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Attraction effect in crowded decision spaces: exploring the impact of decoys in choices among numerous options

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ABSTRACT
Human choices are context-dependent, and options evaluation is biased by the quality and quantity of available alternatives. In the attraction effect, dominated decoys have proven effective in shifting preferences in numerous experiments, yet its relevance in real-life choices remains disputed. Part of the problem lies in the differences between laboratory settings and realistic scenarios: in the lab, participants are tested on ternary choices; in real life, consumers face choices among many options, and interactions with other context effects are frequent. We present two experiments investigating how these factors modulate the attraction effect: we manipulate the number of decoys (study1), and the number of available options (study2). Findings suggest that: (i) the attraction effect remains significant in larger sets; (ii) two decoys are more effective than one, but (iii) adding more undermines the effect; (iv) compromise options have a dampening influence on decoys, making them ineffective at targeting the intermediate option.

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Decoy effect; attraction effect; consumer choice; context effects; decision making

1. Introduction

Over the last 30 years, empirical research on decision making has demonstrated a wide variety of alternative-based context effects (Lichtenstein & Slovic, 2006; Spektor et al., 2021; Trueblood et al., 2013), defined as any influence on option evaluation resulting from its relational properties with other available (or added) alternatives in the choice set (Chernev, 2005; Doyle et al., 1999). To date, the most studied alternative-based context effects are the attraction (Huber et al., 1982) and compromise effects (Simonson, 1989; Simonson & Tversky, 1992), even though other contextual influences regarding alternatives have also been demonstrated (e.g. similarity effect, Tversky, 1972; phantom decoy effect, Pettibone & Wedell, 2000). The attraction effect (AE) emerges when the introduction of a seemingly irrelevant option (the decoy) in a binary choice set strengthens the preference for the baseline alternative that dominates it (the target). Prerequisites of the AE elicitation are the multi-attribute structure of the alternatives (at least two attribute dimensions for each option) and the asymmetrically dominated (AD) structure of the decoy option. The decoy is usually designed to be equally rewarding as the target option on one dimension, while clearly inferior on the other attribute. It should also not be inferior to the other (competitor) alternative (for a review, see Frederick et al., 2014). Accumulation to the threshold models (such as the Multialternative Decision Field Theory – MDFT; Roe et al., 2001; for a review, see Busemeyer et al., 2019 and Trueblood, 2022) account for these effects by describing choice as a dynamic process that evolves over time, in which decision makers gradually accumulate evidence for the available options until reaching an individual threshold of choice: crucially, decision making is interpreted as the result of a comparative process between the available alternatives in which each subjective value is affected by the quality and quantity of the other available alternatives (Cataldo & Cohen, 2019; Noguchi & Stewart, 2014; Turner et al., 2018). In such a process, the decoy option would enhance the target subjective value through a similarity-driven competitive process (Roe et al., 2001).

Even though the relevance of AE outside of laboratory settings has been questioned (Yang & Lynn, 2014),

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several studies have documented its presence in real-life domains such as consumer choices (Frederick et al., 2014; Heath & Chatterjee, 1995; Huber et al., 1982), political decisions (Herne, 1997), evaluation procedures (Slaughter et al., 1999), dating (Ariely, 2009), gambling tasks (Cheng et al., 2012; Huber et al., 1982), intertemporal choices (Marini & Paglieri, 2019), medical prescriptions (Schwartz & Chapman, 1999), and legal decision making (Kelman et al., 1996) and even in recent studies on animal behaviour (Marini, Boschetti, et al., 2023, 2024; Shafir et al., 2002).

In most laboratory studies, however, the AE has been studied in fairly simplified and abstract choice scenarios: typically, contrasting baseline binary choices with ternary contexts (Spektor et al., 2021). This setting facilitates the elicitation of AE for experimental purposes (Huber et al., 2014), yet it may lead to overlook important aspects of the phenomenon in real life. Most realistic choice scenarios nowadays are neither binary nor ternary; conversely, consumers are routinely faced with decisions involving a multiplicity of options, thus making it important to establish whether dominated decoys have an impact also on these noisy choice settings, i.e. decisions where the baseline includes three or more options. Similarly, what happens if more than one decoy is inserted in a choice scenario with all decoys targeting the same option? Is the effect magnified, left unchanged, or does it disappear if decoys get overcrowded? And what are the interactions with other context effects, e.g. the compromise effect? Are decoys equally effective, depending on whether they target either an extreme option (e.g. the best in quality, or the cheapest in price) or a compromise option? These questions are important not only to assess the impact of decoys in real-life choice scenarios, but also to refine our theoretical understanding of the AE, since different theories may support opposite predictions on some of these issues.

It is also worth highlighting that context effects have long been studied in isolation from each other in highly artificial binary/ternary settings. However, real-life scenarios typically offer several options to the costumer that must be able to sample information from different information sources. From an experimental point of view, classical binary/ternary paradigms could be extended in two different ways: (i) by adding other decoy options, and (ii) by increasing the number of competitors (non-dominated alternatives). A third important extension would be to increase the number of attributes on which alternatives are compared, without altering the number of available options. However, as already noted by Huber et al. (2014), the presence of multiple attributes in real-world markets can complicate the detection of dominance, thus undermining the emergence of the attraction effect.

As yet, very few studies explored the possibility of adding more decoys in the choice set, as well as of extending the number of non-dominated options within the choice set. As regards the number of decoys, a preliminary hypothesis suggested that the addition of multiple dominated alternatives would produce an increase in target preferences as a consequence of a reduced cognitive effort (thus prompting also a faster decisional process; Klein & Yadav, 1989). While this prediction was confirmed in some recent studies (Sürücü et al., 2017; Wu & Cosguner, 2020), other works have shown that multiple decoys can be ineffective (Daviet & Webb, 2020) and even invert the choice perceptual focus (Hamilton et al., 2007). In spite of these conflicting results, to the best of our knowledge, no study has systematically manipulated the decoys number.

