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Too Many Fish in the Sea: A Motivational Examination of the Choice Overload Experience

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Abstract

Evidence supports that being overwhelmed by many choice options predicts negative consequences. However, there is uncertainty regarding the effects of *choice overload* on two key motivational dimensions: (1) the extent to which people view their decision as subjectively valuable (versus not), and (2) the extent to which people view themselves as capable (versus incapable) of reaching a good decision. While evaluating their options and while deciding, we assessed theory-based cardiovascular responses reflecting these dimensions. A meta-analysis across two experiments found that participants who made a final selection from many options—relative to those who chose from few or rated many—exhibited cardiovascular responses consistent with greater task engagement (i.e., perceiving greater subjective value), as well as greater threat (i.e., perceiving fewer resources to manage situational demands). The current work suggests a novel motivational account of choice overload, providing insight into the nature and timing of this experience as it occurs.

Keywords: choice overload, cardiovascular reactivity, challenge and threat, psychophysiology

Too Many Fish in the Sea: A Motivational Examination of the Choice Overload Experience

In modern society, people are constantly exposed to more options than they can reasonably consider. Scanning Netflix provides people with nearly 6,000 programs to guiltily binge, while logging on to OkCupid connects people to as many as 5 million other active users. Even searching for something as trivial as a toothbrush yields 30,000 results on Amazon, ranging from manual to mechanical, charcoal to chargeable. Although people broadly seek out and prefer larger (versus smaller) arrays of options (e.g., Berger, Draganaska, & Simonson, 2007), an overabundance of choice can also paradoxically make people less inclined to choose. Research examining *choice overload* demonstrates that people are not only more likely to defer making a decision from many options compared to few options (Anderson, Taylor, & Holloway, 1966; Iyengar & Lepper, 2000; Reed, Digennaro Reed, Chock, & Brozyna, 2011), but demonstrate more negative subjective (e.g., greater regret and dissatisfaction; Haynes, 2009; Markus & Schwartz, 2013; Schwartz, 2004) and objective (e.g., poorer decision quality; Hanoch et al., 2009; Tanius et al., 2009; Botti & Hsee, 2010) outcomes as a result of their choice.

Although ample evidence exists for these negative outcomes (for a review, see Chernev, Bockenhold, & Goodman, 2015), there is less consensus in the literature regarding the motivational states experienced during choice overload. Specifically, there remains uncertainty regarding choice overload's effects on two key motivational dimensions: (1) the extent to which people view their decision as subjectively valuable (versus not), and (2) the extent to which people view themselves as capable (versus incapable) of reaching a good, reasoned decision. For instance, seemingly contradictory research suggests that being exposed to more options results in choices seeming both less (Reed et al., 2011) and more (Schwartz, 2010; Cheek & Schwartz, 2017) subjectively valuable. Additionally, individuals report exceedingly high expectations for their ability to make a good decision when initially presented with many options (Diehl & Poyner, 2010). Despite these initially high expectations, they also ultimately view their decisions as less satisfying and poorer in quality, suggesting that they may feel relatively incapable of reaching a good decision in this context (Haynes, 2009; Markus & Schwartz, 2013; Schwartz, 2004).

Given ambiguities in these key motivational dimensions, multiple and largely incompatible motivational accounts have been posed regarding how choice overload operates in the moment. Thus, the current work used temporally-sensitive, theory-based cardiovascular measures (Blascovich, 2008; Blascovich & Tomaka, 1996; Seery, 2011, 2013; Seery & Quinton, 2016) to assess these motivational dimensions throughout the choice overload experience. Specifically, while initially evaluating their options and while making a decision, we continuously monitored the degree to which individuals perceived a decision task as subjectively valuable or self-relevant (reflected in cardiovascular responses of *task engagement*), and the extent to which individuals perceived themselves as relatively capable or incapable of managing this decision task (reflected in cardiovascular responses of relative *challenge* or *threat*). By continually examining momentary psychological states without interrupting for self-reflection, the current work presents a novel motivational account of the choice overload experience, providing critical insight into both the nature and timing of this experience as it occurs.

Choice Overload

Generally speaking, people tend to prefer having more options over fewer (Berger et al., 2007; Diel & Poyner, 2010; Chernev, 2006; Iyengar & Lepper, 2000). Marketing research demonstrates that consumers are attracted to retailers who offer larger assortments, and that assortment size is an important factor in determining brand choice (Arnold, Oum, & Tigert 1983;

Berger et al., 2007; Broniarczyk et al. 1998; Redden & Hoch 2009). Similarly, Diehl and Poyner (2010) found that participants who were assigned to view many options to choose from held greater expectations for their upcoming choice quality than did those who were assigned to view few options. Consistent with these preferences, there are many benefits to seeking out more options, one being that it increases the likelihood of finding a choice that meets one's desires and needs (Baumol & Ide, 1956; Chernev, 2003). Large choice sets provide greater potential for flexibility and variety-seeking behavior, while also creating the perception of more freedom of choice (Kahn, Moore, & Glazer, 1987; Levav & Zhu, 2009). Relatedly, large assortments tend to reduce individuals' uncertainty of whether their choice set adequately represents all available options. When people have many options to choose from, they can be more confident that this set of options does not lack a potentially superior alternative (Greenleaf & Lehmann, 1995).

Although people desire and hold higher expectations for their decisions when faced with many options, research demonstrates that having too many options also paradoxically decreases one's likelihood of reaching a decision. For example, though people at a grocery store were more likely to approach a stand containing 24 varieties of jam than they were to approach a stand containing six, those who approached the stand containing 24 varieties were considerably less likely to make a purchase (Iyengar & Lepper, 2000). In this same work, students who chose to write about one of 30 extra credit essay topics (versus one of 6 essay topics), were not only less likely to commit to completing their essay, but wrote poorer quality essays overall (Iyengar & Lepper, 2000. Reed and colleagues (2011) found that direct care staff members' willingness to examine options for special-needs programs decreased steadily as the number of choices increased. Relatedly, Anderson and colleagues (1966) found that, when individuals' number of options increased, so too did their tendency to resort to selecting a choice that others had chosen previously, relieving themselves of the onerous duty of making their own decision.

