A Systematic Review and Meta-analysis on the Effect of Food Primes on Food Intake

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

2022 Yitong He

ABSTRACT

Background

Previous evidence suggests exposing humans to food-related cues increases food intake (positive food primes) while showing weight-related cues seemed to reduce food intake (negative food primes). This systematic review and meta-analysis were conducted to verify this dichotomous role of food primes.

Methods

Using selected terms, we searched the PubMed and PsycINFO databases. The effect size was calculated based on the change in mean food intake, standard deviation, and sample size from the included studies. A random-effect model was used in the meta-analysis.

Results

Forty-three studies were eligible based on our inclusion criteria. Positive food primes significantly increased food intake after exposure (SMD: 0.54, 95% CI: 0.28 to 0.8). On the other hand, negative food primes did not have a significant effect on food intake (SMD: -0.87, 95% CI: -1.88 to 0.13).

Conclusions

Exposure to positive food primes increases subsequent food intake. Negative food primes did not have any effect. Further research is needed to assess the impact of positive food prime on different populations and to examine the mechanisms of food primes.

BIOGRAPHICAL SKETCH

Yitong He was born in Shantou in Guangdong Province of China. She completed her bachelor's degree in nutrition at the University of Massachusetts Amherst in MA, USA. Then she continued her studies in nutritional science at Cornell University with a master's degree in 2020, under the mentorship of Dr. David Levitsky. She is looking forward to beginning her dietetics internship in Fall 2022 to pursing the dietitian certificate.

ACKNOWLEDGMENTS

I want to express my deepest gratitude to my committee chair, Dr. David Levitsky, for his invaluable mentorship and support during the last two years and guidance for this thesis. I'm incredibly grateful for his patience in this journey and the expertise that he shared with me. The opportunities and experiences in his research group have been vital for my professional and personal development.

I am also thankful to my minor committee member, Dr. Laura Barre, whose expertise is in statistical analysis and systematic review. Her valuable feedback and suggestions have been instrumental in completing this thesis.

Additionally, I'd like to acknowledge the assistance of a group of undergraduate students from Dr. Levitsky's research group: William Wu, Max Delahunta, Jack Rifkin, Khannh Pham, Kristen Ostergaard, Lucas Achkarian, Makayla Durant, Margaret Pfeiffer, Maria Tollock, Mark Hitrik, Sharan Prasad, Brain Frost, and Teddy Park. I had the pleasure of collaborating with them.

Lastly, I would like to thank my parent, for their continuing love and support, my boyfriend and DNS peers for encouragement and companionship for the past two years. None of these accomplishments would have been possible without them.

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1. Standardized Mean Difference (SMD)
2. Standard Deviations (SD)
3. Standard Error (SE)

Introductory

Obesity has become a widespread health concern in the United States. This health issue has been linked to increased morbidity and mortality related to diabetes, metabolic syndromes, cardiovascular disease, cancer, and a rising risk of psychological problems (Dixon, 2010). The imbalance energy intake due to modern sedentary lifestyles with increased availability of palatable energy-dense food, are considered the main drive of weight gain (Romieu et al., 2017; Selassie & Sinha, 2011); There is an urgent need for weight-loss intervention and weight-gain prevention.

People's food intake is not only determined by homeostatic regulation and the internal circulation of hormones but also by non-homeostatic mechanisms, including environmental factors (Levitsky et al., 2022). The non-homeostatic mechanisms are highly related to the brain reward system, which uses dopamine as the communicator. Dopamine is a primary contributor to affecting food intake, indicating a strong environmental impact (Alonso-Alonso et al., 2015). People less sensitive to rewards need a higher level of dopamine to obtain the same level of satisfaction than others, may have a higher risk of overeating, and become overweight due to the pursuit of pleasure and happiness triggered by dopamine (Stice et al., 2008, 2010). Indeed, the behavior of eating signals and increases the release of dopamine in both human beings and animals, along with reward learning (Hernandez & Hoebel, 1988; Small et al., 2003). Pictures of high-calorie food can activate the brain reward system, more substantially affecting obese individuals than normal-weight individuals (Stoeckel et al., 2008). Veltkamp's

experiment demonstrated that food-related words could also increase subsequent consumption (Veltkamp et al., 2008).

The priming effect was first described and studied by John Bargh. His work demonstrated that participants' behavior could be disturbed by implicit cues intentionally put in the environment without being consciously noticed by people (Bargh et al., 1996). For example, the action of reading words and imagining contents automatically affects people's subsequent behaviors in the related domain (Ferguson & Bargh, 2004). This process did not require individuals' intention. Results from Chartrand and Bargh's experiments had supported that the effect of activated behaviors did not differ from consciously response or passively reaction (Chartrand & Bargh, 1996).

With more attention to the non-homeostatic mechanism of influencing food intake, further research has shown that food priming in various forms might induce eating regardless of the satiety state of the participant. The increasing marketing and advertising with massive food cues have worsened the weight crisis (Cohen, 2008). If the stimulus of food through behaviors and environments can be modified or controlled in some way, it is possible to minimize excessive food intake, through food priming.

The "goal priming" theory suggests that external cues can affect behaviors and lead to reaching the primed goal (Papies, 2016). If a food prime, acts like a primed goal, can evoke the urge to eat, the exact mechanism may work to suppress food intake using a different type of prime, ultimately reaching the goal of weight control. Weight or diet-

related cues, skinny human-like sculpture, exercise, and health cues all appeared to be effective in lower food consumption (Brunner & Siegrist, 2012; Papies & Hamstra, 2010; Stämpfli et al., 2017; Stein et al., 2016). This dichotomous food primes suggests there may be two distinct type of environmental cues that affect human food intake: (a) positive food primes which stimulate eating and (b) negative food primes which may inhibit food intake.

To our knowledge, no review has viewed the food priming literature as two separate processes – positive and negative food primes, and the data on food primes is conflicting in the literature. Thus, this review aims to systematically review and perform a meta-analysis on the impact of food priming on subsequent food intake as positive or negative primes in all populations.

Method

2.1 Searching Strategy

The protocol of this review is registered with Open Science Framework (OSF)-Standard Pre-Data Collection Registration (DOI:10.17605/OSF.IO/TCZQV). Initially, the author searched only PubMed, and a team of 12 undergraduate students from Cornell University reviewed relevant studies from PubMed for screening and data extraction in Excel. We started with a screening process only on PubMed. Then we realized more articles might be eligible for our review. To collect comprehensive literature on this topic, we added another database, PsycINFO. We did not use “primes” or “food priming” as one of the search terms because our research newly defined the concept of food priming and two

different types of food primes. Rarely have studies used this concept. Instead, we used the search terms *"(cue or cues or stimulus or stimuli) and (food intake or appetite)"* to identify related articles published between January 1960 to September 5, 2021. The author searched two electronic databases, PubMed and PsycINFO, using the same search terms.

The downloaded citations were imported into Covidence, a systematic review management program, which removed any duplicate citations. Two Cornell undergraduate students (WL, MD) were recruited as the reviewers for screening. They independently went through Titles and Abstracts. They then screened the Full-text screening via Covidence. The author (YH) served as a third reviewer to resolve any conflict votes during screening between the two reviewers. Finally, two reviewers (WL, MD) and the author (YH) discussed any disagreements that arose and then reached a consensus on the final decisions.

2.2 Eligible Criteria

The initial search included all the articles that matched the search term and were within the desired publication year between 1960 and 2021. The inclusion criteria were primary studies with human objects, published in the English language, described the exposure to a food-related cue, and contained a quantitative measurement of food intake in the unit of grams or kilocalories.

2.3 Data Extraction

Two reviewers (WL, MD) and the author (YH) worked independently extracting desired data from included articles using the modified template on Covidence (See supplement documents). The author (YH) cross-checked all the data extraction and reached a consensus with the two reviewers. Basic information of included articles had the first author's last name, the year of publication, study design, sample size, sex, percentage of females in the sample, mean age, and mean BMI from both control and intervention groups of the study.

2.3.1 Energy Intake

When necessary, energy intake and standard deviation for each study was converted to kcals using the calorie density of the test food. When not directly stated in the study, energy information was derived from published food label data. Standard error (SE) was converted to standard deviation (SD) by multiplying the SE with the square root of the sample size (of the relative group).

We used the online calculators from *Dr. Lee. A.Becker in UCCS* to calculate effect size. SD was calculated using a difference calculator from *Mathcracker*.

2.3.2 Type of Stimulus

The type of priming stimulus was divided into two categories. A positive prime represents the type of food-related stimulus (e.g., Food ads, smell, images of food) that will stimulate or promote people's subsequent food intake after exposure. A negative

prime was defined as a stimulus (e.g., exercise, weight control, idealized body image) that was intended to suppress food intake after exposure.

2.4 Statistics

R Studio was used for all the statistical analysis ("meta" package version 5.2-0 and "metafor" package version 3.0-2). The positive and negative food primes were analyzed separately to avoid algebraic cancellation. As covariates, the data were adjusted for sex, age, and restrained status. To assess the overall food priming effect, we did not use criteria that look for studies with a specific population in the sample or stimulus types. We expected our included studies would not have the same common effect but vary across the studies. We assumed that the true effect size would follow the normal distribution. As a result, a random-effect model was used in the meta-analysis.

Standardized Mean Difference (SMD) was the difference in means between control and intervention groups in selected studies, expressed in the standard deviations (SD) unit. The standardization made it possible to compare these studies without using the same measurement methods.

Heterogeneity between studies presents the extent of true effect sizes varies in the meta-analysis. 25. In other words, how significant is the difference between studies. A 25% indicates a low heterogeneity moderate level; 50% suggests a moderate level, And 75% reveals a substantial heterogeneity.

2.4.1 Subgroup Analyses

All the subgroup analyses were conducted on R Studio using the same package for meta-analysis. Under each category, all consisted of two different groups, and the between-group studies performed a meta-analysis on each group and a comparison to assess any statistical significance.

Restrained Status

A total of 10 groups of data from 8 studies in positive food prime were specified with an unrestrained status and 11 in restrained status in the sample. In the negative food primes, four data groups from three studies had an unrestrained status, and only two groups of data had reported a restrained status. Kemps 2016, Fedoroff 1997, 2003, and Coelho 2008, used the Revised Restraint Scale to define the different statuses. Bellisle 2009, Hillbert 2007, and Haire 2014 used Three-factor Eating Questionaries to assess restrained levels. Collins 20115 and Higgs 2002 used Dutch Eating Behaviors Questionaries to define restrained status. The Coelho's 2009 studies, participants were classified as having high and low weight concerns. We grouped the low weight concerns into unrestrained eaters and the high weight concerns into restrained eaters based on the description of the classification in this study.

Sex

A subgroup analysis was planned to assess the sex difference on the effect of positive and negative food primes.

Age

Included Studies all had a sample with various age ranges but not exceeded the age of 18, or not bellowed or equal to the age of 18. None of a study had a mixture of children and adults in the sample. Part of the studies on this topic had primarily focused on the children population, so we assumed a difference between children and adults on the effect of food primes. We used a mean age of 18 as a division to separate studies into a child (<18) and adults (18) group and conducted a subgroup analysis between these groups.

BMI

Studies in this review include a sample of normal weight, overweight and obese. The first planned subgroup analyses were between normal weight and the rest of the weight status that exceeded the normal weight range. The second intentional subgroup analysis would compare overweight and obese individuals to observe other effect on weight status.

2.5 Risk of Bias

The risk of bias was assessed using a Covidence template, created based on the *Revised Cochrane risk-of-bias tool for randomized trials (ROB2)* guidance from 2019. All included studies were evaluated for "sequence generation", "allocation concealment", "baseline difference between groups", "blinding of participants and personnel", "using appropriate analysis", "reporting missing and incomplete outcome data", "multiple eligible outcome measurements", and "overall risk-of-bias judgment". Both reviewers (WL, MD) and the author (YH) each independently rated one third of all included

studies. The author (YH) cross-checked the decisions and reached a consensus on any disagreements with the other two reviewers.

Result

3.1 Result of the search

A total of 5473 studies were identified from the search (3218 from PsycINFO and 2255 from PubMed). 4604 studies were continued to the Title and Abstract screening after removed duplicates. 153 studies were eligible for full-text screening. Finally, we excluded 110 studies and had 43 studies included for this review. Figure 1 shows the review diagram and the main reasons for exclusion from this review.

3.2 Description of Included Studies

Table 1 shows a summary of all the included studies. Out of all 43 studies, eleven studies were conducted in the USA; seven each in the UK and Netherlands; four in Canada; two each in Australia, Belgium, France, and Germany; and one each in Birmingham, Finland, Iran, Italy, Lebanon, and Switzerland. Eleven studies used a within-subjects design, twenty-eight used a between-subjects design, and four studies applied a combination of within-subject and between-subjects design. Although we did not use “experimental trials” as one of the selection criteria, all eligible studies were conducted in experimental settings because collecting sufficient data requires comparing interventions and control groups.

