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Caffeine's complex influence on the attraction effect: a mixed bag of outcomes

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Abstract

Psychological state alterations induced by substance-related physiological mechanisms affect consumer decision-making. We examine the influence of caffeine—the world's most popular psychostimulant—on the attraction effect. In three double-blinded experiments, we show that caffeine intake via coffee influences consumers' preference for product options that asymmetrically dominate a decoy option in choice sets (i.e., the attraction effect). Using real products in consequential choice tasks, we show that high caffeine intake (200 mg) is associated with a larger attraction effect both on between-subjects and within-subjects levels and in free-choice as well as forced-choice decision tasks. On the contrary, we do not find support for caffeine's influence on the attraction effect when considering intermediate levels of caffeine intake (125 mg) and hypothetical decisions. We discuss theoretical implications for context effect research and practical implications for marketers.

Keywords Asymmetric dominance · Attraction effect · Caffeine · Context effects · Preference reversal · Repulsion effect

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1 Introduction

Caffeine is the world's most popular psychostimulant and has fast-onset activating effects on the central nervous system, resulting in psychophysiological state alterations associated with increased wakefulness, attention, and pleasant arousal (Dixit et al., 2012). About 85% of the adult population in the USA consume at least one caffeinated beverage a day (Mitchell et al., 2014). Caffeine's widespread presence in consumers' everyday lives also covers retail contexts. Consumers engage in shopping activities directly after or while consuming coffee or other forms of caffeine and are, therefore, under the influence of its stimulating effects (Dolbec et al., 2022). In the context of stationary shopping, this link is facilitated by the omnipresence of coffee shops or cafés in city centers as well as in-store coffee consumption offers (e.g., in car dealerships or retail stores).

Despite caffeine's popularity and presence around shopping, researching the effect of caffeine on consumer behavior does not feature prominently in marketing research. This is surprising because the influence of psychophysiological states and their underlying neurophysiological mechanisms on decision-making received increased attention in marketing research (e.g., Lichters et al., 2016a). Additionally, the influence of caffeine has been studied extensively in fields such as biology and medicine (e.g., Carvey et al., 2012), frequently focusing on various psychological and behavioral aspects like information processing speed (Bättig & Buzzi, 1986; Dixit et al., 2012) and affect (Barry et al., 2005).

As an exception, only recently, Biswas et al. (2023) evaluated the impact of caffeine consumption on consumers' purchase behavior. In their study, the authors showed that shoppers who drank a cup of caffeinated coffee before roaming retail stores spent about 50% more money and bought nearly 30% more items than shoppers who drank decaffeinated coffee or water. Being the first study in the field, Biswas et al. (2023) called for further research examining caffeine consumption's impact in different marketing contexts.

Answering this call, we investigate how caffeine consumption impacts consumers' susceptibility to the attraction effect in product choice (AE; Huber et al., 1982), a prominent context effect that describes how the preference relation between two options changes when a third (mostly irrelevant) alternative is introduced. Across a series of three studies, we find mixed effects of caffeine consumption on the AE. On the one hand, the results of two double-blinded lab experiments demonstrate that caffeine enhances the AE in consequential product choices in both forced and free-choice settings as well as in between-subjects and within-subjects designs. On the other hand, a third preregistered double-blinded lab experiment—in which we used a more conservative approach with a lower caffeine dose and hypothetical product choices that are known to mitigate the AE relative to consequential choices (Lichters et al., 2017)—does not offer evidence for the AE-enhancing effect of caffeine. Complementing prior research on this topic (Frederick et al., 2014; Lichters et al., 2015; Yang & Lynn, 2014), our results point to the relevance of factors in the experimental design and their interaction with the emergence of the AE. We discuss the mixed results in this context to the end of providing pathways for further research on caffeine's effects on consumer choices.

2 Theoretical background

The context in which consumers' purchase decisions are embedded (e.g., choice set composition) influences product preferences (e.g., Huber et al., 1982; Simonson, 1989). The umbrella term *context effects* describes how this decision context influences preference formation processes in a seemingly irrational way. While numerous such effects have been identified (see Adler et al., 2023 for an overview), the AE is the most prominent one (Lichters et al., 2015). According to the AE, adding an asymmetrically dominated (or nearly dominated) third alternative (the decoy option) to a core set of two alternatives increases the relative choice share of the alternative dominating the new entrant (the target option) in a way that is incompatible with the concept of stable consumer preferences (Huber et al., 1982).

Numerous social and natural science studies have examined the AE in recent decades, supporting its robustness (Lichters et al., 2015). Similarly, researchers have offered various explanations for the AE's emergence—for an overview, see Kruis et al. (2020). On a foundational note, however, consumers must identify the dominance relationship within the choice set for the AE to emerge (Huber et al., 2014; Simonson, 1989).

In this context, some researchers argue that the AE is rooted in fast, intuitive processing (System 1), noting that detecting the dominance relationship is cognitively untaxing and perceptual (e.g., Dhar & Gorlin, 2013; Pocheptsova et al., 2009). In contrast, recent studies corroborate that the AE is rooted in deliberate, cognitively demanding processing (System 2). These studies' findings show that identifying the dominance relationship requires careful and cognitively demanding attribute-wise comparisons between choice alternatives, especially when choosing between real and complex products (Huber et al., 2014). For example, research has shown that the AE is mitigated in experience-based decisions that are difficult to decode versus description-based decisions that are easy to decode (Hadar et al., 2018) and when consumers act under time pressure (Pettibone, 2012)—situations in which consumers devote fewer cognitive resources to their choices. In addition, Lichters et al. (2017) have shown that the AE is more pronounced when consumers engage in thoughtful examinations of product alternatives in choices that provide economic consequences (vs. hypothetical choices). Overall, these results suggest that the AE is rooted in deliberate and cognitively demanding thought processes rather than being a form of fast, intuitive decision-making.

Consumers' caffeine consumption fosters their alertness (Carvey et al., 2012) by blocking adenosine A_1 and A_{2a} receptors. As a result, adenosine cannot exert its sedative-like properties caused by inhibitory effects on neurons in brain regions that are involved in regulating cortical activity as well as the motivational, emotional, and cognitive aspects of motor behavior (Fisone et al., 2004). The activating effects of typically consumed caffeine doses (25 mg to 200 mg; e.g., 8 fl oz or 236 ml of Pepsi-Cola contain 25 mg, a shot of espresso contains 58 mg to 76 mg, and 12 fl oz or 354 ml plain brewed coffee contain roughly 200 mg of caffeine; Heckman et al., 2010; McCusker et al., 2003) affect consumers in various ways. For example, studies have demonstrated that caffeine improves information processing (e.g., Bättig & Buzzi, 1986; Carvey et al., 2012) and increases attention (Einöther & Giesbrecht,

2013) in terms of, for example, reduced reaction times and error rates in stimulus identification (Maridakis et al., 2009) and other tasks (Aidman et al., 2021; Heatherley et al., 2005). Furthermore, caffeine improves consumers' memory performance and reasoning abilities (Jarvis, 1993). On an affective level, caffeine increases energetic arousal, which is the pleasurable feeling of vibrant excitement (Barry et al., 2005; Thayer, 1986).

