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# "I WANT IT NOW!" INTERTEMPORAL CHOICE THROUGH THE LENS OF VALENCE WEIGHTING BIAS

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The current research presents a novel perspective regarding individual differences in intertemporal choice preferences. We postulate that such differences are partly rooted in individuals' valence weighting proclivities—their characteristic manner of weighting positive and negative valence when constructing an initial evaluation. Importantly, valence weighting bias should predict intertemporal choice most strongly (a) for those who are relatively low in trait self-control and (b) when the magnitude of the available rewards is relatively small, because these two factors are associated with lesser motivation/resources to deliberate extensively about one's decision. More specifically, we propose that those with a more positive weighting bias give greater weight to the clearly positive immediate reward that is under consideration, and under these conditions, the resulting appraisal shapes choice more strongly. Using a performance-based measure of valence weighting tendencies, a hypothetical intertemporal choice task, and a self-report measure of trait self-control, we provide evidence for our hypothesis.

*Keywords:* valence weighting, attitude generalization, intertemporal choice, individual difference

An abundance of social problems (e.g., smoking, diet failure, etc.) seem to stem from individuals making near-sighted decisions in which they prefer smaller but immediate rewards over larger rewards for which they must wait. To study such intertemporal decision-making, researchers typically construct situations involving real or hypothetical immediate and delayed rewards in which the size of the difference between the rewards and the length of delay are systematically varied.

*Supplemental materials are available at https://osf.io/pq2x7.*

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Previous research has documented a variety of situational factors that influence these decisions. For example, people tend to show a dampened preference for the immediate reward when the magnitude of both rewards increases, a finding referred to as the *magnitude effect* (Kirby & Maraković, 1996; Thaler, 1981). Further, people show a dampened preference for immediate rewards when attention is drawn to the date on which the delayed reward will be received rather than the amount of time one has to wait to receive it (*the date/delay effect*; Read, Frederick, Orsel, & Rahman, 2005), when the opportunity costs of selecting the immediate reward are highlighted (Read, Hardisty, & Olivola, 2017), and when induced to think abstractly (e.g., Yi, Stuppy-Sullivan, Pickover, & Landes, 2017; see Frederick, Loewenstein, & O'Donoghue, 2002; Rung & Madden, 2018, for reviews of factors that influence intertemporal decision-making).

Beyond these situational forces, individual differences in the extent to which immediate rewards are preferred have been documented in the literature, as evidenced by stable and consistent intertemporal choice preferences (Kirby, 2009; see Odum, 2011, for a review). Some individuals show an enduring preference for immediate rewards, whereas others prefer delayed rewards. These individual differences matter: A stronger preference for immediate rewards has been linked to less desirable patterns of behavior, including use of illicit drugs and cigarettes (e.g., Bickel, Odum, & Madden, 1999; Kirby, Petry, & Bickel, 1999), as well as unhealthy eating (Barlow, Reeves, McKee, Galea, & Stuckler, 2016; see Reimers, Maylor, Stewart, & Chater, 2009, for a review). These links to meaningful outcomes underscore the importance of understanding the psychological mechanism driving individual differences in intertemporal choice preference.

Why do some people have such difficulty forgoing the immediate reward in favor of receiving the delayed one? We propose that intertemporal decision-making is partly a function of individual differences in valence weighting tendencies, that is, biases that involve greater emphasis on either positive or negative signals. Before fully articulating our rationale for proposing a relation between valence weighting and intertemporal choice, we begin with a brief overview of research concerning individual differences in valence weighting and their assessment. We then turn to a brief consideration of the dominant perspectives regarding intertemporal choice, and finally conclude with the reasoning that underlies our linking the two literatures.

## VALENCE WEIGHTING BIAS

Valence weighting refers to an attitude generalization process in which positive and negative signals are integrated to arrive at an initial appraisal of a novel stimulus (Fazio, Pietri, Rocklage, & Shook, 2015; Rocklage & Fazio, 2014). Some individuals give greater weight to positive signals than negative, whereas others exhibit the reverse tendency. To assess such individual differences in valence weighting, referred to as an individual's valence weighting bias, researchers have used a performance-based measure called BeanFest (Fazio, Eiser, & Shook, 2004). BeanFest consists of two phases. In an initial learning phase, participants interact with and develop attitudes toward a number of previously unfamiliar bean stimuli selected from a large matrix that varies along the dimensions of shape and number of speckles. In a subsequent test phase, participants categorize all of the beans in the matrix (i.e., the familiar game beans, plus novel beans that vary in their resemblance to the game beans) as either helpful or harmful. Of particular interest is the classification of the novel beans, as it requires generalization from the attitudes developed toward the game beans. Participants must weigh the extent to which a novel bean resembles the previously learned positive and negative game beans. As the classification of novel beans is partly a function of how well the game beans are learned, valence weighting bias is indexed as the extent to which positive or negative attitudes generalize more strongly than expected based on the pattern of learning of game beans. Thus, the measure estimates the extent to which participants tend to give greater weight to positive versus negative signals when constructing appraisals of novel stimuli.[1]