Two studies (2/43 = 4.6%) included only male participants; nineteen (19/43=44.2%) had only female participants, and the remaining were mixed sex. Thirteen studies had a sample with children whose ages ranged from 6 to 15, and the remaining were adults. Eight studies were classified as a negative prime. Thirty-five studies were positive prime. Specifically, nine studies used food promotion (e.g., TV ads) as the stimulus, seven used various portion or package sizes (e.g., large package size, single-serving size), seven used food smell exposure (e.g., odor of baking cookies), two used visual food exposure (e.g., images of food), and seven used others (e.g., memory of previous lunch). Eight studies specified the restrained status of the sample and divided the participants into different groups based on this characteristic.

3.3 Meta-analysis

Food Prime

The overall effect size of the positive food priming was statistically significant (Figure 2, SMD: 0.54, 95% CI: 0.28 to 0.8), though the heterogeneity was high (I^2 = 86%). The effect of negative food priming was not significant (Figure 3, SMD: -0.87, 95% CI: -1.88 to 0.13). Like the positive food prime, the heterogeneity was high (I^2 = 85%).

3.3.1 Subgroup Results

Restrained status

In positive food prime studies, there was no significant difference between restrained and unrestrained eaters (Figure 4). The overall effect size in restrained and unrestrained eaters both favored the intervention (Unrestrained SMD: 0.51, 95% CI: 0.10 to 0.92; Restrained

SMD: 0.59, 95% CI: 0.04 to 1.13). Heterogeneity in unrestrained eaters was moderate (I^2 = 67%), but restrained eaters had a high level of heterogeneity (I^2= 81%). In negative food prime, no significant difference was found between unrestrained and unrestrained eaters (Figure 5). The food intake of unrestrained eaters showed no significant difference before and after exposure to a negative food prime (SMD: -2.82, 95% CI: -6.85 to 1.21). Only one study recruited restrained eaters in the sample. The effect was not significant, either. R Studio was able to provide the effect size (SMD: -0.32, 95% CI: -1.02 to 0.38).

Sex

Sixteen studies in the positive prime had only female participants as the sample, and two had exclusively male participants. Five studies in the negative prime included only females as participants, and one studies had solely male in the sample.

The difference in the positive food priming on food intake between females and males was statistically significant (Figure 6, SMD: 0.37, 95% CI: 0.16 to 0.58). Independently, the food intake substantially increased in both females (SMD: 0.24, 95% CI: 0.07 to 0.42) and males (SMD: 1.33, 95% CI: 0.46 to 2.20) with a greater effect observed in males. Females with positive food primes had a low heterogeneity (I^2 = 55%), and males had a high heterogeneity (I^2 = 88%).

Unlike the positive food prime, there was no significant difference between females and males under a negative type stimulus (Figure 7, SMD: -2.48, 95% CI: -5.23 to 0.26). The result of female group (SMD: -2.82, 95% CI: -5.96 to 0.31) was not statistically

significant. Only one group of data from one study conducted a negative prime on a male, so there was not enough data to perform a meta-analysis independently.

Age

In Figure 8, both adult and child participants had a significant increase in food intake after exposure to a positive food prime (SMD: 0.56, 95% CI: 0.29 to 0.82). There was no significant difference between the different age groups of participants (p = 0.61). Children had a moderate-to-high effect (SMD: 0.66, 95% CI: 0.04 to 1.29) compared to the adult group (SMD: 0.49, 95% CI: 0.24 to 0.74).

Figure 9 showed a similar result of subgroup analysis of age with negative food primes exposure. Different age groups did not respond differently to subsequent food intake after exposure to negative food prime (p = 0.14). Additionally, negative food prime did not have a significantly effect on either adult (SMD: -0.98, 95% CI: -2.15 to 0.18) or child (SMD: -0.08, 95% CI: -0.37 to 0.20) samples independently.

BMI

Initially, we planned to examine the influence of BMI on the effect of food prime. However, insufficient BMI data and hybrid weight status in all the samples restricted the possibility of analyzing the effect of food prime among different weight statuses without a high risk of analytical bias. Alternatively, we ran a meta-regression analysis and used the mean BMI value as the only predictor. The result failed to show any significant effect

of weight status on food intake with food priming (positive food primes x BMI, $p = 0.63$; negative food primes x BMI, $p = 0.44$).

Female x Restrained Status (Positive)

With a greater number of studies solely with female in positive food prime existed in this review, we performed a post-hoc subgroup analysis additionally and compared the difference between restrained and unrestrained eaters in female. We could not perform another subgroup analysis with exclusively male participants due to the limited number of studies.

No significant difference ($p = 0.48$) was observed between restrained and unrestrained female eaters on food intake with exposure to a positive food prime (Figure 10). Unrestrained female eaters' consumption significantly increased (SMD: 0.34, 95% CI: 0.02 to 0.67), but not the restrained eaters (SMD: 0.44, 95% CI: -0.08 to 0.97). The difference across the studies in unrestrained female eaters was not significant ($I^2 = 42\%$, $p = 0.08$). Significant difference across studies was observed in restrained female eaters ($I^2 = 74\%$, $p < 0.001$)

Package/portion Size x Prime types

The package/portion size could be confounding in affecting food intake because of the presence of calorie density on food labels and the heterogeneous setting in these studies. Therefore, we added another post-hoc subgroup analysis exclusively on package/portion size food primes and compared the effects of using as a positive or negative food prime.

Figure 11 presents a special subgroup analysis based on the type of food primes (package size food prime x prime type). Positive food primes had a medium effect on subsequent food intake (SMD: 0.82, 95% CI: 0.06 to 1.57). However, the variety between studies was significant as well (I^2 = 89%, p < 0.001). Negative food primes did not have a statistically significant impact on food intake (SMD: 0.28, 95% CI: -0.49 to 1.06). The effect of package size did not have any difference between prime types (p = 0.33). Overall effect from package size was medium and favor intervention group (SMD: 0.62, 95% CI: 0.07 to 1.17).

3.4 Risk of Bias

For "Sequence Generation", only one study was rated as unsure because the paper failed to report any methods of using randomization or specified their method. The remaining studies all indicated how they conducted the experiments and were considered as low risk. Five studies were marked as unsure in "Allocation concealment" due to an unclear description on blinding or masking the purpose of the studies to participants or the lack of randomization. The rest of the studies had demonstrated using a randomization and blinded the participants of the actual purpose of the studies. Only one study did not describe any action on assessment of baseline differences. Nine studies were either unclear or had no process of blinding the participants. None of the studies blinded the research personnel. All the studies used appropriate analysis. Three studies provided no information of reporting "missing outcome data". Fifteen studies were able to collect most of the data from the presented sample and the rest of the studies successfully

collected all the data. Seven studies did not use multiple measurements to examine the expected result and represented a “high risk”; Six studies used only less than two measurements and were rated “probably yes” under this domain, which represented “some concerns”; The remaining studies had over three measurements to examine the result, which were rated “yes”, represented a “low risk”. In summary, 28 studies raised some concerns of bias for all domains; 15 studies were judged high risk in at least one domain of the assessment (Figure 12).

Discussion

The present systematic review and meta-analysis evaluated the effect of exposure to food prime on subsequent food intake in all populations. Of the 43 total studies, the 35 positive food prime studies provided 59 groups of data. Of the negative food prime studies 8 of them contributed to 20 groups of data to the meta-analysis. The result of the meta-analysis suggested that exposure to a positive food prime had a medium effect on increasing post-exposure food consumption in the combined population. Males responded positively to the food cues stimulus more substantially than females, which was not consistent with the result of brain activation by food stimulation (Chao et al., 2017; Killgore & Yurgelun-Todd, 2010). Contradictory to Dr. Wang’s study on brain response to food simulation between sex (Wang Gene-Jack et al., 2009), our findings imply that women might have a greater ability to suppress food intake than men after positive food stimulation. Although no significant difference in food intake was observed.

We did not find any effect of negative food primes on reducing subsequent food intake after exposure, which was inconsistent with a previous review on weight-related cues (Buckland et al., 2018). Although our results were not significant for the negative food prime studies, the studies we analyzed show a trend in reducing food intake post-exposure aside from Haire 2014. Restrained and unrestrained eaters, female and male, and children and adults responded similarly to a negative food prime. The food consumption of the unrestrained eaters, female, adult, and children's groups did not decrease as expected after exposure to the negative food prime. Due to the limited number of eligible data, we could not run a meta-analysis under negative food prime with only restrained eaters and the male group. Regardless of the validity, these studies did not show a trend of lowering intake. All the subgroup results were consistent with the overall effect of the negative food prime.

Unexpectedly, our results did not reveal any difference in the analysis between restrained and unrestrained eaters. Restrained eaters were anticipated to be more sensitive to food-related cues and weight-related cues, resulting in overeating after the former and restrained eating after the latter (Polivy & Herman, 2017). The results from related studies in our review were contradictory. In Fedoroff 1997, Hilbert 2007, and Coelho 2008, restrained eaters reported eating more than unrestrained eaters when exposed to food cues. Ferriday 2008 presented opposing results in which higher intake was observed in the unrestrained group after food cue stimulation. One possible reason for our results is the high heterogeneity between all these studies. Under both types of food primes, studies with specified restrained status showed significant differences. The media of presenting

stimulus varied in each study, including TV ads, visual or olfactory stimulus, imagination, memory, and package size. It is possible that different ways of showing food cues may trigger a different response in food intake due to the complex processes in human brains. The analysis of package/portion size confirmed that larger-than-standard package/portion size positively related to higher intake. This result is persistent with previous evidence that large package/portion size was one of the environment factors that led to excessive food intake (Matthiessen et al., 2003; Rolls et al., 2004). A smaller-than-standard package/portion size was unsuccessful in helping to limit food intake as a negative food prime, which was consistent with our result of the meta-analysis.

To our knowledge, this is the first systematic review and meta-analysis evaluating the effect of both positive and negative food primes on food intake after exposure. The results indicate that when primed with food-related cues, subsequent food intake increases. Our findings suggest that goal priming theory is reasonable in explaining food priming but not reliable at all times to apply as the mechanism behind the effect.

The positive food primes present the related environmental cues to stimulate people's craving for food, and then affects their eating behaviors via a passive, automatic effect. However, it is not clear yet to conclude that the goal priming is the exact mechanism behind the priming effect. The food prime did not always influence participants' food intake. Our result of negative food primes makes it difficult to apply this theory. Unlike positive food primes, negative food primes mostly used a cue to remind participants of their weight or health condition and eventually reflected on impacting subsequent food

intake. This indirect relation might have weakened the effectiveness of the negative food primes. Another explanation of our finding of negative food primes might be related to the brain reward system. We mentioned earlier that the behaviors of consuming food could lead to satisfaction with the reward learning process. Our brain may resist the negative food primes because it correlates to reducing pleasure.

Our available data using a negative prime were conducted on restrained or unrestrained status only. Participants with restrained status had stronger weight control goals than unrestrained ones. Our definition of negative food primes primarily includes cues that remind people of their weight control goals, eventually reflect on inhibiting food intake. In the recent review from Buckland, they concluded that only individuals with strong weight control goals had a significant response toward a negative food prime. This observation raises more questions on the goal priming theory: should the primed goal be set by the receivers themselves or by the cue's givers? Why and how would individuals have a bigger response to positive food primes but not to negative food primes? Should the primed goals and expected outcomes be directly related? For future direction, more research is needed to test the goal priming theory in different food priming settings, examine the mechanisms behind the priming effect, evaluate the strength of the impact of food priming on diverse populations, and test the efficacy of using food priming in helping weight management.

Some limitations in our review should be brought out when interpreting our results. First, relatively fewer data groups were available for us to perform multiple subgroup analyses

in negative food primes. It resulted in fewer studies compared to positive food primes in some of the variables (e.g. restrained eaters, child). In one of the subgroup analyses even failed to present a calculation due to insufficient data (e.g. male). Hence, our studies in negative food primes are inconclusive. Secondly, in all our meta-analysis results, heterogeneity is mostly above moderate (50%), which means there is significant variability in each study ($p < 0.01$). It was predictable because we meant to collect studies from different populations to assess the overall impact of food priming on food intake. The diverse age and sex in the sample might contribute to the variability. Nevertheless, it is better to be cautious when interpretate our result. Third, we did not further distinguish the methods of stimulus under positive and negative food primes. The variation of strength from a single method of stimuli might have diminished or amplified the overall effect on food intake. Despite these limitations, several strengths of this review are noteworthy. First, our initial search included a wide range of publication years and covered two electronic databases in public health and psychology. Sufficient studies in this review added more evidence to the existing research on this topic— abundant food cues around us act as one of the factors in stimulating food consumption. The multiple subgroup analysis performed provide data to direct future research.

For future directions, examine the mechanisms behind the positive and negative food primes separately. Based on the result, the dichotomous food primes may use different mechanisms. Successfully identifying the potential rationale will help use it as an intervention in weight management. We suggest isolating stimulus methods in negative food primes to identify any possible significant effect based on our result. Due to the high

variability across studies, we might have combined the effective and in-effective negative food primes, which resulted in algebraic cancellation.