When the situation does not allow individuals to defer their choice, selecting from many options, relative to few, yields greater retrospective frustration and difficulty with the decision-making process, as well as greater regret and dissatisfaction with whatever decision is made (Chernev et al., 2015; Haynes, 2009). Although an early meta-analysis questioned the support for such effects (Scheibehenne, Greifeneder, & Todd, 2010), a more recent and comprehensive one conducted across 99 studies found a moderate effect size of choice overload (Chernev et al., 2015). Specifically, larger assortments, relative to smaller assortments, were not only found to produce greater choice deferral and switching likelihood, but induce greater post-decisional dissatisfaction, uncertainty, and regret. These negative subjective evaluations of individuals' choices are at least somewhat rooted in reality, as choosing from large choice sets also yields objectively poorer decisions (e.g. Hanoch et al., 2009; Tanius et al., 2009; Botti & Hsee, 2010). For instance, Tanius et al. (2009) found that both younger and older adults chose worse (e.g., more expensive, less convenient) prescription drug plans when choosing from a larger choice set compared to a smaller choice set.

Motivational Accounts of Choice Overload

Despite substantial support for these negative choice overload outcomes, there is considerably less consensus in the literature for the motivational states occurring during its experience. For instance, Reed and colleagues (2011) argued that choice overload situations are demotivating due to perceived search costs (e.g., time, risk, and effort associated with choosing from many options). Specifically, when individuals anticipate that making a choice will be difficult or taxing (e.g., when there are a large number of choices), they should place less value on making that choice, resulting in decreased motivation. However, the experience of choice overload could also result in decisions appearing *more* subjectively valuable and self-relevant, resulting in increased motivation. Being presented with many options makes the opportunity to find a choice that communicates unique information about the self seem ampler, which in turn could make the selection process appear more diagnostic of one's personal characteristics. In contrast, with fewer options to choose from, the constraints of the choice set may limit the extent to which one's choice seems to reveal important characteristics. Consistent with this logic, research demonstrates that having more choices increases the degree to which individuals perceive their decision as indicating more about who they are as a person (Cheek & Schwartz, 2017). Relatedly, Iyengar and Lepper (2000) found that people reported feeling more personally responsible for their choice when selecting from many options versus few options. Counter to a demotivating choice overload perspective, these findings suggest that having more options should increase the degree to which people view their decision as a statement about their identity, even when the domain of the choice itself is relatively mundane in nature (e.g., types of chocolate; Schwartz, 2010).

In addition to questions regarding the subjective value or self-relevance of one's choice, there is also ambiguity in terms of how individuals evaluate their ability to make a good decision from many options versus few options. Although individuals initially hold higher expectations for the quality of their decision when presented with large choice sets versus small choice sets (Diehl & Poyner, 2010), they ultimately hold lower evaluations about their decision quality after-the-fact, suggesting that they may not feel capable of making a good choice in this context. Because past work has largely focused separately on the factors leading people to prefer many options at the outset versus on the post-decisional outcomes of making a choice from these options, it is unclear whether decision expectations shift from relatively positive to relatively negative during the choice overload experience, or if they remain uniformly negative (or positive) throughout. If it is the case that decision expectations shift over the course of the choice overload experience, it is unclear at what point such a shift might occur. For instance, it is theoretically plausible that individuals may feel capable of making a good decision when initially reviewing a large choice set, but may ultimately feel less capable when faced with the task of forming that decision.

Taken together, there remain important theoretical questions regarding individuals' motivational states during the choice overload experience; specifically: the extent to which exposure to many options leads individuals to (1) perceive their decision as subjectively valuable or self-relevant and (2) perceive themselves as capable of reaching a good, reasoned decision. Using psychophysiological measures from the perspective of the biopsychosocial model of challenge/threat (BPSC/T), we explored the nature and timing of individuals' motivational states during choice overload without interrupting their experience for self-reflection. The BPSC/T is particularly useful for addressing these questions, as it focuses specifically on individuals' momentary evaluations along these key motivational dimensions: subjective value or self-relevance (indicated by cardiovascular responses of task engagement) and perceived resources to manage situational demands (indicated by cardiovascular responses of challenge/threat).

The Biopsychosocial Model of Challenge/Threat

The BPSC/T (Blascovich, 2008; Blascovich & Tomaka, 1996; Seery, 2011, 2013; Seery & Quinton, 2016) applies to motivated performance situations in which individuals actively perform instrumental responses to reach self-relevant goals (e.g., making a personally relevant decision). In this context, individuals' level of *task engagement* represents the degree to which the goal is perceived to be subjectively valuable or self-relevant, with greater task engagement corresponding to perceiving a goal as more subjectively valuable or self-relevant. Given task engagement, evaluations of personal resources and situational demands determine the extent to which individuals experience psychological states of challenge versus threat. *Challenge* occurs when individuals' evaluations of personal resources are relatively high and their evaluations of task demands are relatively low. Conversely, *threat* occurs when individuals evaluate task demands as being relatively high and personal resources as being relatively low. Despite these discrete labels, challenge and threat represent two anchors of a single bipolar continuum, such that greater challenge corresponds to feeling more capable of managing situational demands, whereas greater threat corresponds to feeling less capable of managing situational demands. Relative differences in challenge/threat (i.e., greater vs. lesser challenge) are meaningful and reflect the basis for hypotheses.

In total, four cardiovascular measures are used to index task engagement and challenge/threat during motivated performance situations: heart rate (HR); ventricular contractility (VC), a measure of the left ventricle's contractile force (pre-ejection period reactivity × −1); cardiac output (CO), the amount of blood pumped by the heart; and total peripheral resistance (TPR), a measure of net constriction versus dilation in the arterial system. Task engagement is thought to result in an increase in sympathetic-adrenomedullary axis activation and thus increases in HR and VC from baseline, which are common across the challenge/threat continuum (Seery 2011, 2013). Manipulations that should heighten goal self-relevance or value and thus task engagement (e.g., presence of an audience, monetary incentive) have been shown to lead to larger increases in these cardiovascular markers (e.g., Blascovich, Mendes, Hunter, & Salomon, 1999; Seery, Weisbuch, & Blascovich, 2009; also see Fowles, Fisher, & Tranel, 1982; Tranel, Fisher, & Fowles, 1982; for additional discussion, see Seery, 2013), supporting that relatively greater task engagement leads to relatively greater increases in HR and VC. Given task engagement, challenge is thought to lead to greater release of epinephrine than threat, which yields relative dilation in arteries supplying skeletal muscles with blood (e.g., in the arms and legs), thereby facilitating the heart in pumping more blood (Seery 2011, 2013). Challenge is thus marked by lower TPR and higher CO than threat, such that relatively lower TPR and higher CO reflect relatively greater challenge or lesser threat. These cardiovascular responses do not equate to challenge/threat itself, but instead represent a measure of the underlying psychological state.