A relatively lengthy program of research documents that valence weighting bias predicts judgment and behavior across a variety of domains, suggesting that it represents a fundamental, process-oriented personality characteristic (see Fazio et al., 2015, for a review). In one series of studies (Pietri et al., 2013a, Studies 3, 5, and 6), a more positive valence weighting bias was associated with lower risk apprehension, as assessed by the Choice Dilemmas Questionnaire (Wallach, Kogan, & Bem, 1962) and the Domain Specific Risk-Taking Scale (Weber, Blais, & Betz, 2002), and greater risk-taking behavior, as assessed by the Balloon Analogue Risk Task (Lejuez et al., 2002). In addition, a more negative valence weighting bias predicts greater sensitivity to the possibility of interpersonal rejection and more threatening interpretations of ambiguous scenarios (Pietri et al., 2013a, Studies 1 and 2). Importantly, the impact of valence weighting bias extends beyond the lab. In a prospective study involving college students' first few weeks on campus, students with a more positive valence weighting bias actually made more friends over time, and this prospective relation held true over and above the students' reported level of extraversion and the number of campus friends they listed at the beginning of the study (Rocklage, Pietri, & Fazio, 2017). Thus, it appears that valence weighting is an important psychological process that influences judgment and behavior whenever a situation requires that positive and negative signals be integrated to arrive at an appraisal of a novel stimulus.

The influence of valence weighting, however, appears to be greatest when the motivation and/or resources to override one's initial appraisals is relatively low. In one study, the motivation to deliberate on one's initial appraisals was experimentally

1. People appear to be unable to accurately report their performance-based valence weighting tendencies. Pietri and colleagues (2013a) found a null relation between valence weighting bias as assessed by BeanFest and a self-report instrument in which individuals are asked directly to appraise their valence weighting tendencies (e.g., "If you see something that has both negative and positive aspects, in general which do you give more weight to?"). A more recent analysis aggregating across a large number of studies also revealed a correlation of essentially zero, $r(1482) = 0.046$, $p = 0.078$ (Granados Samayoa & Fazio, 2020). See Fazio and colleagues (2015) and Niese and colleagues (2019) for relevant discussions of the null relation between the performance-based measure of valence weighting bias and self-beliefs.

weakened by having participants read a newspaper article reporting presumed scientific research highlighting the benefits of following one's intuitions. Under these circumstances, the influence of valence weighting bias on risk-taking in a novel context was stronger than in a comparison condition in which participants read an article stressing the value of overriding one's intuitive responses. Similarly, the influence of valence weighting bias on exploratory behavior was greatest when the opportunity to deliberate was limited via a restriction of the time participants had to make decisions about sampling novel stimuli (Rocklage & Fazio, 2014).

In addition to being manipulated (as above), prior research has taken a measurement approach to document the impact of motivation and resources to deliberate. Broadly speaking, the impact of these constructs can be assessed using either situational or dispositional variables. As an example of the latter, Zunick, Granados Samayoa, and Fazio (2017) captured motivation and/or resources to deliberate using the Brief Self-Control Scale (Tangney, Baumeister, & Boone, 2004), a self-report measure of trait self-control. The rationale was that this instrument was specifically designed to assess the extent to which people are successful at altering their initial reactions (e.g., emotions and impulses) to promote positive outcomes. Those low in trait self-control are essentially reporting that they lack sufficient motivation or resources to regulate their behavior.[2] As predicted, the relation between valence weighting bias and the outcome of interest was strongest among those with relatively low trait self-control.

Together, the studies in this line of work suggest that valence weighting bias represents a fundamental individual difference serving to shape an individual's initial appraisal of stimuli characterized by positive and negative features that must be integrated. These appraisals then directly inform judgment and behavior, unless individuals have sufficient motivation and resources to further deliberate and adjust their assessments. With this in mind, we conceptualize intertemporal decision-making—a situation involving positive and negative signals that need to be integrated—as an issue of valence weighting. However, before fully outlining our rationale for hypothesizing a relation between valence weighting bias and preference for delayed rewards, we review some of the dominant perspectives on intertemporal choice preferences.