Furthermore, evaluate the strength of the impact of food priming on diverse settings, such as males in positive and negative food primes. Sufficient data from males will allow a comparison between males and females. More studies are needed to conduct with restrained eaters in both males and females. Additionally, future research should separate different BMI to assess if different response exists according to another weight status. Last, distinguish the effect of various stimulus methods in positive food primes.

Conclusion

In conclusion, this systematic review and meta-analysis presented the significant effect of food-related food cues (positive food primes) on increased subsequent food intake in a non-specific population. Yet, the weight-related cues (negative food primes) did not effectively suppress food intake. The limited availability of data may have contributed to this finding. Therefore, further research is needed to examine potential mechanisms behind positive and negative food priming separately and the capability of increasing or suppressing food intake via different stimulus methods in diverse populations.

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Figure and Tables

Table 1 (Summary of All Included Literatures)

Country	Authors	Purpose	Research design	Target population	Cue type	Test Food	Main result (Significance?)	Multiple comparisons
Belgium	Aerts (2019)	Explored possible interaction effects between the suggested portion size and food type.	Between and within-subjects; 2 x 2 x 2 (Portion size x Snack type x order)	Children(mean age 15); Mix gender (61.7% girls)	Image of portion size (Positive)	Grape & Chocolate nuts	Children consumed more when the on-pack stickers suggested a large portion; Children ate significantly more of the healthy snack than the less snack.	(Same stimuli) A: Test food is Grape (healthy snack) B: Chocolate nuts (less healthy snack)

USA	Folkvord (2013)	Examined the effect of advergames that promote energy-dense snacks or fruit on children's ad libitum snack and fruit consumption and to examine whether this consumption differs according to brand and product type.	Between subjects, randomized into four groups, advergame with energy-dense snacks, fruit, nonfood products or control condition	Children (8-10 y); Mix gender	Energy dense snack promotion (Positive)	jelly candy, milk-chocolate candy shells, sliced bananas, and apples	Children who played an advergame that promoted food ate significantly more than nonfood products and control condition; Children who played an advergame promoting energy-dense snacks or fruit ate more energy-dense snack than did the children who	(Exposure to different stimulus) A: Energy dense snack promotion B: Fruit promotion C: Non-food promotion

							played the advergame with nonfood products and control condition.	
Netherlands	Proserpio (2019)	Investigated in a group of obese women the influence of ambient odor exposure, as occurring in a natural contest, on ad libitum food intake and sensory special appetite	Within subjects	Adults; Female; Obese	Bread odor (Positive)	Vegetable soup	Participants ate significant larger amount of soup during the "scented" than during the "unscented" condition.	NA

USA	Chao. (2021)	Examined whether the effects of an experimental paradigm using brief, imagined cue exposure to personal, favorite food or to personal, discrete stressful events separately and differentially increased hunger, anxiety, and food intake compared to neutral cues	Within subjects; Personal imagery scripts of stress, favorite food and neutral-relaxing situation	Adults; Mix gender;	Personalized favorite food imagery scripts (Positive)	high-calorie and low-calorie snack foods (i.e., chips, cookies, popcorn, and pudding or brownies, carrots and grapes)	Neutral stimuli: Did not differ significantly from food and stress stimuli; Males consumed a significantly greater total number calories than females in the food cues, stress and neutral conditions.	NA
Germany	Hilbert (2007)	Investigated food intake and related psychological factors in male restrained and unrestrained	Between subjects; compared between restrained eaters and unrestrained eaters	Adults; Male; Restrained and Unrestrained eaters	Presented with food (Positive)	5 sweet and salty snacks food (e.g., chocolate bars, cookies, chips)	Restrained eaters consumed a larger amount of food than unrestraine	(Same stimuli) A: Unrestrained eaters B: Restrained

		eaters					d eaters.	eaters
UK	Ridley-Siegert (2015)	Investigated whether increased 'wanting', elicited by cues associated with food and whether this increased 'wanting' is specific to cue-associated food or generalizes to all food rewards	Between subjects; Four condition: sweet reward, savory reward, absence of food and no cue condition	Adults; Mix gender;	Visual images of food (Positive)	Chocolate, Potato chips, pretzels, Flapjacks	Participants in the DSchoc condition ate significantly more than those in the DS-, no difference between Dschoc, Dscrisp and No Cue; Males ate significantly more than females.	(Different stimulus) A: Reward with chocolate B: Reward with chips

Canada	Fedoroff (2003)	Whether food cues elicit specific cravings or general desires to eat, and whether such desires are especially elevated in restrained eaters	Between subjects; 3 x 2 x 2 (three cue conditions vs. order of food presented vs. restrained status); randomized control	Adults; Female;	No cue vs. pizza cue vs. cookie cues (Positive)	Cookies, Pizza	Participants had a greater intake in the cued conditions than the no-cues condition; Pizza intake was greater than cookie intake; Restrained eaters ate significantly more in both cue conditions than unrestrained eaters;	(Same stimuli) A: Tasted cookies, Unrestrained eaters B: Tasted Pizza, Unrestrained eaters

Australia	Kemps (2016)	Investigated the role of expectations in the effect of pre-exposure on food intake	2 x 2 x 2 between subjects, randomly assigned (expected food)x (food tasted) x (restrained vs. unrestrained)	Adults; Female;	Expectation of food (thinking about given food) (Positive)	Cookies, Grapes	Participants ate more calories from cookies than from grapes; When participants expected to taste grapes, no difference was found in consumption between restrained or unrestrained eaters; When participants expected to taste cookies, restrained eaters ate significantly less	(Different stimulus) A: taste food match expected food, unrestrained eaters B: taste food match expected food, restrained eater C: taste food match expected food, unrestrained eaters D: taste food match expected food, restrained eaters

							than did unrestrained eaters.	
Netherlands	Folkvord (2015)	Examined the moderating role of attentional bias in the effect of food advertising on actual food intake among children	2x2 between-subject design (type of advergame) x (attentional bias)	Children (mean age: 8.5 y); Mix gender (56% girls)	Advergame with energy-dense food vs. non-food products (Positive)	Jelly cola-cola bottles and milk chocolate candy shells	Children who played the advergame promoting energy-dense snacks ate significantly more than children who played the advergame promoting nonfood products.	NA

France	Rigal (2019)	Examined the "partition effect" during childhood in interaction with some children's motivational appetite features, with the hypothesis that the effect of partition.	2 x 2 mixed design, within subject (Bar vs. Pieces) and between subject (lower vs. higher level) of motivational factors	Children(8 -10 y); Mix gender (58.8%)	2 snack session in two different day with same amount of snack present but in bar or pieces. (Positive)	Chocolate, brioche bread and apple juice	chocolate intake had no difference in either bar or pieces conditions;	NA
Belgium	Aerts (2017)	Examined the effect of package size on children's food intake	2 x 2 between-subject design (larger vs. regular) x (sugared vs. salted);	Children(6 -7 y); Mix gender	4 types of popcorn cup were randomly distributed into 4 different classroom; within the same classroom, children received the same type. (Positive)	salted pr sugared popcorn	Children ate more from the large cup than from the regular cup; ate less with salted popcorn compared to sugared popcorn; Package size did affect consumpti on when	(Same stimulus) A: Sweet popcorn as test food B: Salted popcorn as test food

							children had sugared popcorn (interaction significant).	
USA	Haire (2014)	Examined whether weight and restrained status influence the relationship between package size and consumption	2 x 2 x 2 between-subjects (unrestrained/restrained vs. normal/overweight vs. single-serving/standard serving package size);	Adults; Mix gender (46.9% female);	Single serving package size group vs. Standard package size. (Positive)	Pretzels	ow/ob in SSP ate significantly fewer grams of pretzels than ow/ob in STP condition; ow/ob in STP ate significantly more than normal weight participants.	(Same stimulus) A: unrestrained eaters with normal weight B: unrestrained eaters with overweight and obese C: restrained eaters with normal weight D: restrained

								eaters with overweigh t and obese
Canada	Koh (2009)	Examined the effects of three social/environ mental variables (degree of acquaintance, plate size, and sharing) on eating behaviors.	2x2x2 between-subjects design.	Adults; Female;	Large vs. Small plate (control) (Positive)	Fire-Roasted Tomato Sauce	Participant s ate less in the sharing condition.	NA
USA	Rosenthal (2017)	Investigated the independent and interactive effects of television watching and portion size on consumption during a meal	4 x 2 x 2, between subjects	Adults; Mix gender (85% female);	Small vs. large portion size. (Positive)	Stouffers macaroni and cheese + salad with dressing (light ranch and light Caesar, both same nutrient content)	Participant s had greater consumpti on occurring when received a larger portion size	NA

							compared to smaller portion size.	
Iran	Vakili (2019)	Evaluated the effect of the size of plate, spoon, and fork on food and energy intake during a meal in ob/ow staff	Within-subject design; Randomized controlled trial	Adults; Mix gender (72.5% female);	large vs small utensils, reverse condition in second intervention. (Positive)	Lunch package (Rice, chicken kebab, vegetable salad, dairy drink, soda)	Only rice consumption was greater in large utensils compared to small utensils.	NA
UK	Ogden (2021)	Explored the impact of attention to food cues through either active or passive food preparation, versus attention away from food cues through a non-food distraction task on eating behavior	Between and within-subjects; Randomly allocated	Adults; Female;	Food preparation vs. Video preparation vs. non-food distraction vs. No distraction (Positive)	Cookies, M&M chocolate, hula hoops and mini cheddars	No main effect of intervention on food intake in the taste test measured in terms of both mass and calories consumed.	(Different stimulus) A: Participants prepared the wrap B: Participants watched the video of preparing the wrap

Canada	Fedoroff (1997)	Investigated the effect of pre-exposure to two types of food cues on food intake by restrained and unrestrained eaters	Between subjects; 2 x 4 study	Adults; Female;	Olfactory food cue vs. no cue x cognitive cue x restrained status (Positive)	Pizza	Intake was greater if participants could smell pizza or spent time thinking about pizza; restrained eaters ate significantly more than unrestrained eaters in the smell condition; Intake was significantly lower in the no cue condition compared to the cued conditions.	(Different stimulus) A: No smell, pizza thoughts, unrestrained B: No smell, pizza thoughts, restrained C: Smell, free thoughts, unrestrained D: Smell, free thoughts, restrained E: Smell, pizza thoughts, unrestrained F: Smell, pizza thoughts, restrained

Netherlands	Folkvord (2019)	Examined if priming children with images of diverse vegetables by means of a memory game increased subsequent vegetable intake	Between-subjects; Randomly allocated	Children(7-12 y); Mix gender (58% girls)	Vegetable memory-game vs. Non-food memory-game (Positive)	Carrots	No significant main effect of type of memory game on vegetable intake; Children who played the vegetable memory-game eating on average slightly less vegetables than children who played the non-food memory game.	NA

Lebanon	Gilbert-Diamond (2017)	Tested the effect of food ad exposure on cued eating among children enrolled in a randomized trial and further explored whether a common variant in FTO modified that effect	Between-subjects; Randomly allocated	Children(9-10 y); Mix gender (60% girls)	Food advertisements vs. Toy advertisements (Positive)	gummy candy, cookies, chocolate, and cheese puffs	A statistically significant main effect of the food vs. toy ad exposure on the consumption of the food advertised during the session; Children exposed to food ads consumed more calories of gummy candy than children exposed to toy ads.	NA

USA	Anschutz (2009)	Tested the direct effects of exposure to food commercials on no advertised sweet snack food intake in children while watching television	Between-subjects; Randomly allocated	Children(8-12 y); Mix gender (53.3% girls)	Food commercials vs. Neutral commercials (Positive)	Chocolate-coated peanuts	No main effect of commercial condition on food intake. A significant interaction was observed between condition and sex; Boys ate more in food commercial condition than neutral commercial condition; Girls ate less in food commercial condition than in neutral condition.	NA

Germany	Koenigstorfer (2020)	Investigated the influence of incidental fitness cues on caloric food intake in restrained vs. unrestrained eaters	Between subjects; 2 x 2 (fitness vs. control prime) x (high vs. low restraint)	Adults; Mix gender; (51.5% Female)	Fitness words vs.. Neutral words (Negative)	chips, yogurt and granola mix	The main effects of priming was not significant; Male participants consumed more potato chips than females; Participants high in dietary restraint consumed significantly less when fitness prime presented; unrestrained eaters did not respond to the priming manipulati	(Same stimulus) A: Study 1 of the articles B: Study 2 of the articles

							on;	
UK	Buckland (2014)	Examined the effect of exposure to subtle diet-congruent images on food intake in current dieters and non-dieters, and examined the effect on the four restrained and disinhibited subtypes as identified on the TFEQ	Between subjects; 2 x 2 (diet-congruent food vs. non-food images) x (dieter vs. not dieting); Randomly allocated	Adults; Female;	Diet-congruent food images x Neutral non-food images (Negative)	Bowls of high or low fat, sweet or savory food	No main effects of condition, restraint, or disinhibition on energy intake.	NA