The theoretical underpinnings of these cardiovascular patterns stem from Dienstbier's (1989) model of psychophysiological toughness; specifically, differential activation of the sympathetic-adrenomedullary (SAM) and pituitary-adrenocortical (HPA or PAC) axes. Challenge and threat are both hypothesized to result in heightened SAM activation, but threat is believed to also result in heightened HPA activation, the early stages of which may inhibit the epinephrine-mediated vasodilation that would otherwise occur (Seery, 2011). The validity of these cardiovascular markers has been supported by dozens of studies, which assessed or manipulated challenge/threat states in various ways (e.g., Moore, Vine, Wilson, & Freeman, 2012, 2014; Moore, Wilson, Vine, Coussens, & Freeman, 2013; Scheepers, de Wit, Ellemers, & Sassenberg, 2012; Shimizu, Seery, Weisbuch, & Lupien, 2011; Tomaka, Blascovich, Kelsey, & Leitten, 1993; Tomaka, Blascovich, Kibler, & Ernst, 1997; Turner, Jones, Sheffield, Barker, & Coffee, 2014; Weisbuch-Remington, Mendes, Seery, & Blascovich, 2005; for reviews, see Blascovich, 2008; Seery, 2013). Not only has past work directly manipulated resource-demand evaluations to examine cardiovascular markers of challenge/threat (Moore et al., 2012; 2013;

O'Connor, Arnold, & Maruizio, 2010), but correlational studies have examined these associations using self-report resource-demand pre-task evaluations (Moore et al., 2017; Tomaka et al., 1993, 1997; Turner et al., 2013; Vine et al., 2013; Zanstra, Johnston, & Rabash, 2010). Past work has also assessed or manipulated other psychological constructs that should affect resources-demand evaluations, including self-esteem, social anxiety, task framing, and social power (e.g., Scheepers, de Wit, Ellemers, & Sassenberg, 2012; Shimizu, Seery, Weisbuch, & Lupien, 2011; Seery, Blascovich, Weisbuch, & Vick, 2004; Weisbuch-Remington, Mendes, Seery, & Blascovich, 2005). For instance, instilling participants with feelings of high social power, which is a state defined by the ability to control or possess resources (suggesting high resource evaluations; Keltner, Gruenfeld, & Anderson, 2008), has been shown to predict cardiovascular responses consistent with greater relative challenge. High social anxiety should equate to evaluating low resources and high demands in social situations. Consistent with this, Shimizu et al. (2011) found that women higher in social anxiety exhibited cardiovascular responses consistent with greater relative threat. Importantly, the various methods and designs used to capture resource-demand evaluations have been shown to similarly predict emotional, cognitive, physiological, and behavioral responses during motivated performance situations, with greater challenge broadly resulting in more positive performance outcomes than greater threat (for a systematic review, see Hase, O'Brien, Moore, & Freeman, 2018).

Notably, resource-demand evaluations are thought to be relatively dynamic in nature (see Quigley et al., 2002), such that as circumstances change, initial relative challenge could transition to relative threat, initial relative threat could transition to relative challenge, or either state could shift to disengagement from the task and thus neither challenge nor threat (Seery, 2013). This dynamic nature of resource-demands evaluations should be particularly relevant for the current research question. Past work shows that individuals initially hold positive expectations for their choice quality when selecting from many options (Diehl & Poyner, 2011), but that they ultimately report experiencing more negative outcomes after-the-fact (Chernev et al., 2015; Haynes, 2009). Thus, using momentary cardiovascular responses capable of tracking shifts in resource-demand evaluations may provide insight into the trajectory of individuals' choice overload experiences as they occur. The challenge/threat approach allowed us to track these key underlying motivational states during the choice overload experience, providing an important advantage for the current research question.

Overview and Hypotheses

By monitoring evaluations of subjective value or self-relevance (indicated by cardiovascular responses of task engagement) and perceived capabilities to meet situational demands (indicated by cardiovascular responses of challenge/threat) during various phases of a decision task, the BPSC/T allowed us to test plausible and distinct motivational accounts for choice overload as it occurred. For cardiovascular responses of task engagement, competing hypotheses for choice overload seemed plausible given prior research. First, if the difficulty of facing many options leads people to place low subjective value on their decision (i.e., evaluate a decision-making task as lacking self-relevance), the experience of choice overload (compared to non-choice overload conditions) should result in cardiovascular responses consistent with relatively low task engagement (relatively low HR and VC). However, if having many options leads people to view their decision as a statement about their identity (Schwartz, 2010), choice overload should instead lead individuals to feel as though the decision holds high self-relevance and subjective value, resulting in cardiovascular responses consistent with greater task engagement than when having few options (higher HR and VC).

In terms of cardiovascular responses of challenge/threat, competing hypotheses seemed once again plausible given prior research, particularly for the initial stages of the choice overload experience (i.e., when reviewing options before the choice). When options are ample rather than scarce, it may be the case that participants perceive their ability to make a good, reasoned choice to be relatively high at the outset. Thus, being presented with a large choice set may initially lead participants to evaluate high resources and low demands, resulting in the experience of relative challenge and corresponding cardiovascular responses (high CO, low TPR). This possibility would be consistent with past work demonstrating that people hold higher expectations for the quality of their decision when they are initially presented with many options rather than few (Diehl & Poyner, 2010). Alternatively, it may be the case that participants feel that they lack the time and ability to fully evaluate many options and thus meet their expectations early in the decision process. In other words, even when initially evaluating their options before a choice, those who are exposed to many options may already evaluate holding relatively low personal resources to meet the demands associated with making this choice, resulting in relative threat throughout (low CO, high TPR). Although competing hypotheses seemed plausible for the initial decision stages, we hypothesized that choice overload should eventually result in greater relative threat in the latter stages of the decision experience (i.e., while making a decision). At this point, individuals should perceive that they do not have the time and ability to make a good decision from the large set of options provided to them (i.e., evaluating low resources and high demands). Given these possible divergences across the different stages of choice overload, it was crucial to our hypotheses to separately examine cardiovascular responses measured (1) while participants evaluated their options and (2) while participants actually made their decision.

Experiments

Overview

We conducted two psychophysiological experiments (Experiments 1 and 2) and one follow-up non-psychophysiological experiment (Experiment 3) to examine individuals' momentary experiences during a choice task, as well as evaluations of their choice after-the-fact. Specifically, in Experiments 1 and 2, we assessed cardiovascular responses of task engagement and challenge/threat while participants evaluated and selected from a series of choice options. The primary goals of Experiments 1 and 2 were to maximally highlight these cardiovascular responses, and as a result, our paradigm diverged minorly from those used in previous choice overload research (see Procedures for additional information). Thus, in Experiment 3, we utilized a non-psychophysiological approach to help dispel any potential concerns with the generalizability of our paradigm to other choice overload scenarios, placing specific focus on self-report assessment of individuals' choice overload experiences. Taken together, our multi-modal approach not only allowed us to capture momentary choice overload experiences without interruption, but also helped generate support that our manipulation did in fact create the experience of choice overload as defined in previous work.