## INTERTEMPORAL CHOICE

At this point, we can return to the key question guiding this research. Why do people differ in their intertemporal choice preferences? The traditional economic

2. Note that in this context, self-control is defined as "capacity to change and adapt the self so as to produce a better, more optimal fit between self and world" (Tangney et al., 2004, p. 275), not as a preference for larger, delayed over smaller, sooner rewards (e.g., Ainslie, 1975). This second definition represents what we refer to as intertemporal choice preference, and is the outcome of interest in the current research. Trait self-control and intertemporal choice preferences, as instantiated by the Brief Self-Control Scale and the Monetary Choice Questionnaire, are not only conceptually distinct, but also uncorrelated in our data (all $p$'s > 0.17). Indeed, a large meta-analysis found that self-report measures of trait self-control (including the Brief Self-Control Scale) are only modestly correlated with scores on the Monetary Choice Questionnaire, $r = 0.16$ (Duckworth & Kern, 2011).

perspective proposes that when presented with the two alternatives, individuals assign value to each based on their features. Importantly, as the delay to receipt increases, the subjective value of the reward decreases, a tendency referred to as delay discounting (Mazur, 1987). To make a decision, the alternatives are compared, and the one with the highest subjective present value is then selected (da Matta, Gonçalves, & Bizarro, 2012). This perspective views individual differences in intertemporal choice preference as arising from differences in delay discounting rates and the curvature of utility functions, but does not provide a deeper mechanistic account of how such individuals differ from one another.

To provide such an account, intertemporal choice has been analyzed from the perspective of query theory (Weber et al., 2007). This theory proposes that when faced with an intertemporal choice situation, people make valuation decisions by breaking down the larger question, "Do I prefer a smaller reward now or a larger reward later," into component queries that focus on formulating reasons for either choosing the immediate reward or waiting for the delayed reward. People execute these queries in order, first gathering evidence that supports one choice, then the other. Retrieving reasons in support of the first choice from memory temporarily inhibits the retrieval of reasons in support of the other choice when attention turns to the second query, a phenomenon called output interference. This results in a difference in supportive evidence in favor of the first query, which influences choice (Johnson, Häubl, & Keinan, 2007). According to this account, then, the order in which alternatives are considered exerts a major influence on choice.

Aside from the benefit conferred by output interference, the literature on order effects suggests that the immediate option may also enjoy an advantage simply by virtue of being presented first. For example, Carney and Banaji (2012) have provided evidence that items presented first become associated with greater positivity, as assessed by indirect measures of attitudes. Further, whether the choice involves predicting a coin flip (Bar-Hillel, Peer, & Acquisiti, 2014) or selecting the best wine (Mantokanis, Rodero, Lesschaeve, & Hastie, 2009), the option presented or experienced first tends to be selected more often or preferred.

Similarly, several accounts have been put forth to explain the magnitude effect—the finding of attenuated preference for the immediate reward as the magnitude of both rewards increases. Building on the traditional economic perspective, Loewenstein and Prelec (1992) suggested that the magnitude effect is explained by greater elasticity of the value function when reward magnitude is relatively large. Moving away from the elasticity explanation, Noor (2011) suggested that increased attention to the delayed reward can account for the magnitude effect. Recently, Ballard and colleagues (2017) put forth a self-control account in which the magnitude effect is explained by greater engagement of control processes as the magnitude of the rewards increases because these choices are regarded as more important. In support of their account, the authors first demonstrated greater activation of control-related brain areas when individuals were making large-magnitude choices. In a subsequent experiment, they found an attenuation of the magnitude effect when individuals were asked to justify their choices, a manipulation intended to encourage greater engagement of controlled processing across all trials (i.e., even smaller-magnitude trials). As predicted, on smaller-magnitude trials, leading individuals to justify their choices reduced preference for the immediate reward relative to a control condition. In contrast, the manipulation had little influence on larger-magnitude trials because a greater degree of controlled processing occurs naturally.

## VALENCE WEIGHTING BIAS AND INTERTEMPORAL CHOICE

To arrive at our main hypothesis, we combine insights from various perspectives described above. We propose that individual differences in valence weighting partly underlie individual differences in intertemporal choice preference such that a more positive valence weighting bias is associated with a greater preference for immediate rewards, and that this effect is all the stronger under certain conditions. We reason that when individuals are presented with a choice between an immediate and a larger, delayed reward (in that order), they first consider the immediate reward and then move on to the delayed reward. In this context, we argue for an initial serial and independent consideration of each reward alternative before any comparisons take place (more akin to what is sometimes referred to as integrative rather than comparative information search; Reeck, Wall, & Johnson, 2017).