USA	Fearnbach (2016)	Determined the effect of an acute bout of exercise on the neural P3b response to food cues, and on subsequent appetite feelings and ad libitum energy intake in obese adolescent boys	Within-subjects crossover design	Children (12-15 y); Male	Exercise x Control condition. (Negative)	Buffet (serving food did not specified)	The absolute energy ingested during the ad libitum lunch meal was significantly lower during exercise condition compared with control condition	NA
Switzerland	Brunner (2012)	Investigated the influence of weight-related cues on food intake	Between-subjects;	Adults; Mix gender (70% Female in study 1, 69% Female in study 2);	1. Extremely thin sculptures vs. Control condition 2. Questionaries about weight before taste test vs. No	Chocolate (not specified; assumed Hershey's Milk Chocolate)	Both Study 1 and 2: Participants in the control condition consumed more than did the participants in the experimental	(Different stimulus) A: Study 1 Thin sculptures as stimuli B: Study 2 Weight Questionnaire as stimuli

					questionnaire before taste test (Negative)		condition.	
UK	Buckland (2013)	Examined the moderating role of attentional bias in the effect of food advertising on actual food intake among children	Within-subject; 2 x 2 (diet vs. tempting) x (restrained vs. unrestrained)	Adults; Female;	Diet-congruent condition (exposure to fresh orange) vs. Diet-incongruent condition (Terry's chocolate orange) (Positive)	Fresh orange, chocolate and cereal bars	Total energy intake of snack foods did not differ between conditions; Total energy intake of unrestrained non-dieters did not differ between conditions; Restrained dieters consumed fewer total calories in the diet condition	NA

							compared to the tempting condition.	
USA	Bates (2015)	Examined if the presence of a take-out container given at the beginning of a meal would reduce serving size consumption	Between-subjects; Randomly allocated	Adults; Mix gender; (68% Female)	Placement of a take-out container vs. No container (Negative)	Vegetable lasagna	Participants that were given the take-out container with their meal consumer significant less than those did not have a take-out container; Significant difference of energy intake was observed between male and	NA

							female in the control condition; Men consumed less on average in the experimental group than the control group.	
Birmingham	Higgs (2002)	Determined whether explicit recall of a recent eating episode has an inhibitory effect on short-term intake in a non-patient unrestrained population	Between-subjects; Randomly allocated	Adults; Female;	1. Lunch cue vs. No cue 2. Lunch today vs. Lunch yesterday vs. No cue (Negative)	Cookies	Participants in the "lunch cue" ate significantly less cookies compared with the "no cue" condition; Participants in the "lunch today" condition ate significant	(Different stimulus) A: Study 1 (Lunch cue vs. No cue) B: Study 2 (Lunch today cue vs. Lunch yesterday cue vs. No cue)

							ly less than the participants in both the "no cue" and "lunch yesterday" condition.	
Australia	Monro (2006)	Examined the effects of media-portrayed idealized images on young women's eating behavior.	Between-subjects; Randomly allocated; 2 x 2 (Present vs. Absent cue) x (High vs. Low self-objectification)	Adults; Female;	Presented with idealized body vs. Absent condition (Negative)	Sweet and savory biscuits	In the body present condition, as self-objectification increases so does the total amount of food consumed; In the body absent condition, as self-objectification level increases, the total	NA

							amount of food consumed decreases; As the self-objectification increases, the amount of sweet food decrease.	
Netherlands	Anschutz (2010)	Tested the effects of adult targeted food commercials on actual snack food intake in young children while watching television	Between-subjects; 3 x 2 (Energy dense food vs. Low energy food Neutral commercial) x (maternal encouragement to be thin vs. No maternal encouragement to be thin)	Children (8-12 y); Mix gender	Energy dense food commercials vs. Low energy food commercials vs. Neutral Commercials (Positive)	Chocolate-coated peanuts	Food intake decreased with age and increased with higher ratings of hunger and liking of the test food; Children who perceived maternal encourage	(Same stimulus) A: Energy dense food commercials with no maternal encouragement B: Low energy food commercials with no maternal encouragement C: Energy

							ment to be thin ate slightly more when exposed to energy-dense food commercials and especially when exposed to light food commercials than when exposed to neutral commercials.	dense food commercials with maternal encouragement D: Low energy food commercials with maternal encouragement
France	Bellisle (2009)	Examined how dietary restraint, which in one of our earlier works was shown to modulate the response to environmental	Within-subjects;	Adults; Female;	TV ads with food vs. TV ads without food ads (Positive)	Hachis parmentier and fruit sherbets	No significant group effect or difference were found between conditions.	(Same stimulus) A: Low restrained participants B: High restrained participants

		stimuli, interacts with various psychological and external factors known to affect meal size						
USA	Honselman (2011)	Determined if serving in-shell pistachios, compared to shelled pistachios, resulted in individuals consuming fewer calories.	Within-subjects;	Adults; Mix gender (66% female);	In Shell pistachios vs. Shelled pistachios (Positive)	Pistachios	Subjects in in shell pistachios condition consumed 41% fewer calories compared to subjects in shelled pistachios.	NA
Netherlands	Folkvord (2014)	Examined the role of impulsivity in the effect of food advertisements.	Between-subject; Randomly assigned; 2 x 2 x 2 (energy-dense snacks vs. nonfood products) x (impulsivity high vs. low)	Children (grades 2-3); Mix gender (49.8% girls)	Energy-dense snacks advergame x Nonfood advergame (Positive)	Jelly candy, milk-chocolate candy shells	Children who played an advergame promoting energy-dense snacks ate significantly more	(Same stimulus) A: Low impulsivity participants B: High impulsivity

							than children who played an advergame promoting nonfood products; No effect was found for impulsivity.	participants
Italy	Proserpio (2017)	Investigated the effect of ambient odor exposure on appetite, salivation and food intake	Within-subjects;	Adults; Female;	Ambient odor conditions (beef, chocolate, melon, cucumber) vs. No odor (Positive)	Chocolate rice	Intake was significantly higher after chocolate odor exposure compared to no odor exposure and to melon; Similarly to beef odor condition, intake under this	NA

							condition was significantly higher than during melon exposure.	
Netherlands	Larsen (2012)	Tested whether the effect of olfactory food-cue exposure on young women's food intake was moderated by the duration of the cue exposure and trait impulsivity.	Between-subjects; 2 x 2 (smell vs. no smell) x (short-term vs. long-term)	Adults; Female;	Smell of cookies present vs. No smell present (Positive)	Home-made complete Mix food American Cookies	Neither olfactory cue exposure nor duration of the exposure had a main effect on participants' food intake; Only the participants with low impulsivity scores were significantly influenced by the cue	(Same stimulus) A: Short term exposure B: Long term exposure

							exposure conditions, and ate more when confronted with the odor of baked cookies.	
Finland	Hoppu (2020)	Evaluated the effect of a multisensory eating environment on food choice, intake, and the emotional states of the subjects in a salad lunch buffet setting.	Within-subjects; Randomized	Adults; Female;	Multisensory condition (included orange scent) vs. Control condition (Positive)	Buffet Foods (14 food items)	No significant differences between the control and multisensory conditions on food intake.	NA
UK	Collins (2015)	Tested whether positive mood will reduce the inhibitory effects of memory (lunch cue) on	Between-subjects; 2 x 2 (positive vs. neutral mood) x (lunch cue vs. no cue); Randomly allocated	Adults; Female; (unrestrained)	Lunch cue vs. No cue (Positive)	Custard creams, double chocolate-chip cookies, McVitie's Mini Cheddars	More food was consumed in the positive mood versus neutral	(Same stimulus) A: With positive mood B: With neutral mood

		food consumption					mood condition plus more consumed in the no lunch cue compared to lunch cue condition.	
UK	Halford (2004)	Assessed if children attended to and recognized food advertisements on television more often than advertisements not for foods	Within-subjects	Children (9-11 y); Mix gender (57% girls)	Food-related advertisement vs. Nonfood advertisements (Positive)	Ryvita wholegrain crackers, Haribo Jelly sweets, Chocolate, Butter puffs	The obese and overweight groups ate significantly more than the healthy-weight group both with food ads and non-food ads.	NA

USA	Stein (2016)	Investigated the role of environmental cues associated with exercise that may influence eating through psychological mechanisms such as priming.	Between-subjects; Randomized, 2x2 (priming and self-control)	Adults; Mix gender (65.5% female);	Priming (exercise posters) vs. No-priming condition (Negative)	Cape Cod Potato chips, Mars chocolate M&Ms, Nabisco Oreo Sandwich cookies	No significant main effect was found between priming or self-control conditions when individual difference variables were ignored.	(Same stimulus) A: Self-control placebo. B: Self-control fatigue

USA	Coelho (2009)	Tested whether different types of food-cue exposure lead to differential effects on food intake, particularly in weight-concerned individuals	Between and within-subjects; Randomly allocated	Adults; Female;	Attended food cue vs. Incidental food cue vs. Control (Positive)	M&M's, Kitkat pieces, potato chips, coated peanuts	Individuals with high weight-related concerns who were in the attended-cue condition ate significantly more than did those in the control condition; Individuals with low weight-related concerns who were in the attended-cue condition and tended to eat more than did those	(Same stimulus) A: Incidental cue with low weight related concerned B: Attended cue with low weight related concerned C: Incidental cue with high weight related concerned D: Attended cue with high weight related concerned

							with high weight-related concerns who were in the incidental-cue condition and those with low weight-related concerns who were in the control condition.	
USA	Harris (2009)	Tested the hypothesis that exposure to food advertising during television viewing may also contribute to obesity by triggering automatic snacking of	Between-subjects; Randomly allocated	Children(7-11 y); Mix gender (47.7% girls)	Food advertising vs. Non-food advertising (Positive)	Goldfish crackers	Children who saw the cartoon with food advertising ate considerably more goldfish crackers than did children	(Same stimulus) A: Male B: Female

		available food.					who saw non-food advertising .	
Canada	Coelho (2008)	Investigated the effects of food-cue exposure on restrained and unrestrained eaters.	Between-subjects; Randomly allocated; 2 x 2 (restraint vs. unrestraint) x (food-cue vs. food-cue absent)	Adults; Female;	Food-cue condition vs. No-food-cue condition (Positive)	Chocolate Chip Cookie	Restrained eaters in the cue condition ate smaller amount of chocolate-chip cookies than did restrained eaters in the no-cue condition; Unrestrained eaters in the cue condition did not differ significantly from unrestrained eaters in	NA

							the no-cue condition.	
UK	Ferriday (2008)	Explored the process by which cue exposure promotes greater consumption of food	Within subjects;	Adults; Female;	Cue condition vs. No cue condition (Positive)	Pizza	Participants consumed significantly more pizza in the cue condition than in the no-cue condition; Unrestrained eaters ate significantly more pizza than restrained eaters, both in the cue and no-cue	NA

							condition.	
Netherlands	Jansen (2008)	Tested whether the typically disinhibiting cues food exposure and negative mood induction, elicit overeating in the overweight/obese subtype that is high in negative affect.	Between subjects;	Adults; Female;	Food exposure vs. No-food exposure (Positive)	Chocolate, cookies, chocolate drink, vanilla drink	The obese high in negative affect consumed more in the cue conditions compared to the control condition; Low negative affect obese consumed less in the cue conditions compared to the control	(Same stimulus) A: High negative effect B: Low negative effect

							condition; Obese subtype ate significantly more in a cue condition compared to the neutral condition.	