All three experiments used a four-cell design to test hypotheses. The four conditions included: (1) a 15-option, final choice condition; (2) a 4-option, final choice condition; (3) a 15-option, rating condition; and (4) a 15-option, reversible choice condition. In the 15-option, final choice condition (i.e., the prototypical choice overload condition), participants were asked to make a final selection from 15 options (large set). Consistent with Chernev et al.'s (2015) review and other paradigms used in the choice overload literature (Goodman & Malkoc, 2012; Haynes, 2009; Sela et al., 2009), the prototypical choice overload condition was designed to optimally induce this experience by giving participants limited time (high decision difficulty) to choose among many similarly rated (high decision complexity) and novel (high preference uncertainty) options.

Each of the other three conditions were designed to reduce the likelihood of experiencing choice overload and/or influence components of the paradigm relevant to perceived subjective value or capability during the task. For instance, in the 4-option, final choice condition (from here on, referred to as the 4-option condition), participants were asked to make a final selection, but only chose from a mere 4 options (small set), making it unlikely for choice overload to occur (Chernev, 2003; Chernev et al., 2015; Goodman & Malkoc, 2012; Haynes, 2009; Sela et al., 2009). In the 15-option, rating condition (from here on, referred to as the rating condition), participants were provided 15 options (large set), but did not actually choose among these options. Instead, participants were asked to provide an overall rating of the set. This condition created a paradigm that was functionally similar to the prototypical choice overload condition in terms of the amount of stimuli presented, but again was unlikely to induce choice overload because participants were not making a choice. Finally, in the 15-option, reversible choice condition, participants were asked to make a tentative choice from many options that could be changed later. Although this condition should still induce the experience of choice overload, the finality of one's decision could reasonably impact the degree to which a choice is perceived as subjectively valuable or the degree to which one feels capable of managing it. Compared to a choice that need be final, a tentative choice may lead individuals to view their decision as relatively unimportant or more easily managed. Thus, this reversible choice condition was included to isolate the specific impact of decision finality on these motivational dimensions during choice overload.

Because all three experiments utilized the same design and choice overload paradigm, we depart from the historical norm to present each individually. Following recommendations to use meta-analysis to evaluate replicability (Braver, Thoemmes, & Rosenthal, 2014; Chan & Arvey, 2012; Fabrigar & Wegener, 2016; Goh et al., 2016; Stroebe, 2016), we present our experiments collectively. First, we discuss the participants, methods, and measures used across experiments. We then discuss the meta-analytic results for our psychophysiological measurements (N=232) and for our self-report measurements (N=494). We treat the experiments as a cumulative model test to ensure that we interpret only statistically robust effects.

Method

Participants. Across all three experiments, a total of 494 introductory psychology students (292 women) participated in return for partial course credit and were included in analyses (104 participants in Experiment 1 analyses; 128 participants in Experiment 2 analyses; and 262 participants in Experiment 3 analyses). In a typical study with our set of cardiovascular measures, approximately 10-15 percent of the sample may be lost due to recording problems. In addition to the 104 participants in Experiment 1, 10 participants were excluded from analyses for this reason: 4 due to missing or unusable blood pressure readings, 5 due to unusable impedance cardiography data, and 1 due to a participant's heart condition. An additional 20 participants were excluded from Experiment 1 because of other reasons: 16 due to failure to follow instructions (e.g., not speaking aloud during the task; 14 of these 16 were non-native English speakers who may have struggled with comprehension, an issue addressed in Experiment 2), 3 due to participant withdrawal, and 1 due to technological malfunction. In Experiment 2, we restricted our sample only to individuals who were native English speakers to reduce noncompliance with instructions. In addition to the 128 participants in Experiment 2, 20 participants were excluded from analyses due to cardiovascular recording problems: 11 due to missing or unusable blood pressure readings, 8 due to unusable impedance cardiography data, and 1 due to unusable ECG data. An additional 14 participants were excluded from Experiment 2 because of other reasons: 5 due to failure to follow directions (e.g., not speaking aloud during the task), 4 due to technological malfunction, 2 due to knowledge about the study prior to participation, 1 due to a close relationship with the experimenter, 1 due to skin problems that prevented proper application of cardiovascular sensors, and 1 due to fainting during the study. Finally, in addition to the 262 participants included in Experiment 3 analyses, 6 participants were not included in analyses due to exiting the study prior to completing the dependent measures of interest. Importantly, exclusions did not vary significantly by condition in Experiment 1, χ^2 (3, N = 104) = .923, p = .820, Experiment 2, χ^2 (3, N = 125) = 1.37, p = .71, or Experiment 3, χ^2 (3, N = 262) = 3.56, p = .31. Further, each condition in Experiment 1 contained at least 24 participants (104 total participants), each condition in Experiment 2 contained at least 28 participants (128 total participants), and each condition in Experiment 3 contained at least 58 participants (262 total participants).

As stated previously, there were two time periods during which cardiovascular responses were measured in Experiments 1 and 2: while participants reviewed the options to be rated/chosen from (profile-viewing period) and while participants subsequently stated their rating/choice aloud (decision period). All participants in the retained samples had useable data for the profile-viewing period, but ten total participants (7 participants in Experiment 1, and 3 participants in Experiment 2) lacked usable blood pressure data for the decision period. For this reason, these participants could not be included in analyses for the decision period. Again, for analyses examining the decision period, exclusions did not differ significantly by condition in

Experiment 1, χ^2 (3, N = 97) = 1.60, p = .660, or Experiment 2, χ^2 (3, N = 125) = 1.37, p = .71, and each condition in Experiment 1 and Experiment 2 contained at least 21 and 26 participants, respectively. In total, 97 participants had usable challenge/threat data in Experiment 1, and 125 participants had usable challenge/threat data in Experiment 2.

Our original sample size in Experiment 1 was based on attaining at least 25 participants per condition after typical exclusions, limited by available laboratory resources. The final sample sizes of 104 participants (profile viewing period) and 97 participants (decision period) should have provided adequate power (.80) to detect approximate effect sizes of η_p^2 = .077 and η_p^2 = .083, respectively. In Experiment 2, we based our sample size on the observed effect size for the comparison between the 15-option, final choice condition and the 4-option condition from Experiment 1 (η_p^2 = .058). We targeted a useable sample of 130 to provide power = .80 to detect an effect of this magnitude. The final sample sizes of 128 participants (profile-viewing period) and 125 participants (decision period) fell slightly short due to exclusions surpassing oversampling, but should nonetheless have provided adequate power (> .80) to detect an approximate effect size of η_p^2 = .06. In Experiment 3, the sample size was determined using the effect size across self-report outcomes between the 15-option, final choice and 4-option conditions in Experiments 1 and 2. The final sample size of 262 should have provided adequate power (> .80) to detect an approximate effect size of η_p^2 = .03. For each experiment, results were not analyzed until after data collection was complete.