Building on these findings, we hypothesize that caffeine enhances the AE's magnitude. Given caffeine's positive effects on cognitive processing capabilities (Carvey et al., 2012; Einöther & Giesbrecht, 2013; Jarvis, 1993), its intake should increase the likelihood of detecting dominance relationships in choice sets via a System 2 process. Specifically, we expect consumers to exhibit a greater preference for a target option in the presence of an asymmetrically dominated decoy after caffeine consumption. Formally, we hypothesize that caffeine consumption (vs. consumption of a placebo) increases the AE.

3 Study 1

3.1 Methods

We implemented a 2 (caffeine: treatment vs. placebo)×2 (choice set: decoy absent vs. decoy present) between-subjects design. The lab experiment was masked as a coffee tasting in which participants drank 200 ml of decaffeinated coffee (placebo group). The coffee administered in the treatment group was mixed with 200 mg of pure caffeine, which corresponds to the dose often administered in clinical studies (Aidman et al., 2021; Dixit et al., 2012; see also Einöther & Giesbrecht, 2013 for a review). This dosage compares well with the caffeine content of many energy drinks like Monster Energy (Monster Beverage Corporation, 2023) and standard coffee beverages at vendors like Starbucks (Starbucks Coffee Company, 2023).

All sessions started at 08:30 a.m., caffeine was administered in a double-blinded procedure at the beginning, and no participant consumed caffeine in the four hours before. Actual products described by a brand name, a product picture, a quality rating, and a price constituted the choice stimuli (see Fig. 1). A pre-study series ensured the product's relevance for the target group (Lichters et al., 2015). These pre-studies identified trail mixes as particularly suitable for the study. Each participant completed five choice tasks composed of identical product alternatives at varying prices across choice tasks in a printed questionnaire. Participants in the decoy-absent choice set condition chose between a lower-quality and less expensive competitor (C) and a higher-quality and more expensive target (T). Choice sets in the decoy-present condition consisted of the same product alternatives as in the decoy-absent choice set condition and an additional decoy (D), dominated by T in price and quality. Every choice set included an additional no-buy option (i.e., a free-choice setting).

Participants started the choice tasks 45 minutes after caffeine consumption to ensure the caffeine took full effect (Dixit et al., 2012). In the meantime, they had to complete filler tasks, such as watching unrelated videos. Following Lichters et al.

Article	K-Classic trail mix	Farmer´s Snack trail mix	Ültje trail mix	I prefer not to buy any of those products.
Product rating	2.7	2.4	2.2	
Article picture				
Price	€0.79	€1.59	€1.39	
Your choice	O	O	O	O

Fig. 1 Stimuli including the no-buy option for choice sets manipulated between-subjects in study 1. *Note*. Stiftung Warentest product ratings: Stiftung Warentest is an established German institution for product tests (the German equivalent of US-based Consumer Reports). The product ratings range from 0.5 (best) to 5.5 (worst). The competitor C is on the left, the decoy D is in the middle, and the target T is the option on the right

(2015), we allowed participants to physically inspect the products before indicating their choices from a product shelf without prices. Furthermore, we used a consequential choice setting by implementing a random payoff mechanism (RPM) that introduced real economic consequences by randomly selecting one decision per participant as payoff relevant (see Lichters et al., 2016a). If a participant accepted an offer to purchase an item and the RPM rendered this decision relevant, the participant needed to pay the selling price and receive the product in exchange.

In total, 67 students from varying study fields at a German university participated in the study. A preceding screening process ruled out any allergies or intolerances. Following previous context effect studies (Lichters et al., 2016a), participants received their remuneration two weeks before their session to avoid house money effects (Thaler & Johnson, 1990).

3.2 Results

We discarded three participants due to straight lining, yielding a final sample of $n = 64$ (age: mean = 22.73, SD = 2.42; 54.69% females; $n_{\text{treatment}} = 31$, $n_{\text{placebo}} = 33$). The experimental groups did not differ significantly concerning their height, weight, gender, age, and brand awareness (we find group differences for the body mass index, which does not correlate with choices for the target option).[1]

To evaluate caffeine's influence on the AE, we first compared the relative choice shares of the target option T over the competitor option C in each choice set condition (Table 1). The placebo group's relative choice share for T was not significantly

[1] The Open Science Framework (OSF) provides the data and an R quarto document that details all analyses via https://osf.io/nbydg. For the analyses, we used the R language and environment for statistical computing (R Core Team, 2023) and primarily drew on the following packages and interfaces: *apa* (Gromer, 2020), *brms* (Bürkner, 2017), *lme4* (Bates et al., 2015), *quarto* (Allaire, 2022), *rmisc* (Hope, 2022), *rstatix* (Kassambara, 2023), and *tidyverse* (Wickham et al., 2019).

Table 1 Choice behavior in study 1

	Choice counts[1]		
Placebo	Decoy absent	Decoy present	Fisher's exact test[2]
(Decaf + 0 mg caffeine)	$n = 17$	$n = 16$	
No-buy	35 (41.18%)	34 (42.50%)	
Buy	50 (58.82%)	46 (57.50%)	
C	46 (92.00%)	35 (87.50%)	$p_{directed} = 0.359$, OR = 1.63
T	4 (8.00%)	5 (12.50%)	$BF_{10} = 0.20$
D	–	6	
Treatment (Decaf + 200 mg caffeine)	$n = 16$	$n = 15$	
No-buy	57 (71.25%)	27 (36.00%)	
Buy	23 (28.75%)	48 (64.00%)	
C	17 (73.91%)	18 (39.13%)	$p_{directed} = 0.006$, OR = 4.31
T	6 (26.09%)	28 (60.87%)	$BF_{10} = 12.23$
D	–	2	

C = competitor, *T* = target, *D* = decoy, *n* = number of participants per condition

[1]As participants made five choices each, choice counts per condition are five times the respective number of participants *n*