While this manipulation allows for a deeper understanding of the phenomenon by providing insights into the comparative process underlying the attraction effect, it also enables the investigation of decision-making scenarios where multiple decoy options coexist within the same choice setting. Consider, for example, the case of the same product being sold on different e-commerce platforms at varying prices, or different models of the same product offering distinct technical features at similar prices.

On the one hand, the range-frequency theory (Parducci, 1965) and most sequential sampling models would predict an increased attraction effect within a multiple decoys' choice set, through a further extension of the target range or an easier comparative process that makes the target more salient. On the other hand, the more decoys similar to the target are added, the more the competitor stands out as "the odd one", getting an attention boost that may revert the effect.

Similarly, the AE has been rarely explored in choice sets with more than two non-dominated alternatives. Previous literature mainly focused only on binary baseline choices for two converging reasons: (i) to elicit AE, the decoy option and the dominance structure must be easily recognisable (Huber et al., 2014), and (ii) increasing the number of alternatives makes the task more demanding in terms of attribute-wise comparisons (Noguchi & Stewart, 2014), thus possibly undermining the perceptual component of the AE (Bettman et al., 1998). Moreover, adding non-dominated options to the baseline context may generate possible interferences with other contexts effects (i.e. compromise effect; adding an extreme option to a binary set shifts choice preferences in favour of the compromise alternative; Dimara et al., 2016), and no study has so far investigated the competitive elicitation of different context effects within the same decisional process.

To provide new empirical insights on these unresolved theoretical issues and offer practical guidance in designing effective decoys for real-life applications, we present two consecutive studies that are designed to test AE in more crowded choice settings, i.e. with numerous alternative options available to the decision maker, as a useful intermediate step towards field studies. Study 1 systematically manipulates the number of converging decoys that share the same target, and study 2 investigates the effectiveness of AD decoys in choices among more than two non-dominated alternatives. Taken together, these findings provide novel suggestions on how to design decoys to maximise their effectiveness in complex choice settings, as well as enriching our theoretical understanding of the AE.

2. Study 1. Three is a crowd: on the effectiveness of multiple decoys

2.1. Theoretical background

In our first study, we systematically investigated the impact of adding more decoys to the choice context. Previous theoretical predictions have suggested that adding multiple decoys may have several effects. A first hypothesis proposed that the presence of multiple decoys would reduce cognitive effort and speed up decision-making (Klein & Yadav, 1989). Similarly, range-frequency theory (Parducci, 1965) suggests that further extending the range of the target's worst attribute (e.g. price) should increase its desirability. In line with this, the Multialternative Decision Field Theory postulated a boosting effect for the dominant option as a result of a negative preference state previously assigned to the dominated option (Roe et al., 2001). It would follow that an increased number of comparisons elicited by the inclusion of additional dominated alternatives would contribute to a stronger push of the target subjective value, which would then reach the decisional threshold faster. Additionally, recent neuroeconomics models based on pairwise normalisation assume a stronger attraction effect when multiple clearly inferior decoys are included (Landry & Webb, 2021; Soltani et al., 2012).

Despite these theoretical predictions, empirical findings remain mixed, and only a limited number of studies have examined the impact of adding multiple dominated options on the attraction effect. Moreover, no study to date has specifically investigated this manipulation in the context of consumer choice tasks. The few studies that tested the AE in a choice set with several decoys found a robust increase in target preferences, but this was either observed in perceptual tasks (Dimara et al., 2016) or real-life retail markets (Wu & Cosguner, 2020). The latter case is closer to our interest, with one important difference: in real-life retail markets, the available options number in the hundreds, or even thousands, which makes detecting the presence of decoys especially hard. Under these conditions, it is understandable that increasing the number of decoys would always favour robust AE elicitation, as reported by Wu and Cosguner (2020), since it increases the likelihood of consumers being exposed to at least one target-decoy pair in their option exploration. However, what happens when more decoys sharing the same target are simultaneously accessible to participants? Is it still the case that the more decoys, the stronger their effect? No systematic investigation of this question has been conducted so far, whereas a study by Hamilton and colleagues (2007) showed that adding three different decoys (an asymmetrically dominated decoy and two fully dominated ones) to a baseline choice set shifted the perceptual focus of choice, thus favouring the competitor instead of the target (a reversal of the AE). More generally, it is conceivable that adding more and more options that are manifestly similar to the target will make the competitor stand out as the odd one, thereby granting it an attentional boost.

2.2. Hypotheses

The aim of the first study was to reply to the following research question: What happens if more than one decoy is inserted in a choice scenario with all decoys targeting the same option?

Based on the previous literature, we hypothesised that the AE increases when a second dominated product is added to the choice set (**H1**). However, one might expect that too many converging decoys can cancel out or even reverse the AE, by making the competitor more salient and/or less suspicious looking. This could imply a threshold dynamic in how adding further converging decoys may affect the AE. Specifically, we assumed the AE could increase proportionally to the number of converging decoys until a threshold is reached (**H1a**).

2.3. Methods: participants and procedure

Data collection of the experiments was performed online using Qualtrics. A total sample of 85 university students was recruited for the purposes of study 1 via various social media platforms on university-related groups. The studies were reviewed and approved by the ethical committee of Roma Tre University. Before the experiment, the participants provided some basic demographic information, read the task instructions, and granted their informed consent. After data collection, 8 participants were discarded, based on the following exclusion criteria: 3 participants did not pass the attention check (four trials, visually similar to the other ones but with an unambiguously superior option, randomised within the task), 2 participants took too long to complete the whole task (more than 3SD over the RT mean), and 3 chose the irrelevant decoy option more than 10% of the total number of trials (thus suggesting a general lack of attention). These conservative exclusion criteria were established to avoid biasing the data sample. The remaining 77 subjects (F = 46; age = 27 ± 7) successfully completed the whole task and were informed about the possibility to be randomly extracted to win one of the ten 20€ Amazon coupons. The whole experimental procedure lasted about 15 min and consisted of a single session performed in a within-subjects fashion. Before starting the experiment, participants completed a familiarisation task and were informed about the merchandise categories and their relevant attributes. Subsequently, the experiment began.