Evidence that serial and independent consideration of alternatives takes place during intertemporal choice is provided by two experiments. Sawicki and Bialek (2017) found that in a gains-focused intertemporal task, there was stronger preference for the delayed option when it was presented on the left versus the usual right position. Even more relevant to the current procedure, we conducted an experiment (see supplemental material for details) varying whether the delayed option was presented above or below the immediate option on the computer screen. Presenting the delayed option first increased its selection, especially when reward magnitude was not large. Thus, in accord with query theory, research findings indicate that the immediate alternative enjoys an advantage, at least in part, due to its typical presentation as the first of the two listed alternatives.

Moreover, when the immediate reward is evaluated first and independently, there are no negative aspects to it. One is appraising enthusiasm for receiving a given amount of money immediately. The possibility is clearly positive. Support for this assertion is provided by Read, Olivola, and Hardisty's (2017) work on highlighting the opportunity costs associated with the two alternatives (i.e., what one gives up by choosing an option). In a series of studies, they find that relative to a situation in which opportunity costs are not mentioned (e.g., "Would you prefer $31 today OR $85 in 7 days?"), highlighting the opportunity cost of choosing the delayed reward (e.g., "Would you prefer $31 today OR $0 today and $85 in 7 days?") has no effect on choice. Apparently, the fact that the delayed option involves no immediate money is naturally salient; the opportunity cost is evident. However, highlighting the opportunity cost of selecting the immediate reward (e.g., "Would you prefer $31 today and $0 in 7 days OR $85 in 7 days?") leads to greater patience (i.e., reduced preference for the immediate reward). This suggests that when people assess the options presented in a typical intertemporal choice situation (i.e., with the immediate reward presented first), they focus solely on the positive value of the immediate option, neglecting any consideration of the opportunity cost it necessarily involves with respect to the future option (i.e., the receipt of no money at all in the future).

Thus, at least in certain choice situations, constructing a preference involves appraising a clearly positive alternative in the form of the immediate reward, then appraising a more complex alternative that is larger (a positive feature) in value but only available after a delay (a negative feature), and finally comparing the two. Using this framework, we propose that choice will be partly determined by the relative weight placed on the salient signal that is the immediate reward. Those with a more positive valence weighting bias should place greater weight on this positive signal, and consequently, they should be biased toward selecting it.

However, there is good reason to believe that the strength of this effect will vary according to additional features of both the individual and the situation. As noted earlier, previous research (Rocklage & Fazio, 2014; Zunick et al., 2017) suggests that the influence of valence weighting bias will be greatest when individuals' motivation and/or resources to deliberate on initial appraisals is relatively low. The valence weighting bias-shaped initial preference should serve as a sufficient basis for a decision among such individuals. With this in mind, we predict an interaction between valence weighting bias and trait self-control, such that valence weighting bias's influence on choice will be strongest among those relatively low in trait self-control.

As for the situation, any factor that takes attention away from the immediate reward should weaken the relation between valence weighting bias and choice. One such factor is the magnitude of the rewards under consideration. As noted previously, people show a reduced preference for immediate rewards when magnitudes are relatively large, suggesting that large magnitudes attenuate the immediate reward's attentional advantage (Noor, 2011). We provide further evidence regarding this magnitude effect in the experiment we summarize in the supplemental material. Indeed, research suggests that there is more extensive deliberation at larger reward magnitudes (Ballard et al., 2017). Consequently, we predict that the interaction between valence weighting bias and trait self-control will be strongest when magnitude of the rewards is relatively small.

## THE CURRENT RESEARCH

To test our hypothesis, participants first had their valence weighting tendencies measured through BeanFest, after which their intertemporal decision-making was assessed using the Monetary Choice Questionnaire (MCQ; Kirby & Maraković, 1996). Lastly, their motivation and/or resources to override initial appraisals were assessed via the Brief Self-Control Scale, a common measure of trait self-control. All relevant measures, manipulations, and exclusions are reported. Study materials, data, and syntax files can be retrieved online: https://osf.io/pq2x7/.