Figure 1 (Systematic review flowchart)

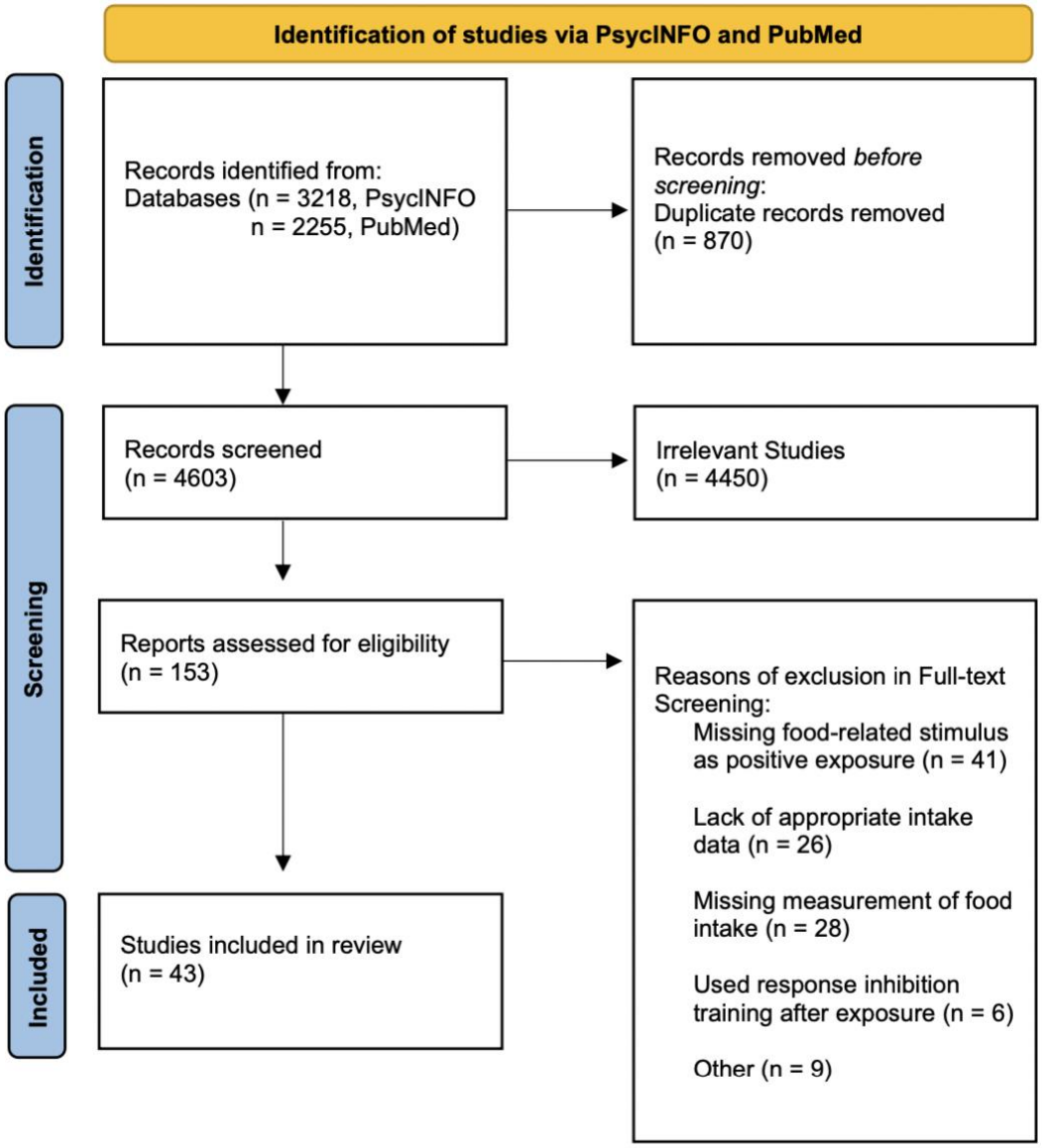


Figure 2 (All Positive Food Primes)

Author and Year	Prime Total	Prime Mean	Prime SD	Control Total	Control Mean	Control SD	SMD	95%–CI	Weight (common)	Weight (random)
Jansen 2008 (B)	27	364.0	187.0	27	489.0	235.0	−0.58	[−1.13; −0.03]	1.3%	1.8%
Coelho 2008	26	251.6	166.2	24	343.7	169.2	−0.54	[−1.11; 0.02]	1.2%	1.7%
Kemps 2016(D)	14	129.0	96.5	13	175.5	81.6	−0.50	[−1.27; 0.27]	0.7%	1.6%
Anschutz 2010(A)	60	151.4	280.7	60	263.8	251.8	−0.42	[−0.78; −0.06]	3.1%	1.8%
Folkvord 2019	47	14.5	11.1	53	18.3	12.8	−0.31	[−0.71; 0.08]	2.6%	1.8%
Kemps 2016(A)	12	146.7	81.3	12	174.3	99.9	−0.29	[−1.10; 0.51]	0.6%	1.6%
Koh 2009	36	999.2	218.4	24	1068.5	301.5	−0.27	[−0.79; 0.25]	1.5%	1.8%
Ogden 2021(B)	20	179.6	95.5	21	210.0	132.8	−0.26	[−0.87; 0.36]	1.1%	1.7%
Fedoroff 2003 (A)	11	227.2	114.0	12	250.0	114.0	−0.19	[−1.01; 0.63]	0.6%	1.6%
Coelho 2009(B)	13	203.8	123.9	16	222.7	89.6	−0.17	[−0.91; 0.56]	0.7%	1.6%
Hoppu 2020	30	15.5	12.7	30	17.9	14.1	−0.17	[−0.68; 0.33]	1.6%	1.8%
Chao 2020	138	479.9	28.9	138	484.3	28.9	−0.15	[−0.39; 0.08]	7.2%	1.9%
Bellisle 2009(B)	20	596.3	149.6	20	612.8	158.2	−0.10	[−0.73; 0.52]	1.0%	1.7%
Bellisle 2009(A)	20	645.3	167.8	20	657.0	203.1	−0.06	[−0.68; 0.56]	1.0%	1.7%
Aerts 2019(B)	47	198.5	124.3	47	198.1	85.2	0.00	[−0.40; 0.41]	2.4%	1.8%
Folkvord 2013(C)	65	128.9	593.6	69	121.7	705.0	0.01	[−0.33; 0.35]	3.5%	1.8%
Anschutz 2009	63	173.8	303.8	57	165.2	377.9	0.02	[−0.33; 0.38]	3.1%	1.8%
Vakili 2019	40	783.7	249.7	40	775.1	249.6	0.03	[−0.40; 0.47]	2.1%	1.8%
Larsen 2012(B)	30	167.0	55.4	24	163.3	80.9	0.05	[−0.48; 0.59]	1.4%	1.8%
Gilbert–Diamond 2017	86	491.5	280.0	86	472.2	268.7	0.07	[−0.23; 0.37]	4.5%	1.9%
Folkvord 2013(B)	67	184.1	725.0	69	121.7	705.0	0.09	[−0.25; 0.42]	3.5%	1.8%
Folkvord 2013(A)	69	197.2	728.3	69	121.7	705.0	0.10	[−0.23; 0.44]	3.6%	1.8%
Ferriday 2008	50	434.0	540.0	50	370.3	540.0	0.12	[−0.28; 0.51]	2.6%	1.8%
Buckland 2013	34	326.7	201.8	34	300.5	219.2	0.12	[−0.35; 0.60]	1.8%	1.8%
Larsen 2012(A)	28	162.0	89.8	27	142.7	78.9	0.23	[−0.31; 0.76]	1.4%	1.8%
Anschutz 2010(C)	60	170.0	239.5	60	113.5	251.8	0.23	[−0.13; 0.59]	3.1%	1.8%
Anschutz 2010(B)	60	174.3	256.0	60	113.5	251.8	0.24	[−0.12; 0.60]	3.1%	1.8%
Harris 2009 (B)	51	120.9	96.6	51	96.1	106.6	0.24	[−0.15; 0.63]	2.6%	1.8%
Ogden 2021(A)	18	244.1	139.4	21	210.0	132.8	0.25	[−0.39; 0.88]	1.0%	1.7%
Folkvord 2014(B)	31	104.6	18.1	23	99.4	21.4	0.26	[−0.28; 0.80]	1.4%	1.8%
Proserpio 2019	30	107.3	82.8	30	84.8	82.9	0.27	[−0.24; 0.78]	1.5%	1.8%
Proserpio 2017	32	324.5	171.8	32	275.2	187.6	0.27	[−0.22; 0.76]	1.6%	1.8%
Kemps 2016(B)	10	116.2	81.6	10	93.5	69.0	0.29	[−0.59; 1.17]	0.5%	1.6%
Aerts 2019(A)	47	71.4	36.9	47	60.8	36.8	0.29	[−0.12; 0.69]	2.4%	1.8%
Coelho 2009(C)	12	233.0	98.5	8	195.7	115.8	0.34	[−0.56; 1.24]	0.5%	1.5%
Fedoroff 2003 (B)	19	274.7	86.9	10	234.1	108.6	0.42	[−0.36; 1.19]	0.7%	1.6%
Fedoroff 1997 (E)	15	287.3	99.6	14	246.9	73.6	0.45	[−0.29; 1.18]	0.7%	1.6%
Folkvord 2015	50	178.0	99.5	42	132.9	87.0	0.48	[0.06; 0.89]	2.3%	1.8%
Halford 2004	42	488.1	142.5	42	419.5	126.3	0.50	[0.07; 0.94]	2.1%	1.8%
Harris 2009 (A)	58	142.3	106.6	58	88.7	92.4	0.53	[0.16; 0.90]	2.9%	1.8%
Coelho 2009(A)	12	297.6	162.6	16	222.7	89.6	0.58	[−0.19; 1.34]	0.7%	1.6%
Anschutz 2010(D)	60	272.9	243.6	60	113.5	251.8	0.64	[0.27; 1.01]	3.0%	1.8%
Rosenthal 2017	20	903.9	270.4	20	734.6	187.1	0.71	[0.07; 1.35]	1.0%	1.7%
Jansen 2008 (A)	26	485.0	202.0	26	341.0	125.0	0.84	[0.28; 1.41]	1.2%	1.7%
Honselman 2011	140	210.8	119.8	140	125.2	75.1	0.85	[0.61; 1.10]	6.7%	1.9%
Fedoroff 1997 (A)	10	334.1	117.4	14	246.9	73.6	0.89	[0.04; 1.75]	0.5%	1.6%
Fedoroff 1997 (B)	11	363.9	176.9	10	222.0	69.9	0.99	[0.08; 1.91]	0.5%	1.5%
Coelho 2009(D)	8	335.0	145.6	8	195.7	115.8	1.00	[−0.06; 2.06]	0.4%	1.4%
Fedoroff 1997 (C)	10	351.0	114.4	14	246.9	72.6	1.09	[0.21; 1.97]	0.5%	1.6%
Fedoroff 1997(D)	11	386.6	162.7	10	212.0	69.9	1.32	[0.35; 2.28]	0.4%	1.5%
Kemps 2016(C)	8	238.0	66.6	9	134.0	81.6	1.32	[0.24; 2.39]	0.3%	1.4%
Aerts 2017(B)	15	167.1	46.8	28	93.7	39.5	1.71	[0.98; 2.44]	0.7%	1.6%
Hilbert 2007(B)	24	349.9	191.7	23	99.4	21.4	1.79	[1.10; 2.47]	0.9%	1.7%
Hilbert 2007(A)	21	522.6	332.5	23	99.4	21.4	1.81	[1.10; 2.52]	0.8%	1.7%
Ridley–Siegert 2015(B)	11	554.6	53.5	15	424.1	50.4	2.44	[1.38; 3.50]	0.4%	1.4%
Fedoroff 1997 (F)	10	453.5	112.3	10	212.0	69.9	2.47	[1.25; 3.69]	0.3%	1.3%
Aerts 2017(A)	26	232.8	50.5	26	111.9	30.9	2.85	[2.06; 3.63]	0.6%	1.6%
Ridley–Siegert 2015(A)	12	657.9	51.1	15	424.1	50.4	4.47	[2.98; 5.96]	0.2%	1.2%
Folkvord 2014(A)	37	203.0	16.4	40	101.9	15.9	6.20	[5.10; 7.30]	0.3%	1.4%
Common effect model	**2060**			**2057**			**0.28**	**[0.21; 0.34]**	**100.0%**	**—**
Overall effect							**0.54**	**[0.28; 0.80]**	**—**	**100.0%**

Heterogeneity: $I^2 = 86\%$, $\tau^2 = 0.9152$, $\chi^2_{58} = 402.99$ ($p < 0.001$)
Test for overall effect (random effects): $z = 4.09$ ($p < 0.001$)

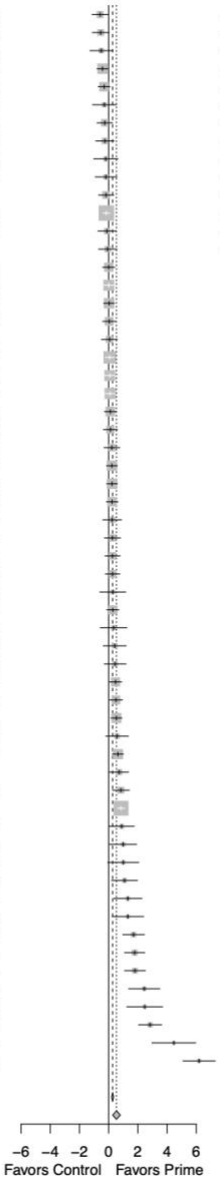


Figure 3 (All Negative Food Primes)