Subjects performed 49 consumer choices among several products characterised by a price and a quality dimension in a pseudo-randomised order (see Supplementary Materials for the list of products and the randomisation procedure). Subjects were asked to select the item they would purchase. In the whole experiment, the target option (of the AD decoy) was always the most expensive option of the binary condition. To test our hypotheses, we designed 4 main within-subject experimental conditions (a baseline condition and three decoy conditions) and 3 distractor blocks (see Table 1).

Table 1. List of experimental conditions.

Condition	Description	Options
Binary Baseline (BB)	Binary choices between a cheaper (C) and a more expensive product (T).	C T
Single Decoy (SD)	Ternary choices with a decoy targeting the most expensive item of BB.	C T T^{AD}
Double Decoy (DD)	Quaternary choices with two decoys targeting the most expensive item of BB.	C T T^{AD} T^{AD2}
Triple Decoy (TD)	Quinary choices with three decoys targeting the most expensive item of BB.	C T T^{AD} T^{AD2} T^{AD3}
Distractor conditions		
Ternary	Ternary choices including a third better and more expensive alternative (Z)	C T Z
Quaternary	Quaternary choices with an AD targeting the most expensive item of BB.	C T T^{AD} Z
Quaternary-bis	Quaternary choices with an AD targeting the most expensive item of BB.	Z C T T^{AD}

2.4. Methods: materials

In all the experimental conditions participants chose between two or more common goods among the best-seller of some leading e-commerce sites. Each item was characterised by two attributes: (i) the price, and (ii) a quality indicator (see Table 1 in the supplementary materials). This study involved 7 products (Camera, Bicycle, Earphones, Tent, Video projector, Sleeping bag, Hard disk) and 7 conditions, for a total of 49 consumer choices for each participant.

Consistently with the e-commerce market, prices were calculated following the diminishing marginal utility law (see supplementary materials). In a nutshell, the more quality one bought, the less one (proportionally) paid (see Figure 1). Moreover, each item was associated with an image from real products on such sites and decoys options were associated with the same picture of their target: we preliminary checked that images did not induce any bias in preferences (see also the supplementary materials for a detailed description of the experimental conditions). In this study, three decoy conditions were developed based on Binary Baseline: Single decoy, Double Decoy, and Triple Decoy. all AD decoys were range decoys dominated on the weakest attribute of the target (price): the decoys costed 5%, 7.5% and 10% more than the target in the three decoy conditions respectively, while offering the same quality. All the decoys were dominated on price dimension, and the target was always the most expensive option in their binary counterpart.

2.5. Results

In our experiments, consistently with previous studies, we used the relative choice share of the target option (RST) with respect to all its competitors to verify the elicitation of context effects (Chernev, 2005; Malkoc et al., 2013; Mourali et al., 2007). In particular, the RST for AE was calculated as:

$$RST = \frac{Pr\ (T)}{Pr\ (T) + Pr\ (C_1)\ + Pr\ (C_2) +\ \ldots + Pr(C_n)}$$

Where Pr(T) was the proportion of target choices and Pr (C) was the proportion of each competitor preferences. AE elicitation is proven by a positive significant change of the relative share of the target (T) in relation to its competitors (C_n) in the baseline conditions compared to the relative multialternative choice sets in which a decoy had been added. For all other statistical conventions, please see the Statistical analysis section in the supplementary materials.

In this study, our main purpose was to assess the impact of the addition of multiple converging decoys

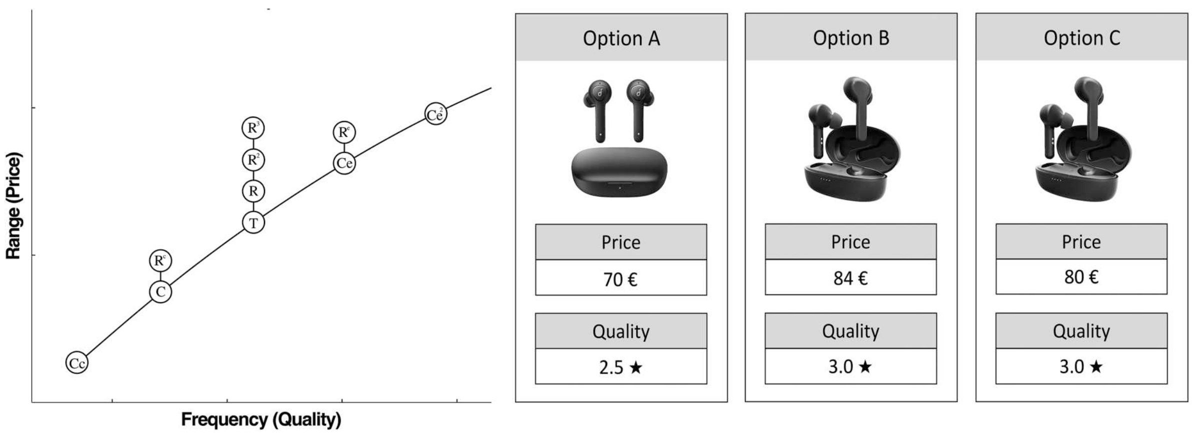

Figure 1. Attribute space and choice architecture. Left panel: locations for the asymmetrically dominated decoys (R, R2, R3, Rc, Re), target (T), and competitor options (C, Ce, Cc, Ce2) plotted in a two-dimensional space defined by range and frequency values. Choice sets presented to subjects contained different combinations of these options: the two baseline options, target and Competitor (C), were always present. Right panel: an example of a ternary choice set with a range AD decoy.