## METHOD

### PARTICIPANTS

Two hundred and ninety-six undergraduate students enrolled in an introductory psychology course at a large Midwestern university participated in an in-lab session in exchange for course credit. We aimed to run as many participants as possible across two semesters. The resulting sample size was well above what is typical for a correlational study involving valence weighting bias. In total, 26 participants were excluded from the analyses. Eight demonstrated poor learning of the game beans. These individuals were identified as outliers in the learning distributions as their values fell 2.5 median absolute deviation units below the median (Leys, Ley, Klein, Bernard, & Licata, 2013). Four individuals showed levels of inconsistency in their responses above recommended standards (i.e., numerous switch points; Kaplan et al., 2016), and an additional 12 individuals selected a single response option for all 27 choices on the MCQ (Kirby & Maracović, 1996). These patterns of responding are suggestive of a lack of attention to the details of the tasks. Lastly, at the end of the session two participants reported not paying attention to the tasks. The final sample consisted of 270 participants (146 females, 124 males). According to a sensitivity analysis, the study was adequately powered to detect a small effect ($f = 0.04$) at 80% power (Faul, Erdfelder, Lang, & Buchner, 2007).

### BEANFEST

BeanFest is an attitude formation and generalization task. As such, there is an initial learning phase in which attitudes are formed and a subsequent test phase in which generalization can be assessed. The learning phase involves 36 beans from six regions of a 10 x 10 matrix of bean stimuli that differ along the dimensions of shape (circular to oblong) and number of speckles (one to ten). Half of these beans (i.e., three of the six types) are assigned positive value (+10 points) and the other half are assigned negative value (–10 points). The learning phase is presented as a game in which the goal is to accumulate points by approaching positive beans and avoiding negative beans, and it consists of three blocks of 36 trials. On each trial, participants see a game bean presented on the screen and are asked whether they would like to select it or not. If a positive bean is selected, 10 points are added to the point total. If a negative bean is selected, 10 points are deducted. If participants decide not to select a bean, they are shown the value of the bean, but their point total does not change. Through this interaction, participants develop positive and negative attitudes toward the six types of game beans (e.g., circular beans with few speckles), depending on their associated point value.

In a subsequent test phase, all 100 beans from the matrix (i.e., the 36 game beans and 64 novel beans) are presented to participants, one at a time. Their task is to indicate whether each bean would have been harmful or helpful during the game phase. This categorization forms the basis for our assessment of attitude formation and generalization tendencies. Valence weighting bias represents the characteristic pattern of attitude generalization demonstrated by each participant. However, because attitude generalization is partly a function of how well the game beans were learned (i.e., attitude formation) and variability exists along this dimension, valence weighting bias is calculated as the difference between the average response to novel beans and the estimated response to novel beans based on the learning of game beans derived from a normative regression equation. This normative regression equation has been calculated using data from thousands of participants that have completed BeanFest over the years (see Fazio et al., 2015, for details).

Valence weighting bias, then, represents the degree to which participants classify novel beans as more positive or negative than one would expect based on their learning of game beans. For example, a more positive valence weighting bias indicates that participants classified more novel beans as positive than expected on the basis of their pattern of learning.

## MONETARY CHOICE QUESTIONNAIRE

Intertemporal decision-making was assessed via the MCQ (Kirby & Maraković, 1996). This instrument consists of 27 items that present choices between an immediate reward (presented toward the top of the screen) and a larger, delayed reward (presented lower). For example, one item asks participants to choose between receiving $31 today OR $85 in 7 days. These items vary in terms of the size of the difference between the rewards, the amount of time one must wait, and the magnitude of the rewards. The items can be grouped into small ($30–$35), medium ($55–$65), and large ($70–$85) categories according to the magnitude of the larger, delayed reward. There are nine items within each category. Importantly, within each magnitude category, the average ratio of the immediate to the delayed reward is roughly equivalent. This feature allows us to investigate the magnitude effect, as we can detect differences in preference for immediate rewards across reward magnitudes while holding reward ratio constant.

The data were scored using an automated scoring spreadsheet provided by Kaplan and colleagues (2016). Though more complicated measures of intertemporal choice preferences exist, we elected to use the proportion of larger, delayed choices as our outcome of interest due to its relative freedom from theoretical assumptions. That said, this measure has been found to correlate very strongly with the often-used log-transformed delay discounting rate parameter $k$ ($r = -0.97$; Myerson, Baumann, & Green, 2014).

## BRIEF SELF-CONTROL SCALE

Trait self-control was assessed using the 13-item Brief Self-Control Scale (Tangney et al., 2004). On this instrument, participants indicate on a five-point scale ranging from 1 (Not at all like me) to 5 (Very much like me) the extent to which statements such as “I am good at resisting temptation” and “I often act without thinking through all the alternatives” (reverse scored) reflect how they typically are. The scale showed good reliability ($\alpha = 0.84$).