Cardiovascular measures (Experiments 1 and 2). Cardiovascular measures were recorded noninvasively, using accepted guidelines (Sherwood et al., 1990). We used the following equipment manufactured and/or distributed by Biopac Systems, Inc (Goleta, CA): NICO100C impedance cardiography (ICG) noninvasive cardiac output module, ECG100C electrocardiogram (ECG) amplifier, and NIBP100A/B noninvasive blood pressure module. ICG signals were detected with a tetrapolar aluminum/mylar tape electrode system, recording basal transthoracic impedance (Z0) and the first derivative of impedance change (dZ/dt), sampled at 1kHz. Using a Standard Lead II electrode configuration (additional spot electrodes on the right arm and left leg, with ground provided by the ICG system), ECG signals were detected and sampled at 1kHz. The blood pressure monitor was wrist-mounted, collecting continual readings (every 10-15 seconds) from the radial artery of participants' nondominant arm. Together, ICG and ECG recordings allowed computation of HR, VC (i.e., pre-ejection period reactivity×-1), and CO. Blood pressure data was used to compute TPR (mean arterial pressure×80/CO; Sherwood et al., 1990). Recorded measurements of cardiovascular function were stored on a computer and analyzed off-line with Biopac Acqknowledge 3.9.2 for Macintosh software, following techniques from previously published challenge/threat research (e.g., Seery, Kondrak, Streamer, Saltsman, & Lamarche, 2016; also see Lupien, Seery, & Almonte, 2012; Shimizu et al., 2011), including ensemble averaging in 60 s intervals (Kelsey & Guethlein, 1990). This approach is comparable to techniques used in other challenge/threat work with different equipment configurations (e.g., de Wit, Scheepers, & Jehn, 2012; Jamieson, Nock, and Mendes, 2012; Kassam, Koslov, & Mendes, 2009; Turner et al., 2013; Vine, Freeman, Moore, Chandra-Ramanan, & Wilson, 2013). Scoring of cardiovascular data was performed blind to condition and other participant data.

Procedure (Experiments 1 and 2). Participants completed the study individually. After the administration of questionnaires unrelated to the current research question[1] and attachment of physiological sensors, participants sat quietly for a 5-minute resting baseline period. Following this baseline period, recorded instructions explained that participants would be viewing a series of online personal profiles and would later be asked to report—depending on condition—an overall rating of the profiles or a final or non-final choice regarding their most preferred profile. As described previously, there were four conditions: 15-option, final choice; 4-option, final choice; 15-option, rating; and 15-option, reversible choice. The nature of participants' task (i.e., whether they would be providing a final or non-final choice or a rating) was explained to participants before viewing the profiles and was reiterated before they reported their decision or rating. Participants were provided a small envelope of laminated cards, each card representing one profile. All profiles were labeled with an identification number printed in the top left corner, and each contained five "facts" about the profile target (created by the research team). These facts covered a wide array of life domains, including academics (e.g., "I'm getting my bachelor's degree in architecture"), occupation (e.g., "I work at a bakery"), and leisure activities (e.g., "I'm addicted to medical dramas"). To help create profiles that were similar in terms of general likability and appeal, the five facts on each profile were matched with one another using a random number generator. We also used a random number generator to determine which profiles would be presented in the small set and the large set.[2]

In order to elicit challenge/threat responses, the choice task was designed to be reasonably motivating and self-relevant across conditions. Not only was the domain of the profile task expected to seem relatively important to individuals (interpersonal relationships), but instructions for completing the task were targeted toward further ensuring overall increases in measures of task engagement from baseline. Although rare in the choice overload literature, instructions asked participants to voice their attitudes and impressions aloud while viewing the personal profiles, as well as explained to participants that their opinions about other people imply a great deal about who they are (e.g., their morals, values, and character). Participants were told they should be thinking about the qualities they find most important and appealing when considering potential friends, roommates, or romantic partners. In all conditions of both experiments, participants were provided 3 minutes to view the profiles as their cardiovascular responses were assessed. Importantly, the number of profiles and amount of content provided on each (15 profiles averaging roughly 34 words in length in the choice overload condition) was based primarily on work by Haynes (2009), which used a similar time duration to examine choice overload (approximately 2.5 minutes to assess 10 options with 50-60 word descriptions for each option).

Once the 3-minute period ended, participants were told to verbally report their decision or rating aloud to the experimenter. Experiments 1 and 2 diverged minorly from one another at this point in the study procedures. In Experiment 1, participants were simply asked to report their decision or rating out loud, which required an average of approximately 27 seconds to report (M = 27.13, SD = 26.77). For this reason, some participants were left with single blood pressure readings and seven with no useable readings during the decision period (requiring excluding their data). Because our continual blood pressure recording instruments allow for a maximum of six distinct readings per minute, task periods that are at least 1 minute in length increase the likelihood of recording multiple readings, thus heightening reliability. For this reason, in Experiment 2, we altered instructions to encourage participants to use 1 full minute to report their choice, thereby increasing the number of blood pressure readings. Rather than simply being asked to state their decision/rating aloud, participants were asked to justify and explain their decision/rating for 60 seconds. Participants were encouraged to speak for the full amount of time. If participants stopped speaking for at least 10 seconds, the experimenter prompted them to continue speaking.

After reporting their decision, participants in both experiments then completed a final series of nine self-report items assessing negative post-decisional outcomes consistent with choice overload: satisfaction (1 item: "How satisfied are you with your decision-making process?", reverse-scored), regret (1 item: "How much do you regret how you went about the decision-making process?"), confidence (1 item: "How confident are you in your decision-making process?", reverse-scored), difficulty (1 item: "How difficult did you find this task?"), desire to change decision (2 items: "If given the opportunity to change your decision, how likely would you be to change it?", "How much do you want to change your decision?"), and frustration/enjoyment (3 items: "How frustrating did you find this task?"; "How much did you enjoy this task?", reverse-scored; "How much would you want to do this task again?", reverse-scored). Items were assessed on a scale ranging from *1 = Not at all* to *7 = Very*. All physiological sensors were then removed before participants were debriefed and thanked.