[2]Fisher's exact test assessing the contingency between competitor C and target T choices and absence versus presence of the decoy in each caffeine condition. We used Fisher's exact tests rather than χ^2 tests for two reasons: First, the cell frequencies in some of our analyses are highly unbalanced, which violates the requirements of χ^2-based testing (Camilli & Hopkins, 1978, 1979; Fisher, 1922). Even though some analyses generally allow χ^2 tests, we wanted to remain consistent in using tests throughout the manuscript, which Fisher's test allows for due to its validity for all cell sizes (Fisher, 1922). Second, Fisher's exact test has become standard in the context effects domain as it produces exact *p* values for a given frequency table (e.g., Doyle et al., 1999; Drolet, 2002; Lichters et al., 2017; Lichters et al., 2016a, b; Müller et al., 2014; Ratneshwar et al., 1987)

higher in the presence of the decoy (decoy-present sets, 12.50%; decoy-absent sets, 8.00%; Fisher's exact $p_{directed} = 0.359$, OR = 1.63, Bayes factor $BF_{10} = 0.20$).[2] However, in the treatment group, T's choice share was significantly higher in the presence of the decoy (decoy-present sets, 60.87%; decoy-absent sets, 26.09%; $p_{directed} = 0.006$, OR = 4.31, $BF_{10} = 12.23$), yielding a significant AE after caffeine intake. Second, as a further robustness check that considers the multiple choices per participant, we conducted a hierarchical logistic regression of choices (coding: C = 0, T = 1) on caffeine (coding: placebo = 0, treatment = 1) and choice set conditions (coding: decoy absent = 0, decoy present = 1) as well as their interaction, nested

[2] The Bayes factor (BF) quantifies the evidence favoring one model (e.g., the null hypothesis that the conditions do not differ) over another model (e.g., the alternative hypothesis that the conditions do differ). In line with the early work of Jeffreys (1961), the limits of 3 (respectively 0.33) and 10 (respectively 0.1) are usually seen as moderate and strong evidence. $BF_{10} = 0.20$ indicates that the data are 0.2 times as likely under the alternative hypothesis than under the null hypothesis (respectively 5 times more likely under the null versus the alternative hypotheses), which provides moderate evidence in favor of the null hypothesis.

within individuals. Our results revealed a significant interaction effect ($\beta = 18.13$, $z = 2.28$, $p = 0.022$, whereas no significant main effects emerged (caffeine (treatment): $\beta = 2.46$, $z = 0.43$, $p = 0.670$; choice set (decoy present): $\beta = 0.91$, $z = 0.15$, $p = 0.884$), indicating that the AE only emerged in the treatment condition. A Bayesian hierarchical logistic regression supports the hypothesized interaction effect (evidence ratio (ER) = 6.16),[3] but indicates no choice set effect (ER = 2.27). The results also suggest that participants in the caffeine (vs. the placebo) condition were more likely to choose the target (ER = 13.71).

4 Study 2

4.1 Methods

In study 2, we evaluated the AE in a 2 (caffeine: treatment vs. placebo; between-subjects) × 2 (choice set: decoy absent vs. decoy present; combined between- and within-subjects) design. We used the same caffeine manipulation, experimental protocol, sample recruitment pool, and screening as in study 1.

The choice tasks were structurally equivalent to those of study 1 but differed regarding the following aspects. First, we did not include a no-buy option to align with prior context effect research, which commonly operates in forced-choice settings (Lichters et al., 2016a). Second, we selected different product categories for the choice tasks based on interview pre-studies. Third, we manipulated choice sets both on a within-subjects and a between-subjects level. On the within-subjects level, participants chose from each of five decoy-absent and five decoy-present choice sets in the product category of chewing gums. The within-subjects decoy-absent choice sets were separated from the decoy-present choice sets by five between-subjects manipulated choice sets in the product category of butter spiced cookies or "spekulatius" (see Fig. 2).[4]

4.2 Results

4.2.1 Within-subjects choice analysis

We discarded two of the total 53 participants due to straight lining, yielding a final sample of $n = 51$ (age: mean = 22.24, SD = 2.19; 29.41% females; $n_{treatment} = 26$,

[3] The evidence ratio (ER) corresponds to a directed hypothesis test, which compares the Bayesian posterior probability for a hypothesis (here: $b > 0$) against its counterpart (i.e., $b \leq 0$). This metric quantifies the evidence in favor of a positive coefficient versus a negative or null coefficient. Limits for the strength of evidence regarding a hypothesis are equivalent to those of the Bayes factor (Bürkner, 2017).

[4] We also report an assessment of the psychological process underlying the influence of caffeine on the AE on the corresponding OSF repository. Specifically, we administered the enhanced version of the cognitive reflection test (CRT-L; Primi et al., 2016) to evaluate caffeine's influence on cognitive capabilities and the self-assessment manikin (SAM) to evaluate caffeine's influence on arousal (Bradley & Lang, 1994).

Article	Orbit peppermints	5 Gum sweet mint	Airwaves menthol
Product rating	2.3	1.9	1.7
Article picture			
Price	€0.59	€0.92	€0.75
Your choice	o	o	o

Article	Edeka butter spiced cookie	Kinkartz butter spiced cookie	Bahlsen butter spiced cookie
Product rating	2.2	1.7	1.6
Article picture			
Price	€0.80	€1.49	€1.20
Your choice	o	o	o

Fig. 2 Stimuli for the within-subjects-manipulated choice sets (above dashed line) and the between-subjects-manipulated choice sets (below dashed line) used in study 2. *Notes*: For product ratings using Stiftung Warentest, see the note in Fig. 1. The competitor C is on the left, the decoy D is in the middle, and the target T is the option on the right

$n_{placebo} = 25$). Participants did not differ between experimental groups regarding the same control variables used in study 1.

To analyze the AE on a within-subjects level, we compared whether participants switched their preference from C to T after adding D to the respective choice set, focusing solely on preference reversals between C and T and vice versa (Huber et al., 1982). In the placebo group, only 4.76% of participants' choices began at C in decoy-absent choice sets and switched to T in decoy-present choice sets, in line with the AE (Table 2). Of the initial decisions made for T in the decoy-absent sets, 4.69% showed switches in the opposite direction, which overall results in a non-significant AE (exact McNemar $p_{directed} = 0.813$, OR = 0.67) but an uninformative Bayes factor ($BF_{10} = 0.77$). In contrast, in the treatment group, 32.56% of C-choices in decoy-absent choice sets switched to T in decoy-present choice sets, while only 3.39% switched in the opposite direction. The AE, therefore, also applies as a within-subjects preference reversal ($p_{directed} = 0.002$, OR = 7.00; $BF_{10} = 18.57$). To account for repeated choices per participant, we defined individual switching rates based on participants' choices originating at C in the decoy-absent choice set, switching to T in the decoy-present choice set (coded as "1"), and the switches in the opposite direction (coded as "-1", all other choice combinations were coded as "0"; Lichters et al., 2016b). Switching rates were significantly higher in the treatment ($M = 0.09$, SD = 0.25) than in the placebo group ($M = -0.01$, SD = 0.12; $t(49) = 1.82$,