to a baseline binary context. To this end, a one-way repeated measure ANOVA was conducted to analyze the RST in the baseline binary condition and in the multi-alternative choice sets with one, two, or three AD decoys (Baseline, Single Decoy, Double Decoy, Triple Decoy). We found a main effect of the condition [$F(3, 228) = 21.13$, $p < .001$, $\eta p^2 = .218$ $(1 - \beta) > .99$] confirming that the number of AD converging decoys had an impact on subjects' preferences. In the Bonferroni corrected post-hoc analyses, we confirmed the attraction effect (AE) elicitation in both the Single Decoy ($M = .69$, $SD = .22$) and Double Decoy ($M = .75$, $SD = .22$) conditions when compared to the Baseline condition ($M = .58$, $SD = .24$; $ps < .001$). Furthermore, there was a significant increase in target preferences when a second decoy was added, as indicated by the post-hoc analysis comparing the Single Decoy and Double Decoy conditions ($p = .002$); on the other hand, no effect was found in the Triple Decoy condition ($M = .59$, $SD = .23$), with respect to the binary Baseline (p = NS) (Figure 2). Moreover, we made sure that our results were not due to a different number of decoy selections across conditions. As assumed, AD preferences did not differ between ternary conditions (Single Decoy = 1.48%; Double Decoy = 2.06%; Triple Decoy = 1.94%; $p = 1.00$). Lastly, since in this study we used a limited number of products and we wanted to incorporate participant-to-participant variability, we verified the previous analysis performing a mixed-effects logistic regression on individual choices, including the identity of the subject and the product classes as random effects in the model. The GLMM reported comparable significance values net of the random effects (see also supplementary materials). Moreover, despite being observed in most of the sample (48% in DD, and 51% in TD), the attraction effect was also found to be reversed in a small number of subjects that consistently showed a repulsion effect (15% in DD, and 10% in TD).

Prior to running response time analyses, we trimmed our dataset to reduce variability and eliminate outliers (see supplementary materials for a description of this process). After data trimming, a Friedman test was conducted to analyze RTs in all the experimental conditions. As regards RTs, we found an increase in the time spent evaluating the choice set proportionally to the number of available alternatives (Friedman test, $\chi 2(7) = 210.85$,

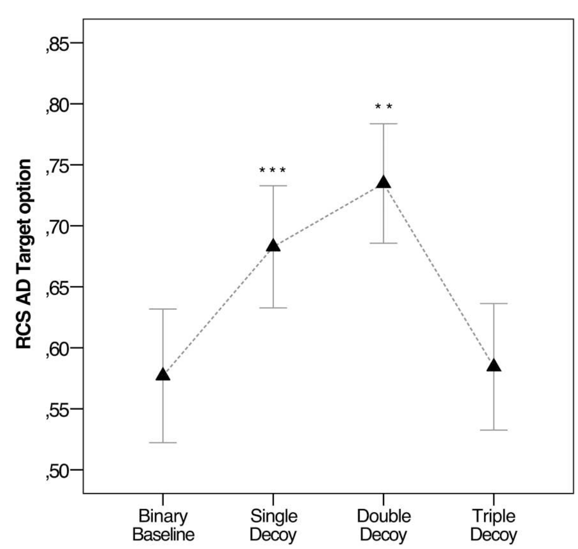

Figure 2. Multiple decoys and Context effect interaction. RCS of the target option increases when one or two decoys were included in the choice set. A second AD decoy addition causes a stronger AE. The inclusion of a third AD decoy annulled the AE elicitation. Horizontal bars and asterisks indicate significant results (***$p < .001$; **$p < .01$; *$p < .05$). Error bars indicate confidence intervals.

$p < .001$, w = .46). More interestingly, comparing the conditions where participants had to choose among four options, we also found a decrease in RTs in the Double Decoy condition (quaternary choices with two decoys; M = 8.61, SD = 2.23) compared to the Quaternary conditions (M = 9.78, SD = 3.11, Z = −4.86, $p < .001$; Quaternary-bis: M = 10.04, SD = 2.87, Z = −5.67, $p < .001$). This indicates a faster decisional process in the Double Decoy conditions, since the presence of multiple decoys dominated by the same target expedites the identification of the superior option, as opposed to quaternary choices where no clearly superior alternative is apparent.

2.6. Discussion

In this study we found (i) an increase in target preferences when one or two decoys were added to the choice set and (ii) a stronger effect in the Double Decoy condition compared to both Baseline and Single Decoy conditions. However, (iii) the addition of a third decoy cancelled out AE, bringing RST at the same levels observed in the Baseline condition, thereby demonstrating that, when it comes to converging decoys, three is indeed a crowd.

Our results on the effect of the second decoy verified H1 confirming both the range-frequency theory and MDFT implications: when the range of the target worst attribute is extended to a larger extent than in the standard ternary condition, it made the dominant option more attractive (Wedell & Pettibone, 1996). Our interpretation is that the inclusion of an additional decoy preserved the dominance structure recognition and intuitively shifts the decision makers attention towards the target, thus enhancing its subjective value (Roe et al., 2001). Moreover, the presence of a second decoy facilitated the comparative process, making the target even more attractive and ensuring that the decision threshold was reached more rapidly – hence the lower RT observed in Double Decoy, with respect to other quaternary conditions with only one decoy.