## RESULTS

We began by investigating whether trait self-control and valence weighting bias correlated with intertemporal choice preferences. Collapsing across magnitude, proportion of delayed choices was not significantly correlated with either trait self-control, $r(268) = 0.066$ (95% CI: –0.053, 0.186), $p = 0.28$, or valence weighting bias, $r(268) = -0.052$ (95% CI: –0.17, 0.069), $p = 0.40$. Further, there was no significant correlation between proportion of delayed choices and trait self-control on trials that were of small, $r(268) = 0.075$ (95% CI: –0.034, 0.19), $p = 0.22$, medium, $r(268) = 0.028$ (95% CI: –0.092, 0.15), $p = 0.65$, or large magnitude, $r(268) = 0.084$ (95% CI: –0.032, 0.20), $p = 0.17$. There was also no significant correlation between proportion of delayed choice and valence weighting bias on trials that were of small, $r(268) = 0.092$ (95% CI: –0.21, 0.028), $p = 0.13$, medium, $r(268) = -0.022$ (95% CI: –0.14, 0.10), $p = 0.72$, or large magnitude, $r(268) = -0.035$ (95% CI: –0.16, 0.090), $p = 0.56$.

However, none of these simple correlations test our conceptual reasoning. To test our main hypothesis, a mixed-model analysis was conducted with reward magnitude, valence weighting bias, trait self-control, and their interactions entered as predictors of the proportion of larger, delayed reward choices. First, a main effect of magnitude emerged, $F(1.9, 513.1) = 8.97$, $p < 0.001$, $\eta_p^2 = 0.033$. The proportion of delayed choices increased as the reward magnitude increased ($M_{small} = 0.39$, $SD_{small} = 0.18$; $M_{medium} = 0.47$, $SD_{medium} = 0.20$; $M_{large} = 0.53$, $SD_{large} = 0.19$). As predicted, the results also revealed a significant two-way interaction between valence weighting bias and trait self-control, $F(1, 266) = 5.03$, $p = 0.03$, $\eta_p^2 = 0.019$. For those relatively low in trait self-control (one *SD* below the mean), a more positive valence weighting bias was significantly associated with a decrease in the number of larger, delayed rewards chosen, $\beta = -0.20$ (95% CI: –0.38, –0.02), $t(266) = -2.18$, $p = 0.03$. For those relatively high in trait self-control (one *SD* above the mean), valence weighting bias did not significantly predict choice, $\beta = 0.06$ (95% CI: –0.09, 0.22), $t(266) = 0.83$, $p = 0.41$ (see Figure 1).

Importantly, this was qualified by the predicted three-way interaction between valence weighting bias, trait self-control, and magnitude, $F(1.9, 513.1) = 3.49$, $p = 0.03$, $\eta_p^2 = 0.013$. To decompose this three-way interaction, we began by probing the valence weighting bias-trait self-control interaction for small-magnitude choices. An ordinary least squares regression analysis revealed a significant interaction between valence weighting bias and trait self-control, $\beta = 0.19$ (95% CI: 0.07, 0.30), $t(266) = 3.18$, $p = 0.002$, that mirrors the interaction obtained above when collapsing across magnitudes. Specifically, for those relatively low in trait self-control (one *SD* below the mean), a more positive valence weighting bias was associated with a decrease in the proportion of larger, delayed rewards chosen, $\beta = -0.30$ (95% CI: –0.48, –0.12), $t(266) = -3.33$, $p = 0.001$. No such effect was obtained for those relatively high in trait self-control (one *SD* above the mean), $\beta = 0.07$ (95% CI: –0.08, 0.22), $t(266) = 0.91$, $p = 0.37$. By contrast, the interaction between valence weighting bias and trait self-control was not significant for either medium-, $\beta = 0.10$ (95% CI:

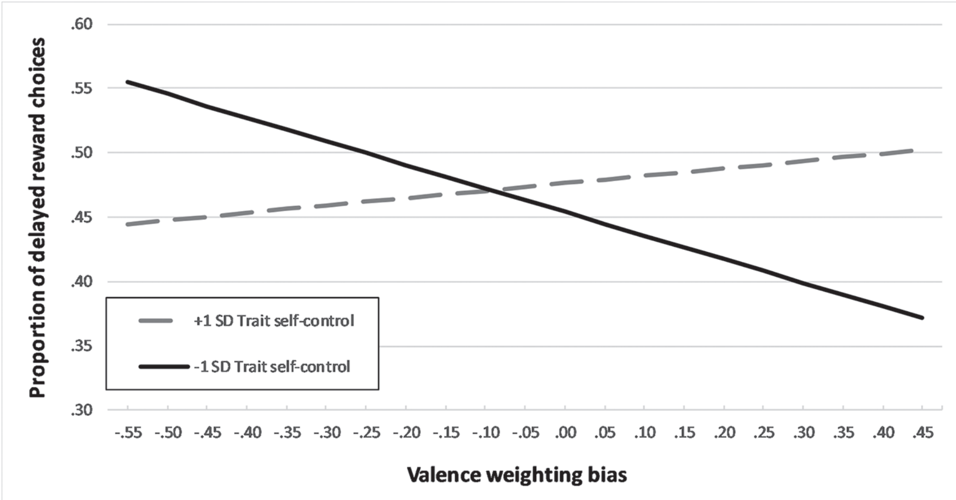


FIGURE 1. Proportion of delayed reward choices predicted by valence weighting bias, trait self-control, and their interaction. Higher numbers on the vertical axis indicate a higher proportion of delayed reward choices.

–0.02, 0.21), $t(266) = 1.64$, $p = 0.10$, or large-magnitude trials, $\beta = 0.09$ (95% CI: –0.02, 0.21), $t(266) = 1.60$, $p = 0.11$ (see Figure 2).

## DISCUSSION

Consistent with our predictions, valence weighting bias predicts intertemporal choice preferences under certain conditions. Collapsing across levels of reward magnitude, there was a significant interaction between valence weighting bias and trait self-control. For those who reported having relatively low trait self-control, a more positive valence weighting bias was associated with a lower proportion of delayed reward choices. This suggests that when a situation arises in which a clearly positive alternative (the immediate reward) is presented first, and must be compared against a more complex alternative (the larger, delayed reward), valence weighting assists in the construction of a choice. Those with a more positive valence weighting bias appear to give greater weight to the clearly positive signal of the immediate reward, and thus, their choices reveal a preference for this alternative. This tendency is particularly evident among individuals who do not believe themselves to have sufficient motivation and/or resources to deliberate on the initial appraisals that are shaped by their valence weighting tendencies (i.e., those with relatively low self-control), consistent with previous research (Rocklage & Fazio, 2014; Zunick et al., 2017).

However, the results also highlight the important role of reward magnitude. When the magnitude was relatively small, valence weighting bias and trait self-control interacted to predict choice in the manner described above. In fact, valence

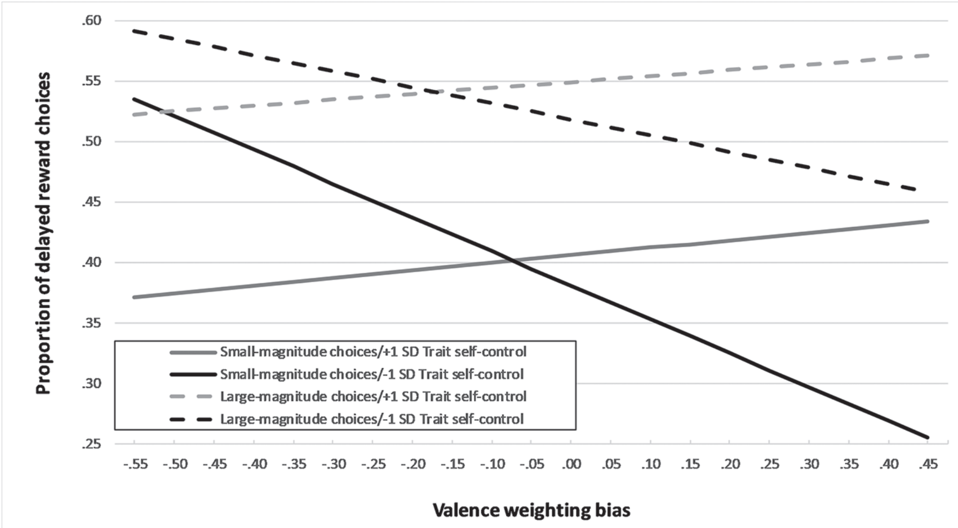


FIGURE 2. Proportion of delayed reward choices predicted by valence weighting bias, trait self-control, delayed reward magnitude, and their relevant interactions. Higher numbers on the vertical axis indicate a higher proportion of delayed reward choices.

weighting bias's influence on choice was strongest when trait self-control was relatively low and the magnitude of the rewards was relatively small. In contrast, when the magnitude was relatively large, this interaction did not reach statistical significance as valence weighting bias's ability to predict choice for those relatively low in trait self-control was weakened considerably. This suggests that as the magnitude of the rewards increases, the delayed reward increasingly draws attention to itself (see the experiment reported in the supplemental material for supportive evidence) and individuals deliberate on their choice to a greater extent (Ballard et al., 2017), tendencies that should attenuate the influence of valence weighting bias on choice.