Table 2 Choice behavior in study 2

	Preference switches[1]			
	Chewing gum (within-subjects)			
Placebo (Decaf + 0 mg caffeine) $n = 25$	Decoy present			Exact McNemar test[2]
Decoy absent	C	T	D	
C	40 (95.24%)	2 (4.76%)	5	$p_{directed} = 0.813$, OR = 0.67
T	3 (4.69%)	61 (95.31%)	14	$BF_{10} = 0.77$
Treatment (Decaf + 200 mg caffeine) $n = 26$	Decoy present			
Decoy absent	C	T	D	
C	29 (67.44%)	14 (32.56%)	4	$p_{directed} = 0.002$, OR = 7.00
T	2 (3.39%)	57 (96.61%)	24	$BF_{10} = 18.57$
	Choice counts[3]			
	Spiced cookies (between-subjects)			
	Decoy absent	Decoy present		Fisher's exact test[4]
Placebo (Decaf + 0 mg caffeine)	$n = 12$	$n = 13$		
C	25 (41.67%)	48 (82.76%)		$p_{directed} < 0.001$, OR = 0.15
T	35 (58.33%)	10 (17.24%)		$BF_{10} > 100$
D	–	2		
Treatment (Decaf + 200 mg caffeine)	$n = 16$	$n = 10$		
C	56 (70.00%)	9 (20.00%)		$p_{directed} < 0.001$, OR = 9.14
T	24 (30.00%)	36 (80.00%)		$BF_{10} > 100$
D	–	5		

C = competitor, T = target, D = decoy, n = number of participants per condition

[1]Participants made five choices, first in the decoy-absent condition and then five in the decoy-present condition. Cell counts in each of the placebo and treatment conditions add up to five times the respective number of participants n

[2]Exact McNemar test for asymmetry of preference switches from decoy-absent to decoy-present choice sets from competitor C to target T versus from target T to competitor C (i.e., lower-left vs. upper-right cell)

[3]As participants made five choices each, choice counts per condition are five times the respective number of participants n

[4]Fisher's exact test assessing the contingency between competitor C and target T choices and absence versus presence of the decoy in each caffeine condition. The motivation for preferring Fisher's exact test over χ^2 tests is explained in the notes of Table 1

$p_{directed} = 0.037$, Cohen's $d = 0.51$). While the BF indicates no clear support for either hypothesis ($BF_{10} = 1.07$), the posterior distribution shows an evidence ratio of 13.97 in favor of the mean being greater than 0 (vs. being at most 0).

4.2.2 Between-subjects choice analysis

For the between-subjects level assessment of the AE, we ran analyses equivalently to study 1. In the placebo group, T's relative choice share was significantly higher in the decoy-absent (58.33%) compared to the decoy-present (17.24%) choice sets (Fisher's exact $p_{directed} < 0.001$, $OR = 0.15$; $BF_{10} > 100$)—a phenomenon known as the repulsion effect (Liao et al., 2021). In contrast, within the treatment group, the relative choice share of T was significantly higher in decoy-present than in decoy-absent choice sets (80.00% vs. 30.00%; $p_{directed} < 0.001$, $OR = 9.14$, $BF_{10} > 100$). Furthermore, a hierarchical logistic regression of choices nested within individuals revealed a significant interaction effect of caffeine and choice set ($\beta = 36.74$, $z = 5.69$, $p < 0.001$), which is substantiated by a very strong ER of 56.55, confirming a stronger AE in the treatment group.

5 Study 3

5.1 Methods

We conducted a third lab experiment to test the robustness of the effect in a more conservative yet higher-powered study. Specifically, we (1) administered a lower caffeine dose of 125 mg in the treatment group to mimic a lower coffee consumption (e.g., a small to medium-sized cup of coffee) and (2) used hypothetical rather than consequential choice scenarios (Lichters et al., 2017). Study 3 implemented a 2 (caffeine: treatment vs. placebo; between-subjects factor) × 2 (choice set: decoy absent vs. decoy present, respectively a double decoy approach; within-subjects factor) mixed design. The decaffeinated coffee administered was mixed with 125 mg of pure caffeine in the treatment group, whereas all other aspects mirrored the first two studies. Plug boards, travel mugs, and headphones constituted the focal product categories in this study, which were first displayed in a decoy-absent and later in a decoy-present choice set. The choice sets containing these products were manipulated equivalently to study 2 but were only presented once per product category and condition. Furthermore, we used hand soaps as a fourth product category using another choice set manipulation approach (i.e., double decoy design). In a double decoy design, both choice sets contain a decoy option that favors a different product in each choice set (see, e.g., Evangelidis et al., 2018). Specifically, each choice set contains three products (i.e., a competitor, a decoy, and a target). However, in the first choice set (upper part of Fig. 3), the decoy D1 favors target T1 (here, the lower-quality and lower-price option), whereas in the second choice set (lower part of Fig. 3), the decoy D2 favors target T2 (here, the higher-quality and higher-price option). Note that the roles of the same non-decoy products as competitor and target switch between choice sets due to the different decoys. That is, the lower-quality and lower-price option is the target (T1) in the first choice set favored by decoy D1 but is the competitor (C2) in the second choice set. On the contrary, the higher-quality and higher-price option is the competitor (C1) in the first choice set but is the target (T2) favored by decoy D2 in the second choice set. In a double decoy design, an AE

Study 3: Stimuli for within-subjects double decoy design – first choice set

	Competitor 1 (C1)	*Decoy 1 (D1)*	*Target 1 (T1)*	
Article	Palmolive with honey	Bevola with honey	Elkos with honey	
Product picture				
Stiftung Warentest quality rating 0.5 = very good 5.5 = poor	2.1	3.1	2.9	I prefer not to buy any of these products.
Price	€1.60	€1.40	€1.20	
Your choice	O	O	O	O

Study 3: Stimuli for within-subjects double decoy design – second choice set

	Competitor 2 (C2)	*Decoy 2 (D2)*	*Target 2 (T2)*	
Article	Elkos with honey	Fa with honey	Palmolive with honey	
Product picture				
Stiftung Warentest quality rating 0.5 = very good 5.5 = poor	2.9	2.3	2.1	I prefer not to buy any of these products.
Price	€1.20	€1.80	€1.60	
Your choice	O	O	O	O

Fig. 3 Stimuli for the double decoy choice sets used in study 3. *Notes*: Stiftung Warentest product ratings: an established German institution for product tests (the equivalent of US-based Consumer Reports). The information in italics above the boxes was not displayed to participants

unfolds if consumers select target T1 (i.e., the lower-quality and lower-price option favored by decoy D1) in the first choice set but switch to target T2 (i.e., the higher-quality and higher-price option favored by decoy D2) in the second choice set.

Every choice set included an additional no-buy option (i.e., a free-choice setting). We ran a power analysis assuming a (based on study 2 conservative) switching rate difference between the treatment and the placebo groups of 8% and a no-buy share of 10% to determine the necessary sample size. The results show that achieving a power of 80% at an alpha level of 5% requires a total sample size of 196. We, therefore, recruited $n = 200$ participants via the ORSEE platform (Greiner, 2015).