Author and Year	Prime Total	Prime Mean	Prime SD	Control Total	Control Mean	Control SD	SMD	95%–CI	Weight (common)	Weight (random)
Collins 2015 (A)	15	256.1	10.6	14	378.7	11.0	−11.07	[−14.21; −7.93]	0.1%	3.5%
Collins 2015 (B)	17	224.3	9.9	16	303.6	10.2	−7.67	[−9.75; −5.59]	0.3%	4.3%
Bates 2015	25	335.0	142.7	25	455.6	117.7	−0.91	[−1.49; −0.32]	4.2%	5.2%
Higgs 2002 (B)	8	111.3	37.7	9	201.0	128.0	−0.88	[−1.89; 0.13]	1.4%	5.0%
Higgs 2002 (A)	10	251.6	77.1	10	319.2	81.5	−0.82	[−1.74; 0.10]	1.7%	5.0%
Haire 2014(D)	8	498.0	477.7	8	719.3	458.1	−0.45	[−1.44; 0.55]	1.5%	5.0%
Brunner 2012 (B)	38	36.9	23.4	40	49.8	33.6	−0.44	[−0.89; 0.01]	7.1%	5.2%
Brunner 2012 (A)	47	38.7	24.4	48	52.8	38.5	−0.43	[−0.84; −0.03]	8.7%	5.2%
Fearnbach 2016	15	1037.0	260.0	15	1116.0	243.0	−0.31	[−1.03; 0.41]	2.8%	5.1%
Stein 2016 (A)	20	180.3	146.4	22	221.2	145.8	−0.28	[−0.88; 0.33]	3.9%	5.2%
Buckland 2014	35	299.8	137.8	32	333.2	117.7	−0.26	[−0.74; 0.22]	6.2%	5.2%
Stein 2016 (B)	21	175.3	99.3	21	202.5	116.4	−0.25	[−0.85; 0.36]	3.9%	5.2%
Koh 2009	25	922.8	345.6	32	993.8	350.7	−0.20	[−0.73; 0.32]	5.2%	5.2%
Haire 2014(C)	8	382.6	207.9	8	424.4	201.7	−0.19	[−1.18; 0.79]	1.5%	5.0%
Koenigstorfer 2020 (A)	65	72.6	116.0	67	91.6	101.9	−0.17	[−0.52; 0.17]	12.3%	5.2%
Monro 2006	34	220.3	141.2	34	245.0	172.5	−0.15	[−0.63; 0.32]	6.3%	5.2%
Rigal 2019	80	249.0	150.4	80	255.9	158.7	−0.04	[−0.35; 0.27]	15.0%	5.2%
Koenigstorfer 2020 (B)	81	157.9	108.5	85	143.1	129.9	0.12	[−0.18; 0.43]	15.5%	5.2%
Haire 2014 (A)	8	745.2	468.5	8	451.4	236.1	0.75	[−0.28; 1.77]	1.4%	5.0%
Haire 2014(B)	8	792.9	264.6	8	293.8	229.4	1.91	[0.67; 3.14]	0.9%	4.9%
	.	.	.	.	.	.			0.0%	0.0%
Common effect model	**568**			**582**			**−0.23**	**[−0.35; −0.11]**	**100.0%**	**—**
Overall effect							**−0.87**	**[−1.88; 0.13]**	**—**	**100.0%**

Heterogeneity: $I^2 = 85\%$, $\tau^2 = 5.0397$, $\chi^2_{19} = 127.05$ ($p < 0.001$)
Test for overall effect (random effects): $z = -1.70$ ($p = 0.09$)

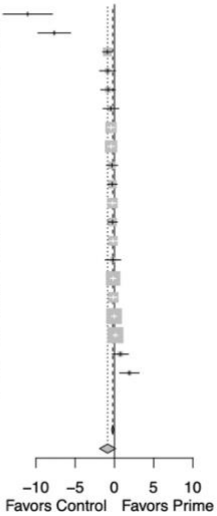


Figure 4 (Restrained Status x Positive Food Primes)

Author and Year	Prime Total	Prime Mean	Prime SD	Control Total	Control Mean	Control SD	SMD	95%–CI	Weight (common)	Weight (random)
Restrained Eaters = FALSE										
Kemps 2016(A)	12	146.7	81.3	12	174.3	99.9	−0.29	[−1.10; 0.51]	3.8%	4.5%
Fedoroff 2003 (A)	11	227.2	114.0	12	250.0	114.0	−0.19	[−1.01; 0.63]	3.7%	4.5%
Coelho 2009(B)	13	203.8	123.9	16	222.7	89.6	−0.17	[−0.91; 0.56]	4.6%	4.8%
Bellisle 2009(A)	20	645.3	167.8	20	657.0	203.1	−0.06	[−0.68; 0.56]	6.4%	5.1%
Fedoroff 2003 (B)	19	274.7	86.9	10	234.1	108.6	0.42	[−0.36; 1.19]	4.1%	4.6%
Fedoroff 1997 (E)	15	287.3	99.6	14	246.9	73.6	0.45	[−0.29; 1.18]	4.5%	4.8%
Coelho 2009(A)	12	297.6	162.6	16	222.7	89.6	0.58	[−0.19; 1.34]	4.2%	4.7%
Fedoroff 1997 (A)	10	334.1	117.4	14	246.9	73.6	0.89	[0.04; 1.75]	3.4%	4.4%
Fedoroff 1997 (C)	10	351.0	114.4	14	246.9	72.6	1.09	[0.21; 1.97]	3.2%	4.3%
Kemps 2016(C)	8	238.0	66.6	9	134.0	81.6	1.32	[0.24; 2.39]	2.1%	3.8%
Hilbert 2007(A)	21	522.6	332.5	23	99.4	21.4	1.81	[1.10; 2.52]	4.9%	4.8%
Common effect model	151			160			0.47	[0.24; 0.71]	44.8%	—
Overall effect							0.51	[0.10; 0.92]	—	50.3%
Heterogeneity: $I^2 = 67\%$, $\tau^2 = 0.3194$, $\chi^2_{10} = 30.66$ ($p < 0.001$)										
Restrained Eaters = TRUE										
Coelho 2008	26	251.6	166.2	24	343.7	169.2	−0.54	[−1.11; 0.02]	7.7%	5.3%
Kemps 2016(D)	14	129.0	96.5	13	175.5	81.6	−0.50	[−1.27; 0.27]	4.2%	4.7%
Bellisle 2009(B)	20	596.3	149.6	20	612.8	158.2	−0.10	[−0.73; 0.52]	6.4%	5.1%
Ferriday 2008	50	434.0	540.0	50	370.3	540.0	0.12	[−0.28; 0.51]	16.0%	5.7%
Kemps 2016(B)	10	116.2	81.6	10	93.5	69.0	0.29	[−0.59; 1.17]	3.2%	4.3%
Coelho 2009(C)	12	233.0	98.5	8	195.7	115.8	0.34	[−0.56; 1.24]	3.0%	4.3%
Fedoroff 1997 (B)	11	363.9	176.9	10	222.0	69.9	0.99	[0.08; 1.91]	2.9%	4.2%
Coelho 2009(D)	8	335.0	145.6	8	195.7	115.8	1.00	[−0.06; 2.06]	2.2%	3.8%
Fedoroff 1997(D)	11	386.6	162.7	10	212.0	69.9	1.32	[0.35; 2.28]	2.7%	4.1%
Hilbert 2007(B)	24	349.9	191.7	23	99.4	21.4	1.79	[1.10; 2.47]	5.3%	4.9%
Fedoroff 1997 (F)	10	453.5	112.3	10	212.0	69.9	2.47	[1.25; 3.69]	1.7%	3.4%
Common effect model	196			186			0.34	[0.13; 0.56]	55.2%	—
Overall effect							0.59	[0.04; 1.13]	—	49.7%
Heterogeneity: $I^2 = 81\%$, $\tau^2 = 0.6801$, $\chi^2_{10} = 53.44$ ($p < 0.001$)										
Common effect model	**347**			**346**			**0.40**	**[0.25; 0.56]**	**100.0%**	**—**
Overall effect							**0.54**	**[0.21; 0.87]**	**—**	**100.0%**

Heterogeneity: $I^2 = 75\%$, $\tau^2 = 0.4587$, $\chi^2_{21} = 84.75$ ($p < 0.001$)
Test for overall effect (random effects): $z = 3.19$ ($p = 0.001$)
Test for subgroup differences (fixed effect): $\chi^2_1 = 0.65$, df = 1 ($p = 0.42$)
Test for subgroup differences (random effects): $\chi^2_1 = 0.05$, df = 1 ($p = 0.82$)

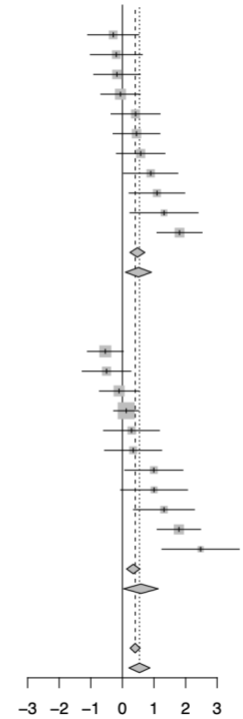


Figure 5 (Restrained Status x Negative Food Primes)

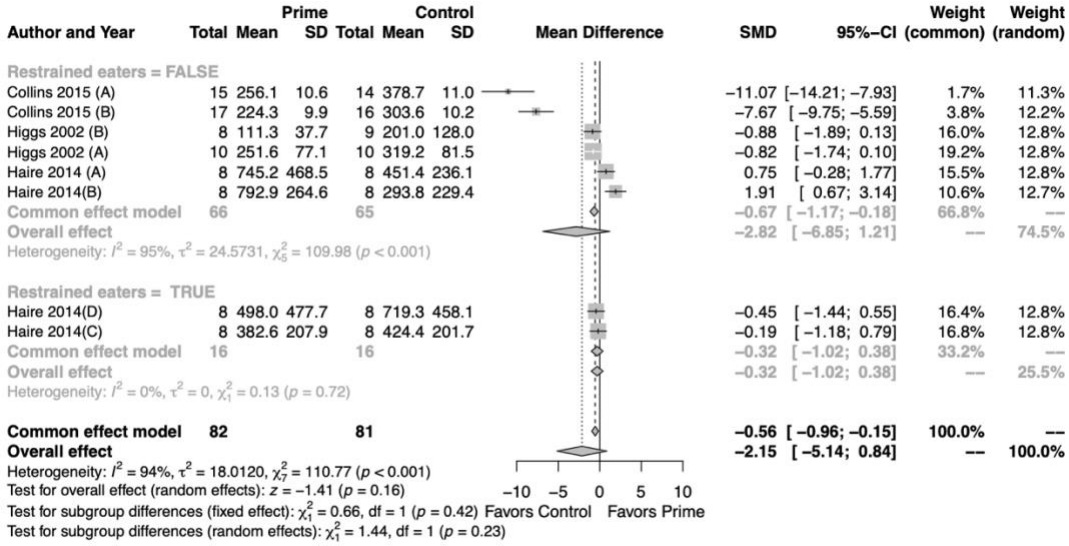


Figure 6 (Sex x Positive Food Primes)