Procedure (Experiment 3). Participants were exposed to an online version of the choice overload manipulation used in Experiments 1 and 2. The online manipulation was identical to the psychophysiological experiments in nearly every regard, except participants were not instructed to speak during the task. Further, because there were no physical profile cards to maneuver and organize as participants saw fit, profile cards in the online study were presented in random order and displayed one-by-one vertically down the webpage. Similar to the laboratory paradigm, cards were presented in a way that suggested they should be read one at a time, but also provided the flexibility to refer back to a previous card, as well as view multiple cards at once. Overall, this presentation was designed to parallel the experiences created by the laboratory paradigm as closely as possible.

After exposure to the manipulation, participants completed a 4-item measure of choice overload (Lau, Hiemisch, & Baumeister, 2015), as well as the 9-item measure used in Experiments 1 and 2. The 4-item measure of choice overload assessed the degree to which participants felt overwhelmed, exhausted, and under pressure by their decision, as well as how difficult it was to keep all of the relevant information together. This measure was assessed on an 11-point scale, ranging from *1 = Not at all* to *11 = Completely true*.

Results: Analytical Strategy and Individual Experiments

As is standard in challenge/threat research (e.g., Lupien et al., 2012; Scheepers et al., 2012; Seery, Leo, Lupien, Kondrak, & Almonte, 2013), cardiovascular reactivity values were calculated by subtracting responses observed during the last baseline minute from those observed during each minute of the 3-minute profile-viewing period (the mean of these three reactivity values was used in analyses) and the decision period (see Llabre, Spitzer, Saab, Ironson, & Schneiderman, 1991, for psychometric justification for the use of change scores in psychophysiology). For extreme reactivity values greater than 3.3 SDs from the mean (p = .001 in a normal distribution; Tabachnick & Fidell, 1996), we winsorized values by adjusting each to be 1% above the next-highest nonextreme value (Experiment 1: for the profile-viewing period, 1 value for CO and 3 values for TPR; for the decision period, 1 value each for CO and TPR; Experiment 2: for the profile-viewing period, 1 value for CO and 4 values for TPR; for the decision period, 1 value for CO and 2 values for TPR). There were no such cases for HR or VC reactivity. This winsorizing process maintained the rank order in the distribution while decreasing the influence of extreme values. Theoretically, changes in TPR and CO should reflect the same underlying physiological activation and indicate relative differences in challenge/threat. Thus, TPR and CO reactivity values were combined into a single index for the profile-viewing period and, separately, the decision period (e.g., Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004; de Wit, Scheepers, & Jehn, 2012; Seery, Weisbuch, & Blascovich, 2009). This served to (1) maximize the reliability of the cardiovascular measures, analogous to averaging over multiple items on a self-report scale; and (2) assess the relative pattern across TPR and CO within participants (e.g., differentiating between individuals with high TPR and low CO vs. those with high TPR and moderate CO). In each psychophysiological experiment, we first converted participants' TPR and CO reactivity values into z-scores and then summed reverse-scored TPR with CO (i.e., TPR was multiplied by -1 because TPR and CO should respond in opposite directions), such that lower index values represented cardiovascular reactivity consistent with greater threat. The resulting index was then standardized for ease of interpretation ($M = 0$, $SD = 1$). Importantly, differences on this index are relative, such that the zero point represents the sample mean rather than a demarcation point between challenge versus threat.

Because increases in HR and VC during task performance are prerequisites for both challenge and threat cardiovascular patterns, it was important to confirm that participants as a whole exhibited significant increases from baseline in HR and VC during both the profile-viewing period and the decision period. In Experiment 1 and 2, one-sample *t* tests revealed that HR and VC reactivity were significantly greater than zero during the profile-viewing period, all $ts > 4.41$, $ps < .001$. Establishing this evidence for task engagement justified testing for relative differences in challenge/threat responses. Once established, HR and VC were also combined into a single index by summing their z-scores to examine differences in task engagement across conditions. The resulting index was standardized, with zero representing the sample mean rather than baseline levels. See Table 1and Table 2 for a correlation matrix and descriptive statistics for all individual and composite measures in Experiments 1 and 2, respectively, as well as Table 3 for unadjusted cell means and standard deviations for each experiment.[3]

Across all analyses (including both psychophysiological and self-report measures), planned contrasts compared the prototypical choice overload condition (i.e., the 15-option, final choice condition) to each of the three other conditions. Because of our interests in different stages of the choice overload experience, we separately examined these planned contrasts for cardiovascular responses of task engagement and challenge/threat during (1) the profile-viewing period[4] and (2) the decision period. For each experiment, we tested effects of condition using analyses of variance (ANOVA) and covariance (ANCOVA) for each dependent measure. For each of the dependent measures, we calculated Fisher's *Zr* for the contrast observed (i.e., 15-option, final choice vs. each other condition) and then tested the mean weighted value of *Zr* across samples. Although we report our results as a collective, Table 4 contains results for each individual experiment.

Meta-Analysis

Task Engagement

Across the two psychophysiological experiments, individuals in the 15-option, final choice condition exhibited cardiovascular responses consistent with greater task engagement compared to those in the 4-option and rating conditions, but not to those in the 15-option, reversible choice condition. Specifically, during the profile-viewing period, the task engagement index in the 15-option, final choice condition was significantly higher than it was in the 4-option condition, r = -.187, z = -2.83, p = .005, 95% CI [-.318, -.058], and in the rating condition, r = -.176, z = -2.62, p =.008, 95% CI [-.305, -.044]. However, the parallel difference relative to the 15-option, reversible choice condition did not reach significance, r = -.109, z = -1.64, p = .101, 95% CI [-.239, .021]. Similarly, during the decision period, participants in the 15-option, final choice condition exhibited significantly higher task engagement than the those in the 4-option condition, $r = -.225$, $z = -3.36$, $p < .001$, 95% CI [-.095, -.036], and marginally significantly higher task engagement than those in the rating condition, $r = -.132$, $z = -1.96$, $p = .050$, 95% CI [-.266, 0]. The parallel difference relative to the 15-option, reversible choice condition did not approach significance, $r = -.007$, $z = -.106$, $p = .928$, 95% CI [-.141, .126].[5] See Figures 1 and 2 for effects of condition across experiments during the profile-viewing and decision periods, respectively.

Overall, task engagement findings suggest that individuals in the 15-option, final choice condition (i.e., the prototypical choice overload condition) evaluated the decision task as holding more subjective value or self-relevance than did those who chose from 4 options and those who rated 15 options. Interestingly, there were no task engagement differences observed between the 15-option, final choice condition and the 15-option, reversible choice condition, suggesting that these conditions did not differ in terms of individuals' evaluations of subjective value or self-relevance.