The 200 participants were assigned to ten groups invited to the lab on consecutive days. All sessions started at 09:00 a.m. with a coffee-tasting task in which we administered caffeine in a double-blinded procedure. Neither of the participants consumed caffeine on the day of the experiment prior to the session.

After the coffee tasting, participants made the first product choice tasks (decoy-absent choice sets and double decoy choice set 1), followed by multiple distractor tasks and the second product choice tasks (decoy-present choice sets and double decoy choice set 2) roughly 40 min after caffeine consumption to ensure that the caffeine took full effect (Dixit et al., 2012). Furthermore, the participants answered two attention check questions in which they were asked to tick the options "3," respectively "5," on a 7-point scale.

We preregistered the hypothesis, procedure, and data analysis plan at https://osf.io/hn2ca and documented the preregistration vis-à-vis our final analyses in a separate file at the OSF repository. We had to deviate slightly from our pre-registered selection criteria (discussed below), which affected the net sample size.

5.2 Results

Participants confirmed several preregistered inclusion criteria (e.g., not having a relevant medical condition like cardiovascular disease; no caffeinated beverage or foods consumed before the experiment). As preregistered, we aimed to exclude participants who did not finish their coffee, for which we employed two measures. We first asked participants to self-report whether they completed the coffee right after the coffee-tasting part of the experiment. Second, student assistants unobtrusively checked each cup after the experiment. Including only those participants who finished the coffee according to both measures led to a final sample size of $n = 118$ (age: mean = 27.19, SD = 10.30; 49.15% female).[5]

While considering only those participants who consumed the coffee in full considerably reduced the sample size, analyzing the full sample of respondents that passed the attention checks ($n = 199$) produced similar findings. We outline the results of both samples below. Additionally, we provide detailed results on the OSF repository.

As in study 2, for the product categories plug boards, travel mugs, and headphones, we compared whether participants switched from the lower-quality and less expensive competitor (C) to the higher-quality and more costly target (T) when an additional decoy (D; dominated by T in price quality) was included in the choice set (i.e., D was added to the decoy-absent choice set solely consisting of C and T) (Table 3). In choice set 2 of the double decoy design that we used for the product category soaps, a decoy D2 favoring the higher-quality and higher-price option (T2; which was the competitor C1 in the first choice set) replaced the decoy D1 from choice set 1 favoring the lower-quality and lower-price option (T1; becoming the competitor C2 in the second choice set) (Table 4). Note that both choice set

[5] Specifically, 118 participants indicated to have finished the coffee according to the self-report measure, while 191 had finished the coffee by the end of the session, according to the student assistants.

Table 3 Choice behavior in study 3: preference switches for product categories plug boards, travel mugs, and headphones (decoy-absent vs. decoy-present design)

	Preference switches			
	Study sample (*n* = 118; $n_{treatment}$ = 66; $n_{placebo}$ = 52)		*Full sample* (*n* = 199; $n_{treatment}$ = 102; $n_{placebo}$ = 97)	
	Plug board		**Plug board**	
Placebo (Decaf + 0 mg caffeine)	Decoy present		Decoy present	
Decoy absent	C	T	C	T
C	11 (91.67%)	6 (16.22%)	20 (95.24%)	9 (12.86%)
T	1 (8.33%)	31 (83.78%)	1 (4.76%)	61 (87.14%)
	Exact McNemar $p_{directed}$ = 0.063[1] OR = 6 BF_{10} = 1.90		Exact McNemar $p_{directed}$ = 0.011 OR = 9 BF_{10} = 5.49	
Treatment (Decaf + 125 mg caffeine)	Decoy present		Decoy present	
Decoy absent	C	T	C	T
C	22 (100.00%)	4 (10.26%)	34 (100.00%)	5 (8.20%)
T	0 (0.00%)	35 (89.74%)	0 (0.00%)	56 (91.80%)
	Exact McNemar $p_{directed}$ = 0.063 BF_{10} = 1.90		Exact McNemar $p_{directed}$ = 0.033 BF_{10} = 2.67	
	Travel mug		**Travel mug**	
Placebo (Decaf + 0 mg caffeine)	Decoy present		Decoy present	
Decoy absent	C	T	C	T
C	8 (100.00%)	1 (2.78%)	20 (100.00%)	3 (5.26%)
T	0 (0.00%)	35 (97.22%)	0 (0.00%)	54 (94.74%)
	Exact McNemar $p_{directed}$ = 0.500 BF_{10} = 1.00		Exact McNemar $p_{directed}$ = 0.125 BF_{10} = 1.42	

Table 3 (continued)

Treatment (Decaf + 125 mg caffeine)	Decoy present		Decoy present	
Decoy absent	C	T	C	T
C	13 (100.00%)	2 (5.41%)	22 (100.00%)	2 (3.70%)
T	0 (0.00%)	35 (94.59%)	0 (0.00%)	52 (96.30%)
	Exact McNemar $p_{directed} = 0.250$ $BF_{10} = 1.14$		Exact McNemar $p_{directed} = 0.250$ $BF_{10} = 1.14$	
	Headphones		**Headphones**	
Placebo (Decaf + 0 mg caffeine)	Decoy present		Decoy present	
Decoy absent	C	T	C	T
C	15 (100.00%)	4 (22.22%)	33 (100.00%)	7 (24.14%)
T	0 (0.00%)	14 (77.78%)	0 (0.00%)	22 (75.86%)
	Exact McNemar $p_{directed} = 0.063$ $BF_{10} = 1.90$		Exact McNemar $p_{directed} = 0.008$ $BF_{10} = 5.90$	
Treatment (Decaf + 125 mg caffeine)	Decoy present		Decoy present	
Decoy absent	C	T	C	T
C	24 (100.00%)	2 (11.11%)	39 (100.00%)	4 (13.33%)
T	0 (0.00%)	16 (88.89%)	0 (0.00%)	26 (86.67%)
	Exact McNemar $p_{directed} = 0.250$ $BF_{10} = 1.14$		Exact McNemar $p_{directed} = 0.063$ $BF_{10} = 1.90$	

C = competitor, *T* = target, *n* = number of participants per condition and sample

[1]Exact McNemar test for asymmetry of preference switches from the decoy-absent choice set to the decoy-present choice set from competitor C to target T versus from target T to competitor C (i.e., upper-right vs. lower-left cell). We do not report odds ratios (ORs) for comparisons involving zero frequency

We report choices for all response options (i.e., choices for the T, C, decoy D, and no-buy choices) in Appendices 1, 2, and 3

manipulations yield an AE if participants switch from the lower-quality and lower-price option to the higher-quality and higher-price option between respective choice sets and that the corresponding analyses are identical. Tables 3 and 4 (study sample columns) highlight that a significant AE only emerged in one out of four product categories (i.e., soaps) in the treatment condition and in zero out of four categories in the placebo condition. The full sample columns in Tables 3 and 4 indicate a significant AE in two out of four product categories (i.e., soaps and plug boards) in the treatment condition and in three of four categories in the placebo condition. While these results show an AE in the overall six significance tests across both samples, the BFs also produce little evidence for the AE. Specifically, four BFs are larger than 3 and thus offer moderate support for an AE, while the other four BFs revolve between 1.00 and 2.67 and thus offer no support for or against an AE.