Though valence weighting bias and trait self-control interacted to predict intertemporal choice preferences, neither variable was significantly correlated with choice on their own. For the reasons outlined previously, the null relation between valence weighting bias and preference for immediate rewards was to be expected. On the other hand, it is interesting to consider how the relation between trait self-control and preference fits with the extant literature. Though some prior research examining the association between trait self-control and preference for delayed rewards has yielded null results (e.g., Kahn, Holmes, Farley, & Kim-Spoon, 2015), other studies have reported a significant positive relation between these variables (e.g., Guan & He, 2018). More to the point, a large meta-analysis conducted by Duckworth and Kern (2011) found that trait self-control (as assessed by self-report measures including the Brief Self-Control Scale) was modestly correlated with preference for delayed rewards on the MCQ ($r$ = 0.16). The null result reported here could reflect the difficulty of detecting such a small effect. That said, future research should code for sample characteristics across studies (e.g., college vs. online, Western vs. non-Western) to identify potential moderators of this relation.

One potential criticism of the present conceptual framework is its seemingly narrow generalizability because it depends upon a specific order in which the reward alternatives are presented (i.e., immediate reward presented first). From a methodological perspective, randomizing order of presentation (i.e., whether the immediate reward is presented first) is a sensible alternative, and researchers do sometimes employ this procedure (e.g., Koffarnus & Bickel, 2014). On trials in which the larger, delayed reward is presented first, the framework predicts that the influence of valence weighting bias will be attenuated. However, on the other half of trials, valence weighting bias will influence choice as demonstrated here. Thus, the overall effect of valence weighting would likely be attenuated by randomizing the order of presentation, but it would not necessarily be rendered inconsequential.

Of course, what may be more important is the order in which options are considered in the real world. We argue that when people face intertemporal choices in real life, the immediate option typically is much more salient. As a result, most people naturally go about constructing a preference by evaluating the most immediate option first, and only then possibly considering the more distant option (e.g., "should I buy these shoes now or save my money for later?"). For this reason, we believe that the presentation order employed in the current research and the demonstrated importance of valence weighting tendencies are very applicable to daily life.

The current findings offer several important contributions. First, they further support the assertion that valence weighting bias is a fundamental, process-oriented personality characteristic by demonstrating its impact in a previously unexplored domain, that of intertemporal choice. Relatedly, they provide another demonstration that individual differences in valence weighting influence judgment and decision-making (also see Pietri et al., 2013a, for additional demonstrations), pointing to the value of integrating these literatures. Most importantly, these results shed some light on the central question guiding this research: Why do some people have such difficulty forgoing the immediate reward in favor of receiving the delayed one? Our findings suggest that one reason why some individuals show a tendency to prefer immediate rewards is that they have a relatively positive valence weighting bias and insufficient motivation and/or mental resources to deliberate on the initial appraisals shaped by that valence weighting tendency.

Future research should address whether valence weighting bias plays a *causal* role in driving intertemporal choice. Though the results reported here are certainly consistent with such a role, no conclusions can be reached without experimental evidence. To address questions about causality, Pietri, Fazio, and Shook (2013b) developed a procedure, referred to as *recalibration*, for experimentally manipulating an individual's valence weighting bias. In this recalibration procedure, participants receive objectively correct feedback about their classification of the novel beans after every trial of the test phase—that is, when they categorize a novel bean correctly (incorrectly), they see a message informing that their classification was correct (incorrect). The end result of this verbal reinforcement procedure is that valence weighting tendencies are shaped toward a more neutral point. In other words, participants are recalibrated to weigh positive and negative signals in a more balanced, objectively correct manner. Indeed, the results of such experiments have indicated that initially cautious individuals become riskier and initially risky individuals become more cautious in their judgments and behavior (Pietri & Fazio, 2017; Pietri et al., 2013b; Rocklage et al., 2017).

A similar approach could be pursued with respect to intertemporal choice, targeting individuals who tend to be unwilling to delay rewards. Those who undergo recalibration should show less preference for immediate rewards relative to those in the control condition. In addition to providing evidence for a causal role of valence weighting bias, supportive evidence could pave the way for the development of a targeted intervention aimed at those experiencing issues stemming from their preference for immediate rewards.

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