Conversely, in line with H1a, we observed a cancellation of the AE in the quinary condition, which included three dominated decoys (Triple Decoy). This result was in contradiction with most theoretical models of AE, according to which more decoys should either further increase the effect or simply preserve it. Here, our interpretation is twofold: on the one hand, it is possible that the addition of several options similar to the target made the isolated different alternative stand out by comparison, thereby increasing the salience of the competitor (see Hamilton et al., 2007); on the other hand, the more decoys were added, the more obvious the AD manipulation became, possibly making participants diffident towards the target. In this experiment, with three or more decoys, the combined effect of a boost in competitor salience and suspiciousness of the target option was apparently sufficient to counterbalance the dominance of the target over all decoys, thereby restoring baseline binary preferences. However, this threshold could be sensitive to the competitors' number, the presentation format and memory processes (Orquin et al., 2013).

In interpreting the present results, it is important to keep in mind that we did not manipulate the positioning of the decoys within the attribute, which could influence the strength of the attraction effect (Liao et al., 2021). Additionally, our focus on range decoys means that the results may not generalise to other types of decoys, such as frequency or range-frequency decoys, which may interact differently with the target (for a review, please see Wollschlaeger & Diederich, 2020). While we have confirmed the impact of adding decoys in this specific context, variations in attribute dominance – such as using decoys that are dominated on multiple attributes – have not been explored in this study.

3. Study 2. Attraction and multiple alternatives: how number of options modulate AE

3.1. Theoretical background

Nowadays, the e-commerce market is growing more and more, and consumers are overwhelmed with a huge variety of products and continuous suggestions, often resulting in an increase of uncertainty or indecisiveness on what to buy or not to buy. The typical binary and ternary contexts used to probe for context effects under laboratory conditions are very far from the rich and dynamic reality of consumers' choice, especially online: it is, therefore, necessary to understand how context effects work in broader choice sets. This second study addressed this challenge in a twofold manner: (i) by manipulating the number of options included in baseline conditions (up to six alternatives); (ii) by manipulating the target of AD decoys.

Previous literature has already shown that the number of options has an effect on consumer choice, and larger choice sets increase the difficulty of the decisional process (Berger et al., 2007; Sela et al., 2009; Simonson, 1999), consumer uncertainty, and post-decisional regret (Berger et al., 2007; Iyengar & Lepper, 2000).

In this study, we investigated the AE elicitation in larger multialternative choice sets. In such contexts, we added a decoy dominated by the middle (or the middle-expensive) option. It is well known that more complex choice scenarios make decision makers more reliant on heuristic strategies, without integrating all the information available (see Payne et al., 1992). In our study, the presence of a decoy in a choice set that includes several options with multiple attributes, thus imposing high working memory demands, could increase processing fluency by creating a similarity-based link with the target option (Novemsky et al., 2007). Similarly, in a complex choice set, the similarity between the dominant and the dominated options could directly attract decision makers' attention towards the target, thus eliciting a gaze cascade effect (Marini et al., 2020; 2023). Moreover, the need to avoid negative emotions (generated by complex comparisons among several attributes) could push decision makers to rely on a salient heuristic approach to the option weighting, as it is easier to justify and more effective in preventing post-decisional regret (Hedgecock & Rao, 2009). This suggests that, even in larger choice sets, the saliency cues (mainly driven by the AD decoy) could override a complex attributes comparison by capturing more attention and providing a convincing reason to prefer the dominant option (Landry & Webb, 2021). For these reasons, we hypothesised that there would be an increase in target preferences as long as the dominance structure remains clear.

Lastly, in Study 2, since larger baseline choice sets include a compromise option (a middle ground between the cheap and the expensive option), we explored in-depth how targeting the compromise option interfered with the efficacy of AD decoys. To date, to the best of our knowledge no study has empirically investigated how the presence of intermediate compromise alternatives can modulate the elicitation of the attraction effect. Since it is well known that in a ternary choice set, decision makers already have a good reason to prefer the middle option (Li, 2020), we assumed that targeting the middle option could interfere with the AE elicitation. However, if this is the case, we should have been able to elicit AE by simply shifting the decoy target (from the compromise to an extreme option). To test this hypothesis, in this experiment, we built three different quaternary conditions in which we varied the AD decoy targets.

3.2. Hypotheses

The primary objective of the second study was to address the following research question: What happens if we add more non-dominated competitors to the choice set?

Based on the theoretical background, we hypothesised that also larger choice sets are sensitive to the AE (**H2**). Secondly, we explored if the presence of a compromise option in the choice set could modify the AE elicitation (**H3**).

3.3. Methods: participants and procedure

For Experiment 2, we recruited a sample of 100 university students. The general methods and procedures were consistent with those used in experiment 1. 13 participants were excluded from the analyses, leaving a final sample of 87 subjects (52 females, mean age = 26 ± 5) who correctly completed the task with an average completion time of 14 min.

Participants performed a total of 60 choices, which were grouped into 10 blocks. The options and choice order were randomised in accordance with experiment 1 methodologies. In line with our hypotheses, we developed four baseline conditions (Binary, Ternary, Quaternary, and Quinary) that did not include an AD decoy. Each baseline condition was matched with a a corresponding decoy condition, in which a decoy option was included (see Table 2).

3.4. Methods: materials

In Study 2, we reused items from Study 1 (as detailed in the supplementary materials). Compared to the previous study, the quaternary baseline and quinary baseline conditions involved four/five different options (without any

Table 2. List of experimental conditions.