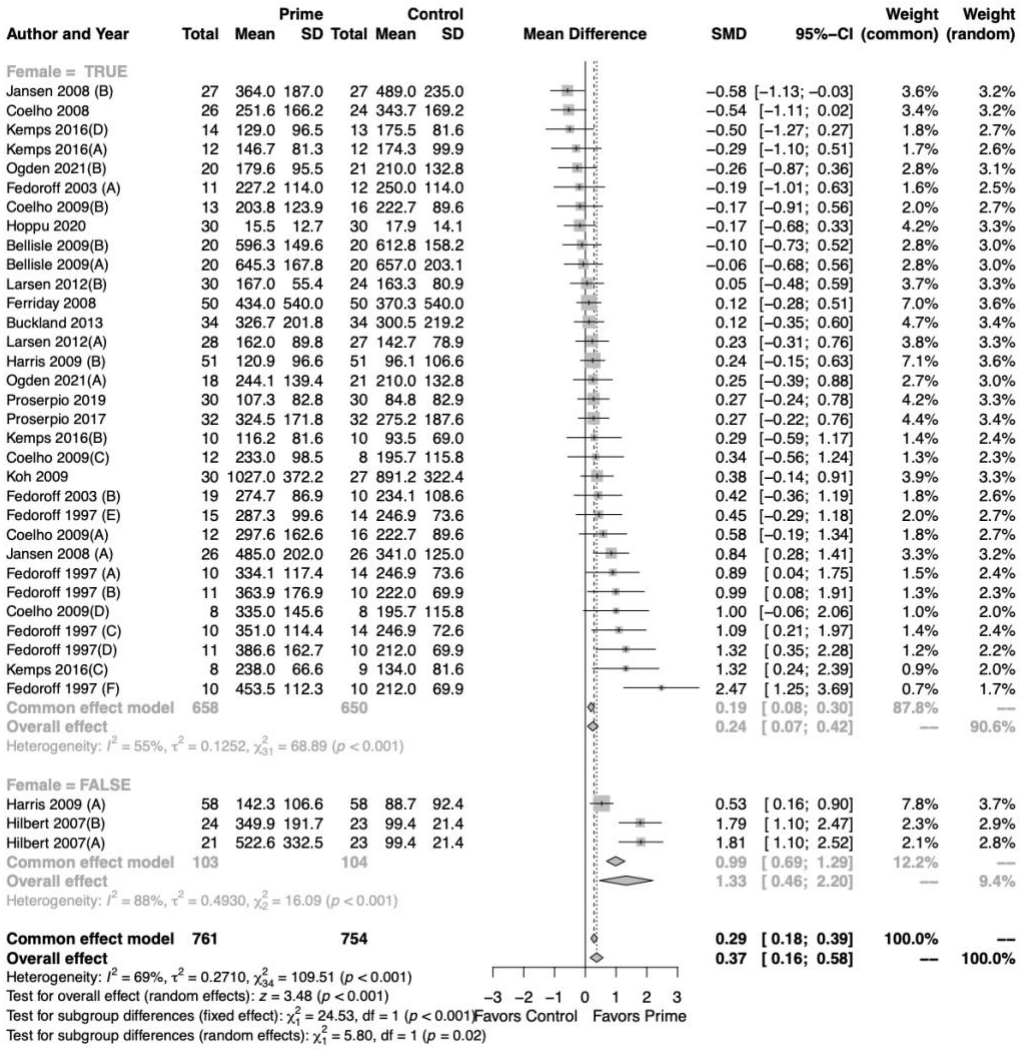
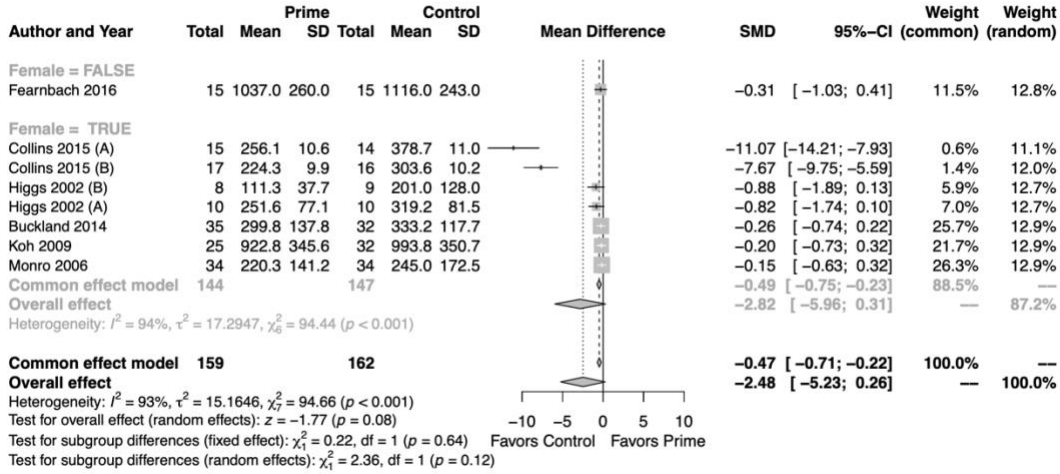


Figure 7 (Sex x Negative Food Primes)



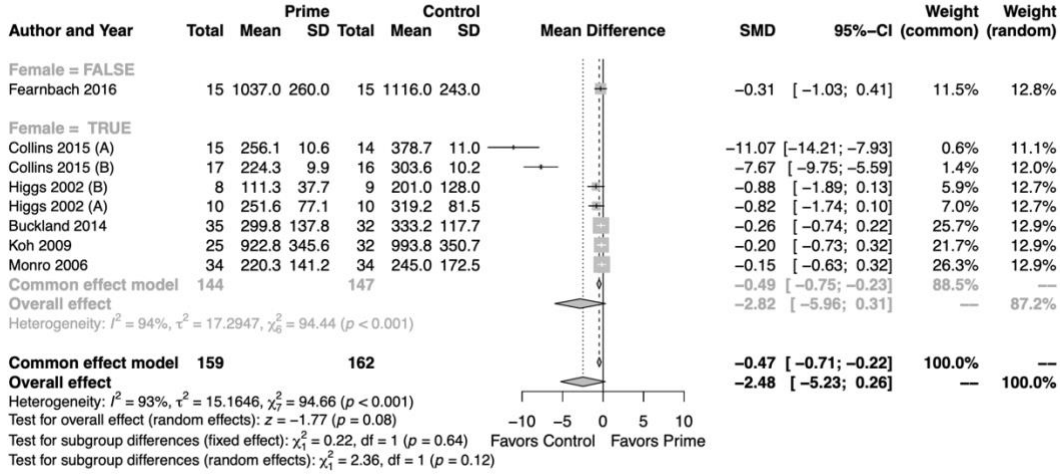
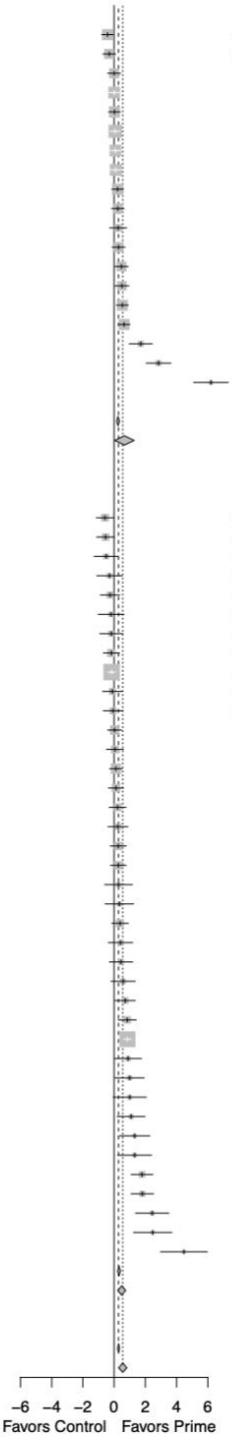


Figure 8 (Age x Positive Food Primes)

Author and Year	Prime Total	Prime Mean	Prime SD	Control Total	Control Mean	Control SD	SMD	95%–CI	Weight (common)	Weight (random)
Adults = FALSE										
Anschutz 2010(A)	60	151.4	280.7	60	263.8	251.8	−0.42	[−0.78; −0.06]	3.2%	1.9%
Folkvord 2019	47	14.5	11.1	53	18.3	12.8	−0.31	[−0.71; 0.08]	2.6%	1.9%
Aerts 2019(B)	47	198.5	124.3	47	198.1	85.2	0.00	[−0.40; 0.41]	2.5%	1.8%
Folkvord 2013(C)	65	128.9	593.6	69	121.7	705.0	0.01	[−0.33; 0.35]	3.6%	1.9%
Anschutz 2009	63	173.8	303.8	57	165.2	377.9	0.02	[−0.33; 0.38]	3.2%	1.9%
Gilbert−Diamond 2017	86	491.5	280.0	86	472.2	268.7	0.07	[−0.23; 0.37]	4.6%	1.9%
Folkvord 2013(B)	67	184.1	725.0	69	121.7	705.0	0.09	[−0.25; 0.42]	3.6%	1.9%
Folkvord 2013(A)	69	197.2	728.3	69	121.7	705.0	0.10	[−0.23; 0.44]	3.7%	1.9%
Anschutz 2010(C)	60	170.0	239.5	60	113.5	251.8	0.23	[−0.13; 0.59]	3.2%	1.9%
Harris 2009 (B)	51	120.9	96.6	51	96.1	106.6	0.24	[−0.15; 0.63]	2.7%	1.9%
Folkvord 2014(B)	31	104.6	18.1	23	99.4	21.4	0.26	[−0.28; 0.80]	1.4%	1.8%
Aerts 2019(A)	47	71.4	36.9	47	60.8	36.8	0.29	[−0.12; 0.69]	2.5%	1.8%
Folkvord 2015	50	178.0	99.5	42	132.9	87.0	0.48	[0.06; 0.89]	2.4%	1.8%
Halford 2004	42	488.1	142.5	42	419.5	126.3	0.50	[0.07; 0.94]	2.2%	1.8%
Harris 2009 (A)	58	142.3	106.6	58	88.7	92.4	0.53	[0.16; 0.90]	3.0%	1.9%
Anschutz 2010(D)	60	272.9	243.6	60	113.5	251.8	0.64	[0.27; 1.01]	3.1%	1.9%
Aerts 2017(B)	15	167.1	46.8	28	93.7	39.5	1.71	[0.98; 2.44]	0.8%	1.7%
Aerts 2017(A)	26	232.8	50.5	26	111.9	30.9	2.85	[2.06; 3.63]	0.7%	1.6%
Folkvord 2014(A)	37	203.0	16.4	40	101.9	15.9	6.20	[5.10; 7.30]	0.3%	1.4%
Anschutz 2010(B)	60	174.3	256.0	60	.	251.8			0.0%	0.0%
Common effect model	1041			1047			0.26	[0.16; 0.35]	49.3%	—
Overall effect							0.66	[0.04; 1.29]	—	34.5%
Heterogeneity: $I^2 = 91\%$, $\tau^2 = 1.8577$, $\chi^2_{16} = 207.57$ ($p < 0.001$)										
Adults = TRUE										
Jansen 2008 (B)	27	364.0	187.0	27	489.0	235.0	−0.58	[−1.13; −0.03]	1.4%	1.8%
Coelho 2008	26	251.6	166.2	24	343.7	169.2	−0.54	[−1.11; 0.02]	1.3%	1.8%
Kemps 2016(D)	14	129.0	96.5	13	175.5	81.6	−0.50	[−1.27; 0.27]	0.7%	1.7%
Kemps 2016(A)	12	146.7	81.3	12	174.3	99.9	−0.29	[−1.10; 0.51]	0.6%	1.6%
Ogden 2021(B)	20	179.6	95.5	21	210.0	132.8	−0.26	[−0.87; 0.36]	1.1%	1.7%
Fedoroff 2003 (A)	11	227.2	114.0	12	250.0	114.0	−0.19	[−1.01; 0.63]	0.6%	1.6%
Coelho 2009(B)	13	203.8	123.9	16	222.7	89.6	−0.17	[−0.91; 0.56]	0.8%	1.7%
Hoppu 2020	30	15.5	12.7	30	17.9	14.1	−0.17	[−0.68; 0.33]	1.6%	1.8%
Chao 2020	138	479.9	28.9	138	484.3	28.9	−0.15	[−0.39; 0.08]	7.4%	1.9%
Bellisle 2009(B)	20	596.3	149.6	20	612.8	158.2	−0.10	[−0.73; 0.52]	1.1%	1.7%
Bellisle 2009(A)	20	645.3	167.8	20	657.0	203.1	−0.06	[−0.68; 0.56]	1.1%	1.7%
Vakili 2019	40	783.7	249.7	40	775.1	249.6	0.03	[−0.40; 0.47]	2.1%	1.8%
Larsen 2012(B)	30	167.0	55.4	24	163.3	80.9	0.05	[−0.48; 0.59]	1.4%	1.8%
Ferriday 2008	50	434.0	540.0	50	370.3	540.0	0.12	[−0.28; 0.51]	2.7%	1.9%
Buckland 2013	34	326.7	201.8	34	300.5	219.2	0.12	[−0.35; 0.60]	1.8%	1.8%
Larsen 2012(A)	28	162.0	89.8	27	142.7	78.9	0.23	[−0.31; 0.76]	1.5%	1.8%
Ogden 2021(A)	18	244.1	139.4	21	210.0	132.8	0.25	[−0.39; 0.88]	1.0%	1.7%
Proserpio 2019	30	107.3	82.8	30	84.8	82.9	0.27	[−0.24; 0.78]	1.6%	1.8%
Proserpio 2017	32	324.5	171.8	32	275.2	187.6	0.27	[−0.22; 0.76]	1.7%	1.8%
Kemps 2016(B)	10	116.2	81.6	10	93.5	69.0	0.29	[−0.59; 1.17]	0.5%	1.6%
Coelho 2009(C)	12	233.0	98.5	8	195.7	115.8	0.34	[−0.56; 1.24]	0.5%	1.6%
Koh 2009	30	1027.0	372.2	27	891.2	322.4	0.38	[−0.14; 0.91]	1.5%	1.8%
Fedoroff 2003 (B)	19	274.7	86.9	10	234.1	108.6	0.42	[−0.36; 1.19]	0.7%	1.7%
Fedoroff 1997 (E)	15	287.3	99.6	14	246.9	73.6	0.45	[−0.29; 1.18]	0.8%	1.7%
Coelho 2009(A)	12	297.6	162.6	16	222.7	89.6	0.58	[−0.19; 1.34]	0.7%	1.7%
Rosenthal 2017	20	903.9	270.4	20	734.6	187.1	0.71	[0.07; 1.35]	1.0%	1.7%
Jansen 2008 (A)	26	485.0	202.0	26	341.0	125.0	0.84	[0.28; 1.41]	1.3%	1.8%
Honselman 2011	140	210.8	119.8	140	125.2	75.1	0.85	[0.61; 1.10]	6.9%	1.9%
Fedoroff 1997 (A)	10	334.1	117.4	14	246.9	73.6	0.89	[0.04; 1.75]	0.6%	1.6%
Fedoroff 1997 (B)	11	363.9	176.9	10	222.0	69.9	0.99	[0.08; 1.91]	0.5%	1.6%
Coelho 2009(D)	8	335.0	145.6	8	195.7	115.8	1.00	[−0.06; 2.06]	0.4%	1.5%
Fedoroff 1997 (C)	10	351.0	114.4	14	246.9	72.6	1.09	[0.21; 1.97]	0.5%	1.6%
Fedoroff 1997(D)	11	386.6	162.7	10	212.0	69.9	1.32	[0.35; 2.28]	0.4%	1.5%
Kemps 2016(C)	8	238.0	66.6	9	134.0	81.6	1.32	[0.24; 2.39]	0.4%	1.5%
Hilbert 2007(B)	24	349.9	191.7	23	99.4	21.4	1.79	[1.10; 2.47]	0.9%	1.7%
Hilbert 2007(A)	21	522.6	332.5	23	99.4	21.4	1.81	[1.10; 2.52]	0.8%	1.7%
Ridley−Siegert 2015(B)	11	554.6	53.5	15	424.1	50.4	2.44	[1.38; 3.50]	0.4%	1.5%
Fedoroff 1997 (F)	10	453.5	112.3	10	212.0	69.9	2.47	[1.25; 3.69]	0.3%	1.4%
Ridley−Siegert 2015(A)	12	657.9	51.1	15	424.1	50.4	4.47	[2.98; 5.96]	0.2%	1.2%
Common effect model	1013			1013			0.32	[0.23; 0.41]	50.7%	—
Overall effect							0.49	[0.24; 0.74]	—	65.5%
Heterogeneity: $I^2 = 80\%$, $\tau^2 = 0.5066$, $\chi^2_{38} = 190.32$ ($p < 0.001$)										
Common effect model	**2054**			**2060**			**0.29**	**[0.22; 0.35]**	**100.0%**	**—**
Overall effect							**0.56**	**[0.29; 0.82]**	**—**	**100.0%**



