their dreams, and given that they are focused on recording a series of places and people and events that are

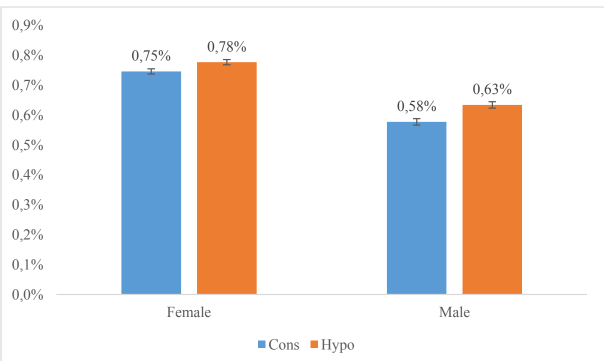


*Figure 7*. Percent of Taste Dreams by Sex. This shows the percent of taste dreams for both females and males and for both conservative and hypothetical coding methods. Error bars represent standard error of the mean. All differences are non-significant.

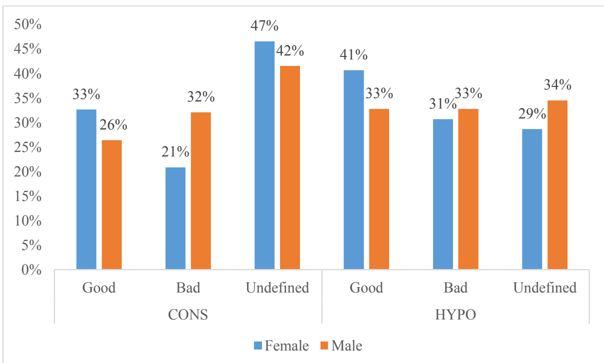


*Figure 8*. Sex Differences in Percent of Tastes by Valence. The percent of taste experiences by valence, between females and males and between conservative and hypothetical coding methods. Expressed as percentages of all taste experiences.