Condition	Description	Options
Binary Baseline (BB)	Binary choices between a cheaper (C) and a more expensive product (T).	C T
Decoy on Binary (DB)	Ternary choices with a decoy targeting the most expensive item of BB.	C T T^{AD}
Ternary baseline (TB)	Ternary choices with a compromise decoy (X) for the expensive item of BB.	C T X
Decoy on Ternary (DT)	Quaternary choices with an AD targeting the middle option of TB.	C T T^{AD} X
Decoy on Cheapest Ternary	Quaternary choices with an AD targeting the cheapest option of TB.	C C^{AD} T X
Decoy on Costliest Ternary	Quaternary choices with an AD targeting the expensive option of TB.	C T X X^{AD}
Quaternary Baseline (QtB)	Quaternary choices among four different products, with no decoy.	A C T X
Decoy on Quaternary (DQt)	Quinary choices with an AD targeting the third most expensive item of QtB.	A C T T^{AD} X
Quinary baseline (QnB)	Quinary choices with three compromise decoys for the expensive item of BB.	A C T X Z
Decoy on Quinary (DQn)	Senary choices with an AD decoy targeting the middle option of QnB.	A C T T^{AD} X Z

AD decoy), and the compromise/costliest and compromise options were targeted by an AD decoy in the decoy on quaternary and decoy on quinary conditions. Additionally, to comprehensively explore the impact of the AD decoy in ternary contexts, we built three different quaternary conditions, each with a decoy dominated by one of the baseline options of the ternary condition.

3.5. Results

In experiment 2, preliminary analyses were conducted following previous study procedures. Our hypotheses on the role of the number of options in the choice set in modifying the AE were tested by means of a one-way repeated measures ANOVA on the RST in the 6 conditions that shared the same target: Binary Baseline, Decoy on Binary, Ternary baseline, Decoy on Ternary, Quaternary Baseline, Decoy on Quaternary, Quinary baseline, and Decoy on Quinary. We observed a significant main effect of the condition [F (7, 602) = 28.71, $p < .001$, $\eta p^2 = .250$ $(1 - \beta) > .99$]. However, here we were particularly interested in the Bonferroni corrected post-hoc analyses. First of all, we replicated the increase in the RST in the Decoy on Binary (M = .71, SD = .23) condition compared to the Binary Baseline (M = .58, SD = .23; $p < .001$). Secondly, we did not find any evidence of the AE when we compared the Ternary baseline (M = .41, SD = .28) with the Decoy on Ternary condition, where the decoy was dominated by the intermediate option (M = .43, SD = .32; $p = 1.00$). Conversely, we observed a positive increase in the RST in the Decoy on Quaternary condition (M = .44, SD = .29) as compared with the Quaternary Baseline (M = .33, SD = .25; $p < .001$), whereas AE elicitation failed again to appear in the comparison between the Quinary baseline condition (Qui; M = .37, SD = .26) with the Decoy on Quinary condition (M = .35, SD = .27; $p = 1.00$) (Figure 3). These results have also been controlled for product and participant variability using GLMM analysis (see supplementary materials). Moreover, as in the previous study, also the conditions that revealed a significant attraction effect elicitation reported a limited number of subjects who exhibited a reversed repulsion effect (Decoy on binary: 15% Decoy on quaternary: 18%). Taken together, these results confirm H2, (i.e. AE elicitation was observed also in larger choice sets), and clarify H3, (i.e. "true compromise" alternatives appeared to be remarkably immune to AD decoys).

Furthermore, we calculated the magnitude of the AE-induced preference shift by subtracting the RST in baseline choice from the RST in decoy conditions, then we run a Friedman test on this measure, which showed a significant main effect of the conditions [$\chi 2(3) = 7.795$, $p = 0.05$]. However, subsequent Wilcoxon signed-rank test post-hoc did not elicit a statistically significant change among all conditions where AE occurred ($p = 1.00$): this suggested that, whenever AE occurs, it had a similar effect on choice behaviour, regardless of the number of baseline options.

In addition, we wanted to further verify that the lack of effectiveness of AD decoys in targeting the intermediate alternative in ternary and quinary (odd) contexts was, in fact, due to the immunisation property of "true

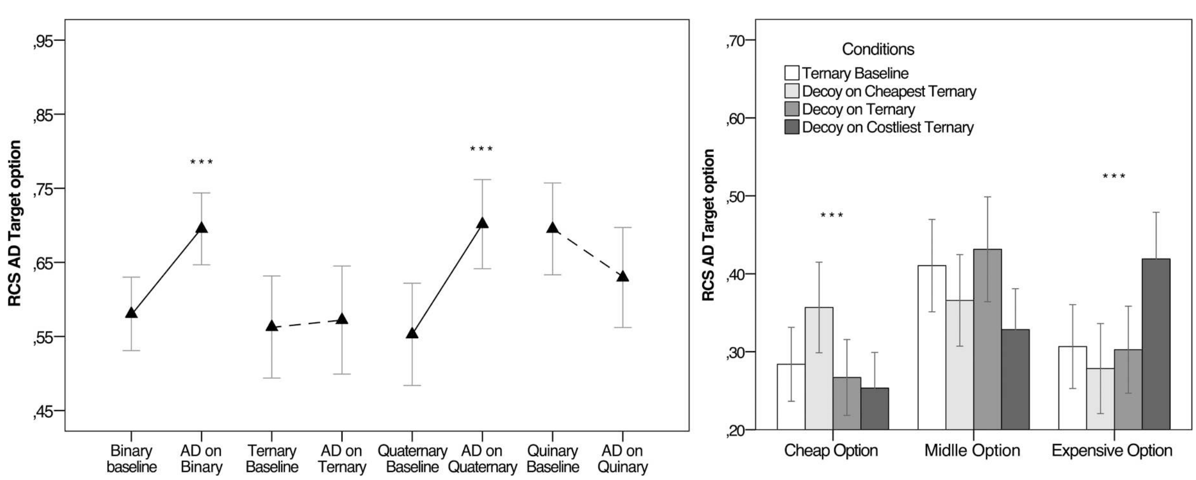

Figure 3. AE in Multialternative Contexts: Left panel: RCS of the AD target option calculated including all the competitors' options. AE elicitation in the ternary (AD on binary) and quinary (AD on quaternary) decoy conditions (solid lines represent significant AE). Right panel: The AE is elicited only when the AD decoy is not dominated by a (unique) compromise option. The AD decoy in a quaternary context shifted subjects' preferences only when it was inferior to the cheaper option (from 28% to 36%) or to the more expensive one (from 31% to 42%). No effect was found with AD decoys targeting the compromise alternative (from 41% to 43%). All the conventions as in Figure 2.