Heterogeneity: $I^2 = 86\%$, $\tau^2 = 0.9250$, $\chi^2_{57} = 398.77$ ($p < 0.001$)
Test for overall effect (random effects): $z = 4.16$ ($p < 0.001$)
Test for subgroup differences (fixed effect): $\chi^2_1 = 0.88$, df = 1 ($p = 0.35$)
Test for subgroup differences (random effects): $\chi^2_1 = 0.26$, df = 1 ($p = 0.61$)

Figure 9 (Age x Negative Food Primes)

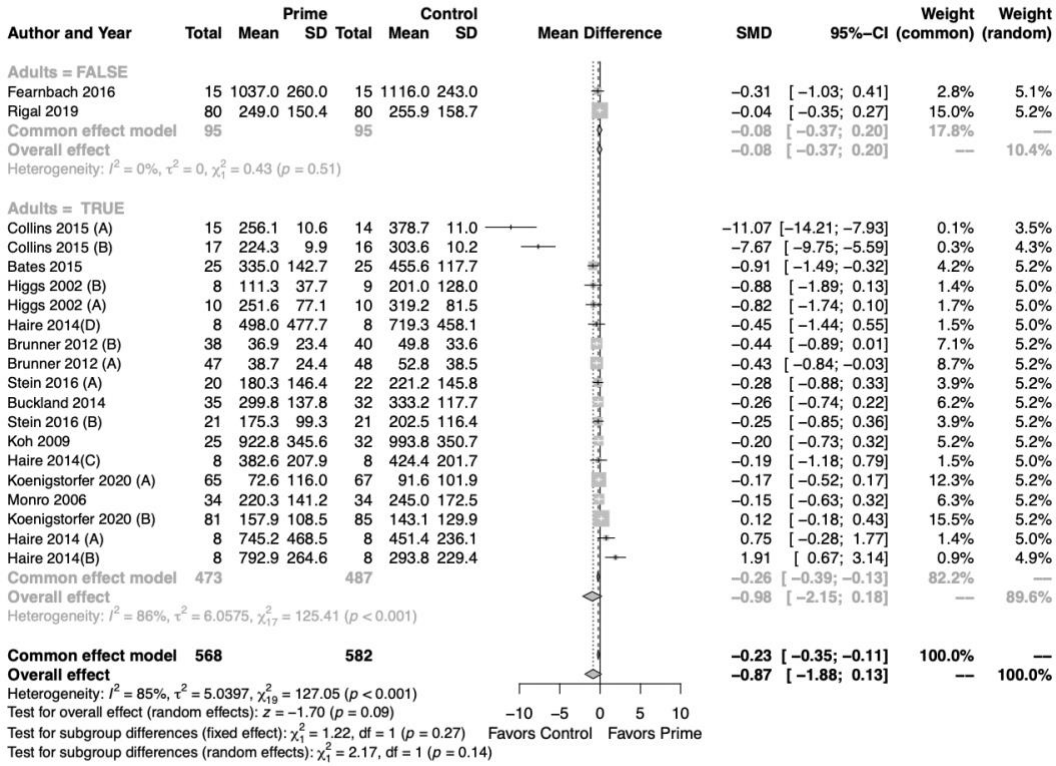


Figure 10 (Female x Restrained Status in Positive Food Primes)

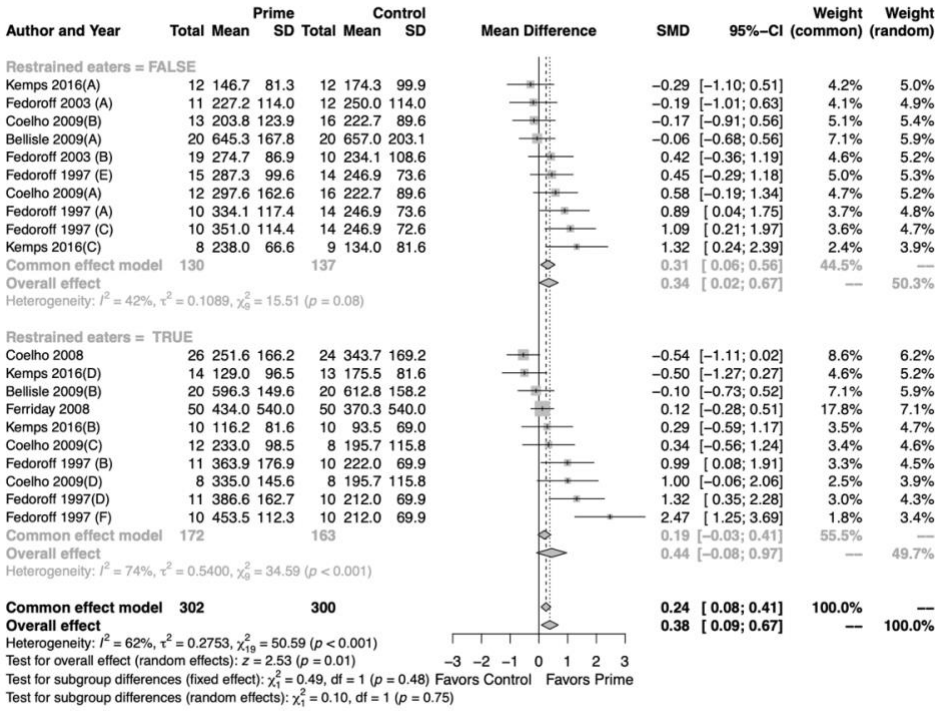


Figure 11 (Package size x Primes Type)

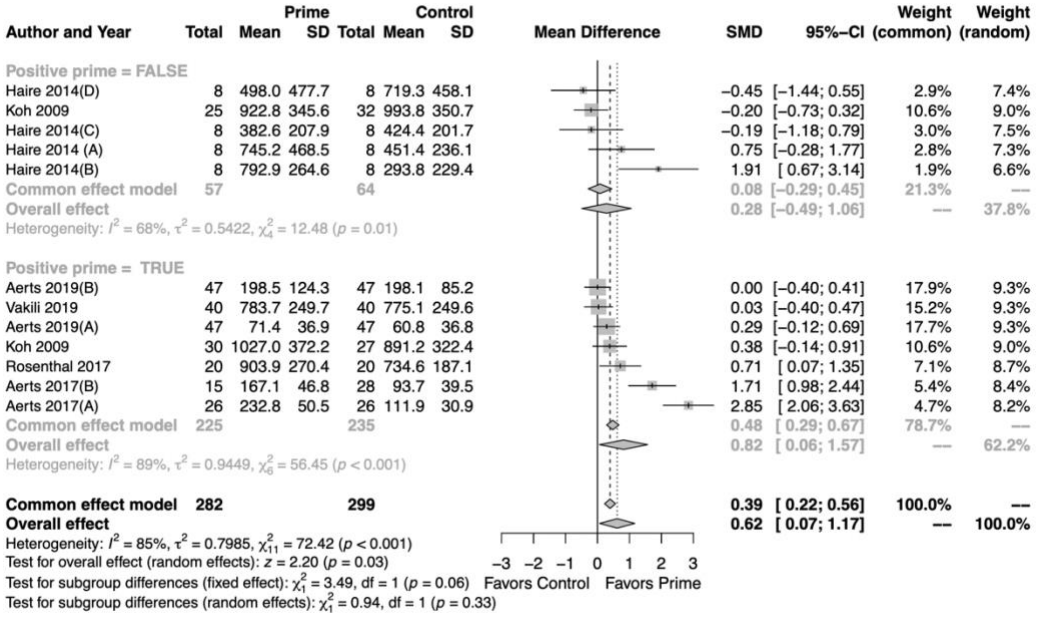
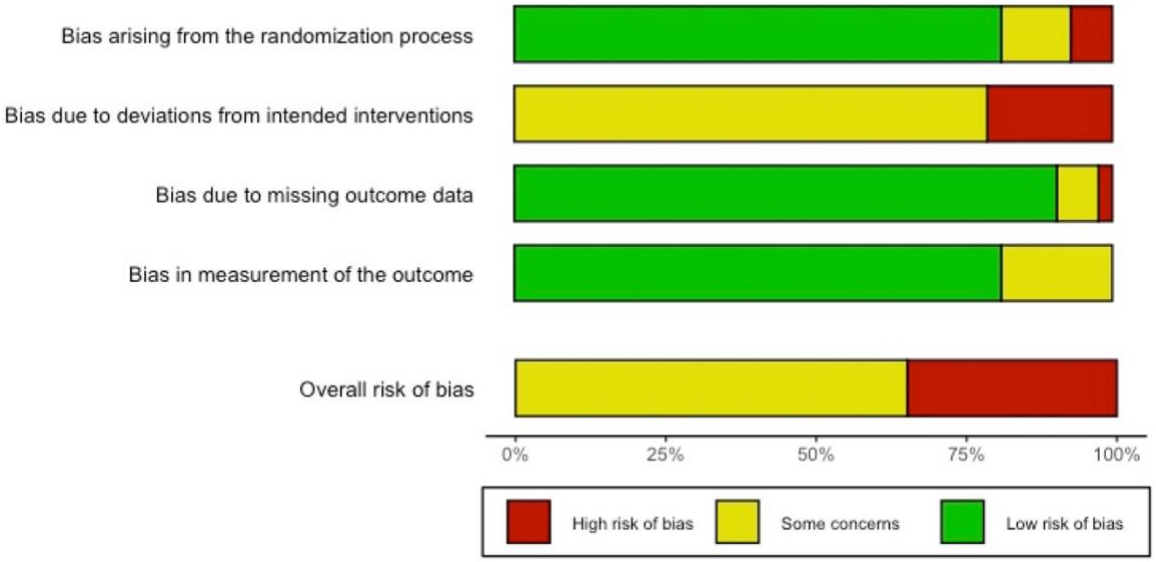


Figure 12 Risk of Bias



Supplement

1. List of undergraduate students that helped on original review

Jack Rifkin	Khanh Pham
Kristen Ostergaard	Lucas Achkarian
Makayla Durant	Margaret Pfeiffer
Maria Tollock	Mark Hitrik
Sharan Prasad	Brain Frost
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2. Reviewers for Covidence

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3. Template of Risk of Bias

(Rate accordingly)

Sequence Generation	Allocation Concealment	Assess baseline difference between groups	Blinding of participants	Blinding of personnel	Using appropriate analysis	Missing outcome data	Incomplete outcome data	Multiple outcome measurements
yes	yes	yes	yes	yes	yes	yes	yes	yes
no	no	no	no	no	no	nearly all	no	probably yes
unsure	unsure	unsure	unsure	unsure	unsure	no information	unsure	unsure
								no

Category in the ROB plots

1. Bias arising from the randomization process
   a) Sequence generation
   b) Allocation concealment
   c) Assess baseline difference between groups
2. Bias due to deviations from intended interventions
   a) Blinding of participants
   b) Blinding of personnel
3. Bias due to missing outcome data
   a) Missing outcome data
   b) Incomplete outcome data
4. Bias in measurement of the outcome
   a) Using appropriate analysis
   b) Multiple outcome measurements
5. Overall risk of bias