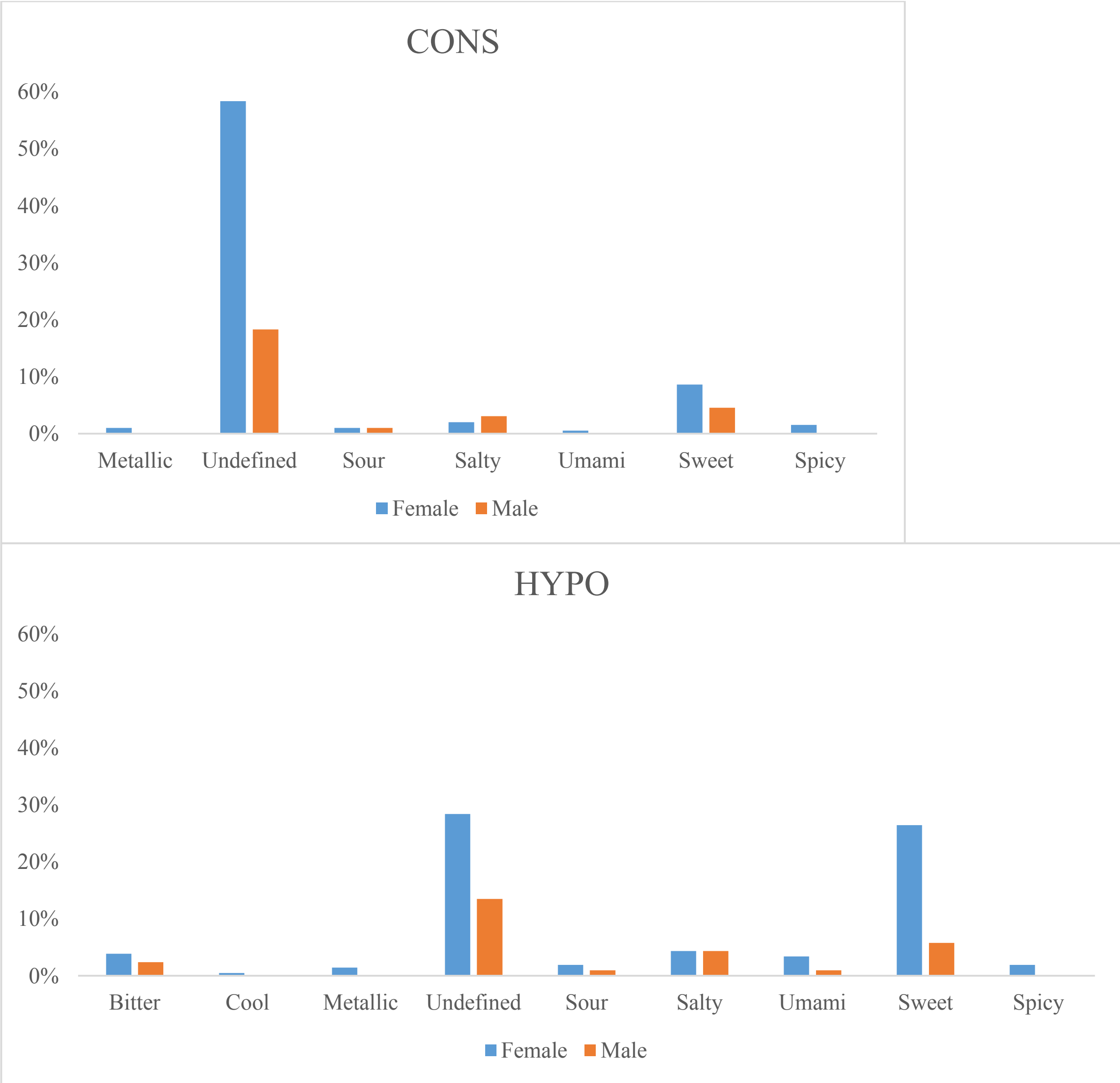


*Figure 9*. Sex Differences in Percent of Tastes by Class. The percent of taste experiences by class/flavor, between females and males and between conservative and hypothetical coding methods. Expressed as percentages of all taste experiences.

already difficult to remember, it is not unusual that more attention is paid to valence than class, and this likely represents a parsimony of dream report procedure—not every detail can be explicated to its full extent, regardless of memory (and to that end, not every detail can be sufficiently remembered upon waking). For the hypothetical coding procedure, the same trend was observed but with a smaller difference between class and valence uncertainties, and, unsurprisingly, a lower uncertainty overall (Figure 4). From this, one can see that valence is always more definitively recorded than class/flavor, and that if estimations are made as to likely valences and classes, class certainty is benefited more than valence certainty (in other words, more class estimations are/must be made).

To this end, the distinction between conservative and hypothetical coding systems seems necessary, in consideration of the typical vagueness of dream reports. Coding uncertainty is clearly diminished, but at the expense of a different kind of uncertainty—that from estimation. Comparison of the two methods found the largest differences between codings involving sweet and bitter tastes (followed to a lesser extent by umami, salty, sour, cool, metallic, and spicy), which is in accordance with the observation that the majority of estimates moved from undefined (cons) to sweet (hypo) or undefined to bitter, and fewer from undefined to a different class. A strong positive correlation was found between the prevalence of a given class/flavor across dreams (with cons) and its percent difference between cons and hypo. Contrary to class, valence changed evenly across coding methods: both bad and good valences increased by about 7.5% between cons and hypo (and undefined decreased consequently by about 15%).

When compared against each other, many dream series fell significantly below or above the mean number of taste dreams (0.69% cons; 0.73% hypo), though this is likely due in part to certain series having very few dreams in them (as low as 16), as well as individual differences in dreaming, dream recall, and dream reporting (Figure 5). When dream series with fewer than 400 dreams were removed, only four dream series fell within a 95% confidence interval of the mean, with eight significantly below and four significantly above (Figure 6). It is not clear what differentiates certain dream series from others in this regard. Based on the information supplied by DreamBank, ease and detail of recall may be a factor, but the data is insufficient to make concrete conclusions. When the non-truncated data is observed, all three series of blind dreamers lie significantly above the mean (in addition, Jasmine, also significantly above the mean, had severely impaired vision due to congenital optic nerve hypoplasia; Domhoff & Schneider, 2020); however, it is impossible to make any definitive conclusions about this relationship, due to small sample sizes. See Hurovitz et al. (1999) for a study dedicated to the dreams of blind people, which finds a substantial percentage of taste/smell/touch experiences in dreams, and Meaidi et al., (2014) for more nuance on dreams of blind people, which also finds elevated gustatory content.

## 4.2. Discussion of Sex Differences

Females had more taste dreams (as a percent of all dreams) than males, irrespective of coding method, though this difference was not significant and of a very small effect size (Figure 7). Females also had on average more dreams (though not significantly more, and with a small effect size) in their dream series than males did in their dream series (though keep in mind that some series are of individuals and others are of groups; no series is of mixed sex). This is in keeping with prior literature, which demonstrates that females tend to recall their dreams more often than males (possibly for a variety of reasons; see Schredl & Reinhard, 2007). Additionally, sex differences are known to exist in food and taste preferences: females may be more oriented toward attention to food and taste as a result of both sociocultural pressures and hormonal appetite regulation (Lombardo et al., 2019). This may be particularly important, as attention seems to affect the perceptual details that make it into dream reports (for instance, Raymond et al., 2002, as later mentioned).

No significant sex differences between valence or class were found, and differences were of small effect size. However, females appeared to have somewhat more positively valenced taste dreams and fewer negatively valenced taste dreams than males (by percent); this difference is more apparent with the conservative coding method. Additionally, females appeared to have substantially more sweet (especially with hypo) and undefined (with both cons and hypo) tastes, by percent (see Figures 8 & 9).