compromise" options. To test this, we compared options' preferences (cheap, compromise and expensive product preferences; dependent variable) in the Ternary baseline condition with, respectively, the Decoy on Ternary (AD decoy targeting the compromise option), the Decoy on Cheapest Ternary (AD decoy targeting the cheaper option), and the Decoy on Costliest Ternary conditions (AD decoy targeting the more expensive option) by means of a two-way ANOVA (Condition*Option). Firstly, we did not observe a main effect of the alternatives [F $(2, 172) = 2.48$, $p = .09$, $\eta p^2 = .03$], indicating that, collapsing all the four conditions together options selection did not differ between them. Secondly, we could not observe an effect of the session since, by collapsing each option choice share, we always reached the total number of choices of all participants (Cheap selections + Compromise selections + Expensive selections = 100%). On the contrary, we found a strong significant interaction [F $(6, 516) = 10.81$, $p < .001$, $\eta p^2 = .112$ $(1 - \beta) > .99$] proving a different choice share of the options depending on which condition was presented. As predicted, compared to the ternary baseline, we observed an increase in the cheaper option preferences when the AD decoy was dominated by that option in ternary costliest condition (cheap option preferences: from 28% to 36%; $p = .035$). Symmetrically, we found an increase in the more expensive alternative selections when it dominated the irrelevant option in the decoy on costliest ternary condition (expensive option preferences: from 31% to 42%; $p < .001$). On the contrary no effect was found with AD decoys targeting the compromise alternative (middle option preferences: from 41% to 43%; NS), thereby confirming H3 (Figure 3). In short, the AD decoys shifted subjects' preferences only when it targeted an extreme option, with respect to both the ternary baseline and the other quaternary conditions.

3.6. Discussion

In study 2, we tested the AE elicitation in larger choice sets as well as its interaction with CE in some multiattribute and multi-alternative decision contexts. As concerns the AE in multi-alternative contexts, our results highlighted an increase in target share due to the inclusion of an AD decoy both within more traditional choice scenarios (binary vs ternary contexts) and with larger sets of options (ternary vs quaternary and quaternary vs quinary choice sets). In general, our results suggested that AE also emerges in larger choice scenarios.

Finally, despite confirming the AE in larger choice set, we systematically documented the ineffectiveness of AD decoys in targeting "true compromise" options. The fact that the decoy is ineffective when it targets the compromise option is a novel but predictable result. Indeed, the middle option was chosen significantly more in the baseline ternary context (41%) than if choices were equally balanced across the three options (33%). Subjects thus already had a strong preference for the middle option, which is one of the factors that is known to decrease the attraction effect (Lichters et al., 2015).

A corollary of this finding is that attraction is an odd thing (pun intended): that is, targeting the intermediate alternative in a choice among an odd number of options does not work, even though decoys remain effective in these contexts when targeting non-compromise options. This result may be interpreted as another instance in which the AE fails to shift preferences because a clear preference has already stabilised: in this case, a preference for the compromise option. Moreover, if the decision makers already had a good reason to prefer the middle option (i.e. loss aversion; for which unstable preference had already been shifted in the baseline ternary condition) in the ternary context, the elicitation of AE when targeting an extreme option in the same contexts would suggest that AE is stronger than CE (Wollschlaeger & Diederich, 2020), even though the latter modulates the effectiveness of the former, by making true compromises immune to attraction. This interpretation aligned well with models that explain the decoy effect as providing justification for one's preferences (so called value-added models; see Connolly et al., 2013; Simonson, 1989; also Weddell & Pettibone, 1996, for a comparison with other models): since subjects already had an easily accessible reason to favor the true compromise option in choices among odd-numbered alternatives (the fact that it was a perfect compromise, indeed), the additional justification provided by AD decoys was unnecessary and thus ineffective; however, when those decoys targeted instead a different option in the same choice set, they succeeded in shifting choices towards their target and away from true compromises. This suggested that AD decoys were ineffective when a justification for choosing their target already existed, yet, in the absence of such justification, they provided a stronger justification than the one offered by CE.

4. Conclusion

How does the attraction effect change, depending on the choice architecture? Most previous studies have focused on the AE elicitation in binary baseline choice sets to ensure a clear recognition of the dominance structure and to avoid any interference with other context effects. To date, no study has systematically investigated the role of multiple decoys and AE elicitation in larger and more complex decision scenarios. This was a significant oversight, not only from a theoretical standpoint, but also for practical reasons: consumer choices in real life typically involve large sets of options, in which multiple context effects are likely to occur, either by accident or by design. This is true in general, and even more so in e-commerce and online consumption (e.g. streaming services), where the search for additional choice options is often trivial, so much so that information and choice overload are frequent occurrences. Understanding the impact of decoys in these contexts requires a sharp increase in the complexity of the choice scenarios used in laboratory experiments as a stepping stone towards properly designed field studies: in fact, the difficulty in translating AE effects from highly stylised toy examples to field applications may not only pertain option representation, as previously documented (Frederick et al., 2014; Lichters et al., 2015, 2017: Yang & Lynn, 2014), but also the number of alternatives, the interaction with other context effects, and the specific design of decoys. The studies presented in this paper offer valuable insight into the robustness of the attraction effect in relation to such manipulations.

Firstly, we proved that a further range extension due to adding more than one converging (range-based) decoy strengthens the AE. This effect is consistent with sequential sampling models: as long as the dominance structure is clearly salient, the second decoy provides an extra boost to the target subjective value. However, it would be wrong to conclude that "the more, the merrier" when it comes to decoys: on the contrary, the extra emphasis given to the inferiority of the target by multiple converging decoys can be offset by (i) the salience conferred to the competitor, by making it the only different alternative against a bunch of similar options, and (ii) the diffidence generated against the target, insofar as it looks as if someone is trying too hard to bias our choice towards it. The relevance of these tradeoffs was documented in study 1, where adding three converging AD decoys cancelled out the AE.