Challenge/Threat

Given observed differences in the task engagement index, analyses for the challenge/threat index controlled for task engagement (see below for additional comment). Across Experiments 1 and 2, there was also evidence that individuals in the 15-option, final choice condition (i.e., the prototypical choice overload condition) tended to exhibit cardiovascular responses consistent with greater relative threat compared to those in the 4-option condition and the rating condition. Although most prominent during the decision period, the prototypical choice overload condition tended to elicit greater relative threat than these conditions throughout the decision-making experience, suggesting that shifts in momentary evaluations did not vary systematically over the course of the task.[6] Specifically, during the profile-viewing period, the challenge/threat index in the 15-option, final choice condition was significantly lower (greater threat) than it was in the 4-option condition, $r = .165$, $z = 2.51$, $p = .012$, 95% CI [.037, .296]. The parallel difference approached significance relative to the rating condition, $r = .116$, $z = 1.76$, $p = .078$, 95% CI [-.013, .246] and the 15-option, reversible choice condition, $r = .118$, $z = 1.80$, $p = .072$, 95% CI [-.011, .248]. During the decision period, the challenge/threat index in the 15-option, final choice condition was significantly lower (greater threat) than in the 4-option condition, $r = .207$, $z = 3.09$, $p = .002$, 95% CI [.077, .343], and in the rating condition, $r = .212$, $z = 3.16$, $p = .002$, 95% CI [.082, .348]. The parallel difference relative to the 15-option, reversible choice condition did not reach significance, $r = .112$, $z = 1.66$, $p = .098$, 95% CI [-.021, .246]. See Figures 3 and 4 for effects of condition across experiments during the profile-viewing and decision periods, respectively.

Overall, our findings indicate that participants in the 15-option, final choice condition, compared to those in the 4-option and rating conditions, exhibited cardiovascular responses consistent with evaluating relatively low resources to meet the demands of the choice task. In other words, both while reviewing the profiles and while reporting a decision, those in the prototypical choice overload condition exhibited cardiovascular responses consistent with feeling less capable of managing their decision than did those in the 4-option and rating conditions. Similar to our task engagement findings, there were no differences in challenge/threat responses between the 15-option, final choice condition and the 15-option, reversible choice conditions. Importantly, we included the task engagement index as a covariate in all challenge/threat analyses, ensuring that any observed differences were specific to challenge/threat and not due to reactivity in general. Because task engagement is a component of challenge/threat, it would otherwise be possible that parallel findings for task engagement and challenge/threat could actually be explained by task engagement alone, such as if the greatest task engagement co-occurred with the most extreme challenge/threat. The same overall pattern of results emerged without this covariate, as well as when HR and VC were included separately as covariates in each model.

Self-Report Measures

We assessed self-report measures across all three independent samples. Overall, we found that those in the 15-option, final choice condition reported experiencing greater overall choice overload relative to those in the 4-option condition, $r = -.129$, $z = -2.86$, $p = .004$, 95% CI [-.129, -.216].[7] The parallel differences did not reach significance relative to the rating condition, $r = -.044$, $z = -0.968$, $p = .333$, 95% CI [-.132, .045], or the 15-option, reversible choice condition, $r = .044$, $z = 1.10$, $p = .272$, 95% CI [-.039, .138]. Notably, the magnitude of effect size between the 15-option, final choice condition and the 4-option condition is comparable to those found in the broader choice overload meta-analysis conducted by Chernev et al. (2015).

General Discussion

Although ample evidence exists for choice overload's negative subjective (e.g., greater regret and dissatisfaction; Haynes, 2009; Markus & Schwartz, 2013; Schwartz, 2004) and objective outcomes (e.g., poorer decision quality), there is uncertainty regarding how choice overload impacts two key motivational dimensions: (1) the extent to which people view their decision as subjectively valuable (versus not), and (2) the extent to which people view themselves as capable (versus incapable) of reaching a good decision in this context. The current work used a psychophysiological approach to observe these key motivational dimensions during a choice overload paradigm that closely adhered to past work (e.g., Chernev et al., 2015; Chernev & Hamilton, 2009; Haynes, 2009; Iyenger & Lepper, 2000; Sela, Berger, & Liu, 2009) and replicated choice overload effects. Specifically, results of a meta-analysis demonstrated that participants in the 15-option, final choice condition reported significantly greater choice overload than those in the 4-option condition, suggesting that our paradigm created choice overload as conceptualized in previous research.[8]

Using the perspective of the BPSC/T, we used a constellation of cardiovascular measures to continuously monitor the degree to which individuals perceived a choice as subjectively valuable or self-relevant (indicating cardiovascular responses of *task engagement*), and the extent to which they perceived holding the resources to manage this decision (indicating cardiovascular responses of *challenge*/*threat*). Despite work arguing that choosing from many options (compared to few) should result in a decision seeming less subjectively valuable or less important, the current studies found no evidence for this hypothesis (i.e., lower task engagement). Instead, a meta-analysis across two experiments found that participants who made a final selection from many options exhibited cardiovascular responses consistent with greater task engagement than did those who made a selection from few options or who rated many options. Although emerging most consistently while reporting their choice, we also found that participants who made a final selection from many options, relative to those who chose from few or who rated many, exhibited cardiovascular responses consistent with greater threat throughout the decision experience. The meta-analysis failed to show compelling support for reliable differences between the 15-option, final and reversible choice conditions, suggesting that decision finality may not be a central factor in shaping individuals' momentary experience of choice overload.

High task engagement is consistent with evaluating the decision as highly self-relevant, which supports the hypothesis that choice overload may lead to decisions seeming more self-expressive or self-revealing (see Cheek & Schwartz, 2017). Threat is consistent with evaluating low resources and high demands (Blascovich, 2008; Blascovich & Tomaka, 1996; Seery, 2011, 2013; Seery & Quinton, 2016), and given the similarity in results across profile and decision periods, this supports the hypothesis that individuals do not actually feel capable of making a good, reasoned decision throughout the choice overload experience (despite past work arguing that they should hold positive expectations at the outset; Diehl & Poyner, 2011). Theoretically, this threat should follow from individuals perceiving that they do not possess the time or ability to reasonably consider all of their choice options. Seery & Quinton (2016) argued that evaluations of likelihood of success or likely degree of success is a core influence on the balance of resources/demands. Inadequate time and ability to consider all options should thus lead to evaluating relatively low resources/high demands. Given that we found this difference throughout both the profile-viewing and decision periods, it suggests that individuals begin forming these evaluations in the early stages of their decision process. Importantly, the observed effects do not derive simply from the amount of stimuli presented to individuals, as participants who made a choice from many options also exhibited greater threat than did those who assigned a rating to the same number of options. Further, all challenge/threat analyses were conducted controlling for task engagement, ensuring that the observed challenge/threat differences were not simply due to differences in reactivity more generally.