## 4.3. Discussion of Methodology and Uncertainty

People are often very bad at recording the details of taste experiences in dreams, or provide vague ("would taste really good", "tastes almost as if it were meant to be eaten", "just as tasty as it is real"), apophatic ("they aren't sour but they aren't really sweet either", "the salad wasn't spicy"), or pragmatically unverifiable ("like Vital Green", "cocaine", "like pee") descriptions. Other peculiarities include noticing a lack of taste ("I couldn't really taste in this dream", "didn't have any taste at all, but somehow they were delicious"), typos ("I…ate it. Was it sweet."), uncertainties over whether taste was actually experienced ("He was sampling them to see if they were sour. He gave me one. I was drinking it."), and lack of distinction between taste and description ("sweet raisin bread", "sour milk", "salty water"). Unfortunately, in the context of analyzing self-reported dreams in journal format many years after the reporting, greater precision of description cannot be obtained. Other dream-study methods may excel here (see Domhoff, 2000, and Ruby, 2011 for overviews).

Importantly, people are also very bad at remembering and reporting taste experiences in waking life. For example, Villinger et al. (2021) found a significant memory-experience gap when analyzing day-to-day eating happiness (averaging eating enjoyment, pleasure, and taste). Interestingly, only negative (and not positive) peak eating experiences were found to have a significant effect on retrospection, and participants generally evaluated their eating experiences as more negative in memory than in the moment. That positively valenced tastes stand out in dreams is thus peculiar. Additionally, Raymond et al.'s (2002) study on the dreams of recent burn victims found dreamt pain experienced dramatically above the norm (30% compared to 1%), suggesting that dreamt and recalled sensory experiences are substantially impacted by waking attentional factors (also see Schredl et al., 2017).

Another methodological issue is that certain descriptors of taste (namely "weird" and "funny") are used frequently, but are difficult to operationalize. For the purposes of this analysis, "weird" was considered neutral and "funny" was considered bad, as this seems to be generally how these tastes are construed (i.e., "weird" seems to imply no valence judgement, and "funny" might seem like a good thing, but in the context of taste, it is generally used negatively; e.g., "this milk tastes funny; has it gone bad?"). Additionally, "funny" tended to occur within the context of other negative descriptors, while "weird" occurred in all contexts.

A related issue is that certain taste experiences are difficult to classify unidimensionally: e.g., milk, cheese, roast beef, bread, noodles, wine, whisky, carrots, veggies, toothpaste, cinnamon—all of these are composite tastes, and difficult to fit into the single-class system. This suggests a possible methodological flaw, but it is not clear what better and practical classification alternative exists. Another good example of the single-class problem is Edna: Dream 9, who describes a sandwich of bread, pickles, peanut butter, and grapes, saying, "I could taste each thing separately, although they were all together"; though this is a relatively rare occurrence.

Lastly, the construction and justification for the word-string search term can be found in Appendix A, and is here compared to similar strings in prior studies. Bulkeley and Domhoff's (2010) thorough analysis of the DreamBank Van series uses ^tastes?^ ^tasting^ ^tasted^ ^sweet^ ^salty^ ^bitter^ ^salty^ ^delicious^ ^disgusting^ for gustation. This study uses ^tastes?^ ^(tast(y|ed|ing))^ ^sweet^ ^salty^ ^bitter^ ^savou?ry^ ^spicy^ ^sour^ ^delicious^ ^disgusting^ ^bite^. The prior study misses occurrences of "tasty", "savo(u)ry", "spicy", and "sour", and for some reason includes "salty" twice. Not including "bite" enhances automated searches; however, the current analysis confirms that this misses several taste occurrences. While these various false negatives are relatively uncommon, the optimization of word-strings is well worth consideration. As a final example, "disgusting" is not only used to describe tastes, but also many other experiences, contributing to false positives if unchecked. This demonstrates the necessity for human verification of search results, and may account for the 0.3% differential between that study and the current one (in addition to selecting only dreamer-experienced sensations).

### 4.4. Discussion of Eating versus Tasting Dreams

It may seem puzzling that only a very small percent of dreams include taste (around 0.7%), while for most people, every day includes a few meals' worth of taste experiences. A cursory analysis conducted on the same DreamBank dataset found eating to be mentioned in 5.8% of dreams—substantially more than 0.7%. This number is undoubtedly inflated by false positives, as the eating analysis did not benefit from human verification of regex results; however, the difference between eating and tasting is still large enough to warrant consideration.