We ran a series of further analyses to check the results' robustness. Specifically, we analyzed whether the mean of switching rates is higher in the treatment vs. the placebo group using an independent samples *t*-test for each respective product category. The results suggest that caffeine affects the AE neither in the study sample nor the full sample (all $|t| \leq 1.09$, all $p \geq 0.281$, and all $|d| \leq 0.21$). With $0.17 \leq BF_{10} \leq 0.35$, our Bayesian analysis offers evidence favoring the null hypothesis.

Finally, for the product categories plug boards, travel mugs, and headphones, we ran a meta-analysis on whether the participants made an AE choice switch (i.e., switching from competitor C in the decoy-absent choice set to the target T in the decoy-present choice set) versus not making an AE choice switch (i.e., making any other choice combination)—note that we excluded soaps from this analysis due to the different nature of the double decoy approach. For the analysis, the product categories serve as repeated measures that denote a within-sample factor and are clustered into two independent subgroups (i.e., the caffeine conditions). The results in Fig. 4 indicate a low overall prevalence of the AE of 6% (95% CI [4%; 10%] in the study sample and 5% (95% CI [4%; 8%] in the full sample. Supporting the results from our previous analyses, the AE's prevalence does not differ between the subgroups (test for subgroup difference in the study sample: $\chi^2(1) = 2.24$, $p = 0.13$; full sample: $\chi^2(1) = 2.80$, $p = 0.09$).

To summarize, study 3 identifies significant AE choice patterns in some conditions, while the Bayesian analysis does not provide clear evidence for or against an AE. An additional meta-analysis also indicates that study 3 does not support our hypothesis. Therefore, multiple analytical approaches suggest that the AE did not emerge differently in the caffeine and placebo conditions.

6 General discussion

This research adds to the growing body of knowledge about the influence of substance-induced psychophysiological state alterations on consumer behavior (e.g., Lichters et al., 2016a). Despite caffeine being the world's most popular psychostimulant (Dixit et al., 2012) and its omnipresence in various shopping contexts (Dolbec et al., 2022), its influence on consumers' decision-making is vastly understudied. Extending Biswas et al. (2023) and following the authors' call for further research

Table 4 Choice behavior in study 3: Preference switches for product category soaps (double decoy design)

	Preference switches			
	Study sample (*n* = *118*; $n_{treatment}$ = *66*; $n_{placebo}$ = *52*)		*Full sample* (*n* = *199*; $n_{treatment}$ = *102*; $n_{placebo}$ = *97*)	
Placebo (Decaf + 0 mg caffeine)	Choice set 2		Choice set 2	
Choice set 1	T2 (=C1)	C2 (=T1)	T2 (=C1)	C2 (=T1)
C1 (=T2)	17 (85.00%)	0 (0.00%)	28 (73.68%)	1 (2.63%)
T1 (=C2)	3 (15.00%)	21 (100.00%)	10 (26.32%)	37 (97.37%)
	Exact McNemar[1] $p_{directed}$ = 0.125 BF_{10} = 1.42		Exact McNemar $p_{directed}$ = 0.006 OR = 10 BF_{10} = 8.25	
Treatment (Decaf + 125 mg caffeine)	Choice set 2		Choice set 2	
Choice set 1	T2 (=C1)	C2 (=T1)	T2 (=C1)	C2 (=T1)
C1 (=T2)	23 (79.31%)	0 (0.00%)	33 (82.50%)	0 (0.00%)
T1 (=C2)	6 (20.69%)	18 (100.00%)	7 (17.50%)	34 (100.00%)
	Exact McNemar $p_{directed}$ = 0.016 BF_{10} = 3.90		Exact McNemar $p_{directed}$ = 0.008 BF_{10} = 5.90	

T1/C2 = lower-quality and lower-price option (target in choice set 1 but competitor in choice set 2), T2/C1 = higher-quality and higher-price option (target in choice set 2 but competitor in choice set 1), *n* = number of participants per condition and sample

[1]Exact McNemar test for asymmetry of preference switches from choice set 1 to choice set 2 from target T1 (=C2) to target T2 (=C1) versus from competitor C1 (=T2) to competitor C2 (=T1; i.e., lower-left vs. upper-right cell). We do not report odds ratios (ORs) for comparisons involving zero frequency

We report choices for all response options (i.e., choices for T1, T2, C1, C2, the decoys D1/D2, and no-buy choices) in Appendix 4

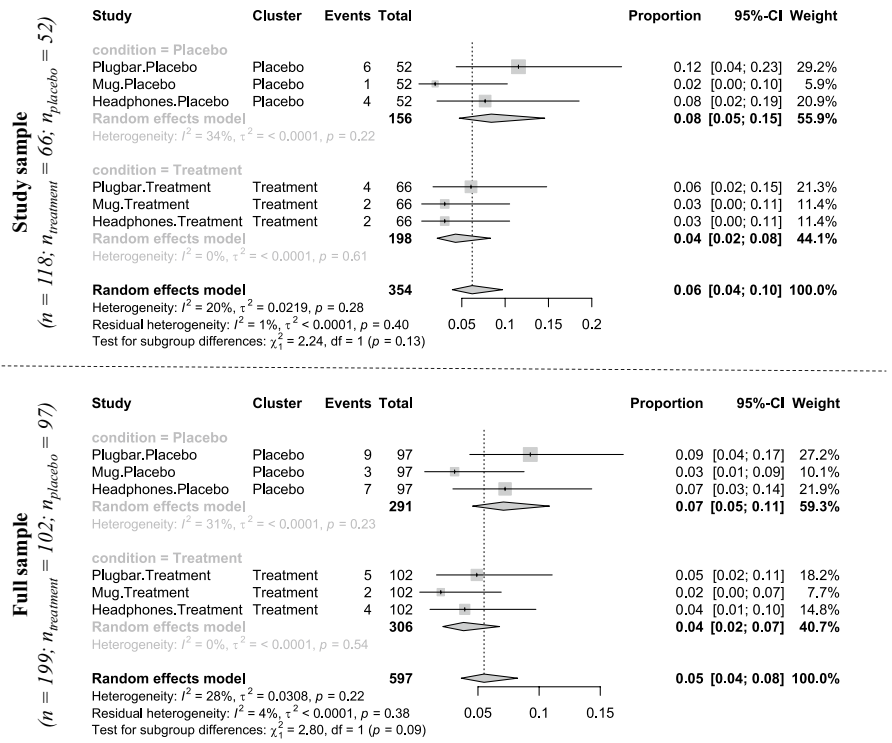

Fig. 4 Meta-analytical results and forest plots for the product categories plug boards, travel mugs, and headphones (study 3). *Notes*: Product categories are repeated measures (within-sample factor) clustered into two independent subgroups (caffeine conditions). The proportions display the participants who make an AE choice switch (i.e., switching from competitor C in the decoy-absent choice set to target T in the decoy-present choice set) versus not making an AE choice switch (i.e., making any other choice combination). The forest plots display the proportions, their 95% confidence intervals, and the aggregated effects per subgroup

on this topic, we conducted three double-blinded lab experiments to examine the influence of caffeine on the AE. While the results of the first two lab experiments offer clear support for caffeine's influence on the emergence of the AE, analyzing the effect in a more conservative setting using a lower caffeine dose and hypothetical choices fails to replicate the effect.