In this paper, we also explored how the attraction varies as we extend the choice set, and how it can be modulated by the presence of compromise alternatives. Here, we documented that the attraction effect has a significant impact in choices among larger sets of alternatives (i.e. up to five options in the baseline condition). In line with previous studies, we hypothesised a preliminary heuristic approach to the decision, with preliminary reliance on a non-compensatory decision-making strategy to eliminate alternatives that do not meet a specific criterion (Gudigantala et al., 2008; Hauser et al., 2009; Samuelson & Zeckhauser, 1988; Sarver, 2008). In this scanning phase, attention is drawn to the salient dominance structure through a similarity-based process that avoid heavy cognitive loads (mainly supported by the decoy introduction). Subsequently, once the search range has been restricted, the attribute-wise comparative process comes into play, thus eliciting the attraction effect (Marini et al., 2020; Noguchi & Stewart, 2014). A deeper RTs and eye-tracking analysis would be needed to further verify this hypothesis.

However, in both studies, although AE-related manipulations influenced most of the respondents, we also found a relevant portion of the sample (about 15%) showing a consistent reduction in the choice share of the target (i.e. repulsion effect). This result is not surprising and falls within subjects' heterogeneity. Previous studies documented that the magnitude and the direction of contexts effects might vary across individuals, especially when baseline prior preferences have not been measured (Crosetto & Gaudeul, 2016; Frederick et al., 2014).

Lastly, besides documenting the effectiveness of AE with larger option sets, we uncovered some hitherto unknown interactions between AE and CE. Most notably, we observed an immunisation effect of true compromises with respect to AE: decoys that target the intermediate option among an odd number of alternatives simply fail to work, even though they are perfectly effective when targeting one of the extreme options in those choice contexts.

This suggests that the compromise effect might offer a more robust basis for decision-making, as extremeness aversion already provides a sound reason to prefer the middle option in cases of decisional uncertainty, making the presence of AD decoys redundant in enhancing the attractiveness of the compromise option. The decoy effect, being more susceptible to manipulation, may be less effective in such contexts, as it is inherently more of a bias than a genuine heuristic for decision-making. In short, in situations where a solid justification for preference already exists (i.e. the compromise option), higher-order influences (such as the comparative process altered by the presence of an asymmetrically dominated decoy) appear to be ineffective. This aligns with the notion that the compromise effect is inherently more stable and less prone to external influence.

It would be tempting to interpret this fact as demonstrating that the CE can cancel out the AE, insofar as extremeness aversion already provides a valid reason to prefer the middle option in case of decisional uncertainty, thereby making AD decoys redundant in motivating preference for that option. All considered, it seems more prudent, for the time being, to treat this finding as an insulation effect characteristic of compromise options, not necessarily causally related to the boost in preference sometimes observed due to CE. This immunity to AE of true compromises is a novel result and we believe it will deserve further investigation in future studies: our current interpretation suggests to see it as partial confirmation of justification-based models of context effects since AD decoys do not work when they target options for which good justification for preference is already apparent (true compromises), whereas they work well (indeed, better than CE) when such justification is absent.

Taken together, these results show that, even if context effects have long been studied, a lot of ground remains to be covered, especially when it comes to more realistic, noisy, and complex decision-making scenarios. The current trend to emphasise the importance of laboratory research for business applications and the need to develop personalisation algorithms that take into account cognitive biases in e-commerce decision-making (Lee & Greenley, 2010; Lilien et al., 2002) makes these considerations even more pressing: if we want to develop behavioural insight that will be valuable in real-life markets, we need to enhance the similarity of our laboratory settings with those markets. Investigating whether and how decoy effects work in crowded decision contexts is a necessary and long overdue step in that direction.

This study has some limitations that future researchers may address in similar research projects. First, in these experiments, we used commercial products from real e-commerce sites simplifying their representation by means of only two representative attributes (i.e. price and quality). We acknowledge that real-world decision contexts often involve more than two attributes, which could add complexity to the attraction effect (Huber et al., 2014). In scenarios with multiple attributes, the salience of certain attributes likely affects how decision-makers weigh their options, and it becomes more challenging to detect asymmetrical dominance. Secondly, we used choice scenarios in which available alternatives were arrayed in base sets of balanced alternatives, thus simplifying participants' sampling procedures and product comparisons. Furthermore, the use of identical images for the target and decoy may have simplified the comparative process between them. Both these procedures have been adopted for experimental purposes and do not ensure the reproducibility of these results in real e-commerce markets in which customers have to compare products going back and forth between different screens on several attributes. For these reasons, despite some relevant ecological improvements (i.e. the use of an online survey to simulate e-commerce purchase decisions and the enrichment of traditional AE-related paradigms), these studies can be thought of as a useful preliminary step towards field studies. Indeed, their methodology is still more similar to laboratory research. Moreover, previous research has shown that learning processes can also affect the sampling strategies, thus modifying participants' choices during the experiment (Orquin et al., 2013). Similarly, also the allocation of attention and information research strategies have been found to be affected by repeated choice tasks (Knoepfle et al., 2009). In our experiment, it means that targets' price values became more relevant and repeated across options, thus making these options more memorable and possibly increasing their selections.

Data availability statement

The data that support the findings of these studies are available on the Open Science Framework (OSF) at: https://osf.io/g2dak/?view_only=6b2960a3e0c940c49a7645c8febecc75.

Author contributions

MM and FP designed the experimental conditions; MM and DC programmed the software for running the experiments; MM and AA collected the data, and MM performed the statistical analysis; all authors contributed to the interpretation of the data, DC and MM reviewed the relevant literature, and MM and FP wrote the paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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