Given this, it seems likely that dreamt taste experiences are not as rare as they appear, but are recorded quite rarely in dream reports. People generally do not pay considerable attention to the precise valences and flavors of their day-to-day meals, and reporting dreams often requires the utilization of limited memory resources to begin with. Reporting bias is also possible: for instance, dreamers may not mention that an apple tastes like an apple, because it seems obvious to them. However, they do not appear to be biased by unexpected tastes superseding expected tastes: There are many cases of normal or expected tastes that are reported either as specific tastes or general statements about the experience (e.g., “a huge squash, pumpkin in color and taste”; “muffin cake…tastes really nice”; “lots of chocolate and tastes great”). Notably, this happens for both good and bad “expected tastes”.

### 4.5. Discussion of Notable Dreams

Appendix B excerpts a few notable taste experiences in dreams. These have been selected to demonstrate how rich, varied, bizarre, and surprising dream gustation can be. This dataset is of course anecdotal, but from it one can at least begin to understand the extents to which dream gustation is possible. It is observed that that: 1) dreams of poisoned food are not uncommon, and sometimes co-occur with bad tastes; 2) taste can cause vomiting or vomit-like sensations in dreams; 3) tastes can engender other dreamt sensations (including sensations as specific as a dry or sticky mouth, or even shivering and disgust reactions); 4) tastes can be unexpected, and/or contrary to reality; 5) taste can be accompanied by texture sensations; 6) non-food items can be successfully tasted and/or eaten; 7) deliciousness can be appreciated without taste; 8) lack of taste can be acknowledged; 9) bad tastes can be anticipated without being tasted; and 10) tastes can alter the instantiation of subsequent tastes.

It remains unclear how many, and to what extent, waking-life sensations and perceptions are replicable in dreams; however, this analysis certainly begins to broaden the landscape of possibility.

## 5. Limitations

Several notable limitations exist, most of which have already been discussed. First, the inherent imperfection of regex word-strings results either in an efficient but imprecise string that misses salient data, or an inefficient but precise string that requires considerable time in the form of human verification. Improvements in machine learning could assist here, though contextual information is crucial in the analysis of recorded taste experiences. Second, linguistic and mnemonic uncertainties make it difficult to be confident in the pattern of results; that is, are dreamers really experiencing more sweet tastes, or do they have a predilection toward better remembering/and or describing that taste? Third, the coding system is inherently imperfect, and was unable to employ multiple raters, and it is certainly possible that superior systems could be generated to efficiently and effectively code dream sensations against the obstacle of vague, apophatic, unverifiable, or uncertain dream reports. However, even a perfect coding system would not alter the fact that even waking tastes generally go unremembered. Fourth, because dream gustation is so rare, a sample size of 28,003 is insufficient for precise analysis. Domhoff (2018) suggests at least 125 dream reports are necessary for most measures; however, the critical n can be calculated (see Domhoff, 2018) for the prevalence of dream gustation (0.7%): Given that h-values range from 0.20 to 0.40 for most content categories in dream analysis (Domhoff, 2018), the critical n for gustation as a whole is likely somewhere between 7,000 and 28,000. The computed critical n for occurrences of only sour tastes, for example (occurring in 0.014% of dreams), may be well over a million. Given the very finite number of reliable dream series, a more powerful analysis of dream gustation may be difficult to come by, though necessary for greater confidence in results.

## 6. Future Work

In addition to addressing the limitations above, future studies may consider conducting gustatory analysis on a large, reliable dataset from a database separate from DreamBank. Cross-cultural datasets could be of particular interest, given the cultural aspect of waking-life taste and eating. Additionally, investigation into the aforementioned possibilities of linguistic confounding variables on sensation and perception in dream reports, and comparison of the taste profiles of waking and dreaming individuals, should prove insightful. Again: what might we understand about our capacity for sensation and perception in the objective world if we can understand its counterpart in the mental world?

Research into machine learning technologies capable of automating the search of dream series while simultaneously offering accurate and context-dependent results is highly recommended. Exploration of the role played by dreamt taste experiences—e.g., when and in what context they tend to occur, whether there are prior or subsequent shifts in mood or emotions, or whether they have any direct impact on the remainder of the dream—also seems useful.

Lastly, DreamBank-based study of dreamt sensory modalities may provide an alternative to single-series studies, such as the olfactory and thermatosensory studies by Michael Schredl (2016; 2019), which use a large, single-dreamer series, rather than a database of many individuals' dreams (which likely accounts for the 0.2% taste dreams reported [2016]: well within the expected range, but representative only of a single individual). Both approaches have their benefits and drawbacks.

## Data Availability

All the dream reports used in this study can be found on DreamBank at https://www.dreambank.net/ (and one in Appendix B). See Appendix A for the specific search queries used. Raw data with codes can be found in Appendix C.

## Appendices A to C

See: https://journals.ub.uni-heidelberg.de/index.php/IJoDR/libraryFiles/downloadPublic/650

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## Conflicts of Interest

The author reports no conflicts of interest.

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