Our results have important implications for marketing theory and practice, given their seeming inconsistencies. On the theoretical side, our results show that large doses of caffeine can increase the AE. In studies 1 and 2, we used 200 mg of caffeine in the treatment group, which corresponds to the dose commonly used in clinical research (Aidman et al., 2021; Dixit et al., 2012; see also Einöther & Giesbrecht, 2013 for a review) and also compares well with the caffeine content in many energy drinks (Monster Beverage Corporation, 2023) or coffee products from popular vendors (Starbucks Coffee Company, 2023). On the other hand, the caffeine dose administered in study 3 corresponds to that of a home-brewed small to

medium-sized coffee. In the latter study, we also considered a hypothetical choice setting—as is common in AE research (Lichters et al., 2015)—which has been shown to diminish the AE's magnitude (Lichters et al., 2017). We expected these variations to be inconsequential for the effect under investigation. However, contrary to our expectations, we could not isolate caffeine's impact on the strength of the AE under hypothetical choice scenarios, which diminish the AE's strength—as evident in our study 3's findings.

Our results showcase the effects of methodological choices on the AE, which have been discussed in previous literature (e.g., Frederick et al., 2014; Huber et al., 2014; Lichters et al., 2015; Yang & Lynn, 2014) and offer various avenues for future research. For example, the caffeine dose in study 3 (125 mg) may have been too weak to increase the AE to a magnitude similar to that in studies 1 and 2 (200 mg caffeine). However, Biswas et al. (2023) found positive effects of caffeine on consumers' purchase and spending behavior for even smaller caffeine doses of 100 mg or less. In light of these results, further research should identify which consumption situations are more or less susceptible to caffeine's influence as caffeine increases System 2 processing (e.g., Carvey et al., 2012) and impulsivity (Biswas et al., 2023). For example, caffeine may have a larger effect on impulsive and less cognitively demanding choice processes while exerting a smaller influence on the AE since this effect requires a more effortful cognitive processing of attribute levels across all choice options to identify the dominance relationship (Huber et al., 2014). If caffeine plays a dominant role in impulsive purchase decisions, it also seems to be a promising research direction to evaluate its contribution to compulsive buying disorder (Neuner et al., 2005). Furthermore, caffeine might unfold more substantial effects in situations where consumers are already at the end of a taxing working day. This is because recent research highlights caffeine's positive role in reducing decision errors in cognitive tests or even simulated driving tasks for sleep-deprived participants (Aidman et al., 2021).

Relatedly, our use of hypothetical, non-consequential choices in study 3 likely reduced the cognitive effort participants were willing to invest during the product choice, thereby mitigating caffeine's impact. While this explanation may seem trivial, researchers rarely acknowledge that their design choices may affect cognitive processes that serve as drivers or inhibitors of the AE and other context effects. Quantifying the impact of research design choices versus other manipulations requires complex study designs and high sample sizes to safeguard sufficient statistical power. For example, the three studies presented in this paper alone vary in the following factors, which could easily be combined into dozens of research designs: (1) Two levels of AE manipulations (between vs. within-subjects); (2) three levels of caffeine doses (decaf + 0 mg, decaf + 125 mg, decaf + 200 mg); (3) two levels of choice framings (consequential vs. hypothetical choices); (4) two levels of choice formats (free vs. forced choice); (5) two product types (fast-moving consumer goods vs. durable products) with all-in-all seven different product categories and 22 unique products. Disentangling these factors' effects would contribute to adequately identifying the extent to which the AE is susceptible or resistant to research design choices. To quantify the impact that design choices have on the AE, future research could meta-analytically test its effect size as a function of design factors whose

impact has been neglected in previous meta-analyses on the AE (Heath & Chatterjee, 1995; Milberg et al., 2014). Such an analysis should consider the impact of publication bias that systematically masks null or mixed effects—similar to related research on nudging (Maier et al., 2022). Since such an endeavor would require more resources than a single research group can provide, a reasonable approach would be a big-team science project (Forscher et al., 2023). Following such an approach would also increase the practical value of AE research since practitioners would gain a more accurate estimate of the effect's size and variability in different situations. From our research alone, we can conclude that high doses of caffeine in a binding choice setting—as is common in retail settings—increase the AE, while lower doses have little or no effect.

Appendix 1

Table 5 Choice behavior in study 3: preference switches for product category plug boards (decoy absent vs. decoy present design)

	Preference switches				
	Study sample (n = 118)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 52	Decoy present				Exact McNemar test[1]
Decoy absent	C	T	D	No-buy	
C	11 (91.67%)	6 (16.22%)	0	0	$p_{directed}$ = .063
T	1 (8.33%)	31 (83.78%)	0	0	OR = 6
No-buy	0	1	0	2	BF_{10} = 1.90
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 66	Decoy present				
Decoy absent	C	T	D	No-buy	
C	22 (100.00%)	4 (10.26%)	0	0	$p_{directed}$ = .063
T	0 (0.00%)	35 (89.74%)	1	1	BF_{10} = 1.90
No-buy	0	0	0	3	
	Full sample (n = 199)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 97	Decoy present				Exact McNemar test
Decoy absent	C	T	D	No-buy	
C	20 (95.24%)	9 (12.86%)	0	0	$p_{directed}$ = .011
T	1 (4.76%)	61 (87.14%)	0	0	OR = 9
No-buy	0	2	0	4	BF_{10} = 5.49
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 102	Decoy present				
Decoy absent	C	T	D	No-buy	
C	34 (100.00%)	5 (8.20%)	0	0	$p_{directed}$ = .033
T	0 (0.00%)	56 (91.80%)	2	1	BF_{10} = 2.67
No-buy	0	2	0	4	

C = competitor, T = target, D = decoy, n = number of participants per condition and sample

[1]Exact McNemar test for asymmetry of preference switches from the decoy-absent choice set to the decoy-present choice set from competitor C to target T versus from target T to competitor C (i.e., lower-left vs. upper-right cell within the dashed square). We do not report odds ratios (ORs) for comparisons involving a frequency of zero

Appendix 2

Table 6 Choice behavior in study 3: preference switches for product category travel mugs (decoy absent vs. decoy present design)

	Preference switches				
	Study sample (n = 118)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 52	Decoy present				Exact McNemar test[1]
Decoy absent	C	T	D	No-buy	
C	8 (100.00%)	1 (2.78%)	0	0	$p_{directed}$ = .500
T	0 (0.00%)	35 (97.22%)	0	1	BF_{10} = 1.00
No-buy	0	1	0	6	
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 66	Decoy present				
Decoy absent	C	T	D	No-buy	
C	13 (100.00%)	2 (5.41%)	0	0	$p_{directed}$ = .250
T	0 (0.00%)	35 (94.59%)	1	0	BF_{10} = 1.14
No-buy	0	1	1	13	
	Full sample (n = 199)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 97	Decoy present				Exact McNemar test
Decoy absent	C	T	D	No-buy	
C	20 (100.00%)	3 (5.26%)	0	0	$p_{directed}$ = .125
T	0 (0.00%)	54 (94.74%)	0	3	BF_{10} = 1.42
No-buy	0	2	0	15	
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 102	Decoy present				
Decoy absent	C	T	D	No-buy	
C	22 (100.00%)	2 (3.70%)	0	0	$p_{directed}$ = .250
T	0 (0.00%)	52 (96.30%)	1	0	BF_{10} = 1.14
No-buy	0	1	1	23	

C = competitor, T = target, D = decoy, n = number of participants per condition and sample

[1]Exact McNemar test for asymmetry of preference switches from the decoy-absent choice set to the decoy-present choice set from competitor C to target T versus from target T to competitor C (i.e., lower-left vs. upper-right cell within the dashed square). We do not report odds ratios (ORs) for comparisons involving a frequency of zero

Appendix 3

Table 7 Choice behavior in study 3: preference switches for product category headphones (decoy absent vs. decoy present design)

	Preference switches				
	Study sample (n = 118)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 52	Decoy present				Exact McNemar test[1]
Decoy absent	C	T	D	No-buy	
C	15 (100.00%)	4 (22.22%)	0	1	$p_{directed}$ = .063
T	0 (0.00%)	14 (77.78%)	0	0	BF_{10} = 1.90
No-buy	0	1	0	17	
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 66	Decoy present				
Decoy absent	C	T	D	No-buy	
C	24 (100.00%)	2 (11.11%)	0	0	$p_{directed}$ = .250
T	0 (0.00%)	16 (88.89%)	0	0	BF_{10} = 1.14
No-buy	0	1	0	23	
	Full sample (n = 199)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 97	Decoy present				Exact McNemar test
Decoy absent	C	T	D	No-buy	
C	33 (100.00%)	7 (24.14%)	0	1	$p_{directed}$ = .008
T	0 (0.00%)	22 (75.86%)	1	0	BF_{10} = 5.90
No-buy	0	3	0	30	
Treatment (decaf + 125 mg caffeine) $n_{treatment}$ = 102	Decoy present				
Decoy absent	C	T	D	No-buy	
C	39 (100.00%)	4 (13.33%)	0	0	$p_{directed}$ = .063
T	0 (0.00%)	26 (86.67%)	0	0	BF_{10} = 1.90
No-buy	0	2	0	31	

C = competitor, T = target, D = decoy, n = number of participants per condition and sample

[1]Exact McNemar test for asymmetry of preference switches from the decoy-absent choice set to the decoy-present choice set from competitor C to target T versus from target T to competitor C (i.e., lower-left vs. upper-right cell within the dashed square). We do not report odds ratios (ORs) for comparisons involving a frequency of zero

Appendix 4

Table 8 Choice behavior in study 3: preference switches for product category soaps (double decoy design)

	Preference switches				
	Study sample (n = 118)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 52	Choice set 2				Exact McNemar test[1]
Choice set 1	C2 (=T1)	T2 (=C1)	D2	No-buy	
T1 (=C2)	21 (100.00%)	3 (15.00%)	0	0	$p_{directed}$ = .125
C1 (=T2)	0 (0.00%)	17 (85.00%)	2	1	BF_{10} = 1.42
D1	0	0	0	0	
No-buy	0	0	0	8	
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 66	Choice set 2				
Choice set 1	C2 (=T1)	T2 (=C1)	D2	No-buy	
T1 (=C2)	18 (100.00%)	6 (20.69%)	1	0	$p_{directed}$ = .016
C1 (=T2)	0 (0.00%)	23 (79.31%)	0	1	BF_{10} = 3.90
D1	1	0	1	0	
No-buy	0	0	0	15	
	Full sample (n = 199)				
Placebo (Decaf + 0 mg caffeine) $n_{placebo}$ = 97	Choice set 2				Exact McNemar test
Choice set 1	C2 (=T1)	T2 (=C1)	D2	No-buy	
T1 (=C2)	37 (97.37%)	10 (26.32%)	0	0	$p_{directed}$ = .006
C1 (=T2)	1 (2.63%)	28 (73.68%)	2	1	OR = 10
D1	0	0	0	0	BF_{10} = 8.25
No-buy	1	0	0	17	
Treatment (Decaf + 125 mg caffeine) $n_{treatment}$ = 102	Choice set 2				
Choice set 1	C2 (=T1)	T2 (=C1)	D2	No-buy	
T1 (=C2)	34 (100.00%)	7 (17.50%)	1	0	$p_{directed}$ = .008
C1 (=T2)	0 (0.00%)	33 (82.50%)	0	1	BF_{10} = 5.90
D1	3	0	1	0	
No-buy	0	0	0	22	

T1/C2 = lower-quality and lower-price option (target in choice set 1 but competitor in choice set 2), T2/C1 = higher-quality and higher-price option (target in choice set 2 but competitor in choice set 1), D1/D2 = decoy in choice set 1 and 2, respectively, n = number of participants per condition and sample

[1]Exact McNemar test for asymmetry of preference switches from the choice set 1 to the choice set 2 from competitor C2 (=T1) to target T2 (=C1) versus from target T2 (=C1) to competitor C2 (=T1; i.e., lower-left vs. upper-right cell within the dashed square). We do not report odds ratios (ORs) for comparisons involving a frequency of zero

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Data availability We provide all datasets, the analyses' *R* scripts, and accompanying supplemental materials within the *Open Science Framework*: https://osf.io/nbydg

Declarations

Ethics approval and consent to participate Studies 1 and 2 were approved by the ethics board of Otto-von-Guericke University's research cluster of consumer research. All study participants provided informed written consent before enrolling in the studies.

Conflict of interest The authors declare no competing interests.

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