Profile-Viewing Versus Decision Periods

One explanation for the lack of differences across profile-viewing versus decision periods is that because individuals knew their decision goal (final/reversible decision, rating) before they saw any options, they could have started forming a decision during the profile-viewing period, thus resulting in similar responses across the viewing and decision periods. Although this is possible, three points are worthy of note. First, people typically have an initial goal to make a choice before they evaluate specific options, both in the choice overload literature and in everyday decision-making more broadly. In studies focusing on individuals' decision goal, this goal is often established prior to participants viewing their options (e.g., Fukukura, Ferguson, & Fujita, 2013; Polman, 2012). The fact that this was the case in the current work is consistent with capturing the phenomenon of interest. Second, participants in Experiment 1 were only asked to state their decision/rating aloud, not justify it. Inconsistent with them having already reached a decision during the profile-viewing period, they spent approximately 27 seconds on average making their report. Importantly, the 15-option, final choice condition did not significantly differ from any of the other conditions in terms of how much time participants required to make their decision, Fs < 3.03, ps > .085, η_p^2s < .033, suggesting that individuals across conditions were actively making their choice during the decision period. Third, if observed effects of condition on challenge/threat depend on the act of deciding rather than viewing options, and individuals were deciding during the profile-viewing period, differences between conditions should be largest at the end of the viewing period rather than at the beginning. At the beginning of the profile-viewing period, participants in all conditions would have required some time to view at least some of their options, during which time there would be relatively little opportunity for the 4-option and 15-option choice and rating conditions to differ. Only later in the period would, for example, the 15-option, final choice condition require mentally juggling more simultaneous alternatives than the 4-option condition. In contrast to this logic, however, no such differences emerged across minutes within the profile-viewing period (see Footnote 4). Although this does not rule out the possibility that our findings reflect that participants were actually deciding during the viewing period, it suggests that differences observed during the viewing period are influenced by anticipating the eventual decision goal, before differential cognitive demands associated with various goals have actually been experienced. Future work could more directly address this possibility by assessing individuals' expectations prior to beginning the choice task or by manipulating whether or not participants' choice goals are presented prior to evaluation.

Limitations and Future Directions

The current studies are limited in several ways. Although the difference in challenge/threat between the 15-option, final and reversible choice conditions was in the direction of the final choice yielding greater threat, the meta-analysis failed to show compelling support for the reliability of this effect. One possibility is that our manipulation of reversibility was too subtle to create an effect detectable with our sample sizes. Relatedly, this lack of difference could in part be due to the decision context itself. In order to examine challenge/threat responses, it was necessary that the choice paradigm be reasonably motivating and self-relevant across conditions. Not only was the domain of the choice task expected to be relatively important to individuals (interpersonal relationships), but instructions for completing the task were targeted toward further maximizing task engagement (e.g., speaking aloud for the experimenter to hear). In this context, it could be the case that even a reversible choice was perceived to suggest a great deal of information about the self. Thus, similar to a final choice, a tentative choice in this context could lead individuals to view their decision as both relatively important and unmanageable.

This issue points to a broader limitation of this work: Across all studies, we used the same choice task to examine our hypotheses. As stated, this paradigm did diverge somewhat from previous choice overload paradigms, as participants were asked to publicly report their thoughts about each option, as well as their decision to the experimenter. Although similar think-aloud paradigms have been used to assess qualitative responses to having many options (e.g., Pan & Zhang, 2012; Woll, 1986), public decisions are relatively rare in the choice overload literature, and no work to our knowledge has explicitly tested the effect of public versus private decisions on the choice overload experience. Experiment 3 did not require participants to speak out loud, but still relied on the same decision context (interpersonal relationships). Thus, although using this particular choice overload paradigm across studies allowed us to maximize cardiovascular reactivity and increase our statistical power across studies, it also limits our ability to generalize the current findings to other decision contexts. For instance, it remains possible that the motivational processes observed during our choice overload paradigm operate differently when individuals are making other kinds of decisions or making their decisions privately. The current work cannot speak directly to this possibility; future research should explore these motivational processes using different choice paradigms and decision contexts.

Decision Quality. Although the current work only examined subjective post-decision evaluations, integrating past work in both the choice overload and challenge/threat literatures regarding objective decision quality could lead to interesting future research. A great deal of work in the choice overload literature has focused specifically on decision quality (e.g., Schram & Sonnemans, 2011; Tanius et al., 2009; Wood et al., 2011). Schram and Sonnemans (2011), for instance, found that an increase in the number of alternatives not only resulted in participants considering a lower fraction of available information to make their decision, but decreased the objective quality of the decision they made. Similarly, past challenge/threat work has also argued that, compared to challenge, the experience of relative threat may result in poorer decision-making, as greater threat has been associated with less cognitive flexibility when forming decisions. Specifically, individuals exhibiting relative threat made fewer adjustments from self-generated anchors (Kassam et al., 2009) and demonstrated greater resistance to opposing viewpoints (de Wit et al., 2012) than did individuals exhibiting relative challenge. Taken together, examining the choice overload experience under a challenge/threat lens may present important theoretical implications for both literatures in terms of exploring the objective consequences of individuals' choices. For instance, it could be the case that individuals experiencing relative threat are more likely to feel overwhelmed generally when making decisions, leading to objectively poorer decision-making strategies. It is also possible that challenge/threat responses contribute to differences in decision quality in the face of choice overload. Future research could aim to focus more specifically on objective components of individuals' decisions, as well as the subsequent behavioral consequences of overload-induced psychological threat.

Choice Overload: A Motivational Paradox

Past researchers examining the subjective and behavioral outcomes of choice overload have famously termed this experience the "Paradox of Choice." Our findings depict a similarly paradoxical motivational account, extending previous work connecting choice overload to identity expression (e.g., Schwartz, 2010; Cheek & Schwartz, 2017). Although previous work argued that choosing from many options reduces the subjective value one places on a choice, other research suggests that choice overload should make the opportunity to find a choice that communicates unique information about one's identity seem more abundant, making the decision appear more valuable or diagnostic of the self. Consistent with this latter theorizing, our findings suggest that selecting from many options leads individuals to exhibit cardiovascular responses consistent with greater task engagement, or evaluating their decision as more subjectively valuable or self-relevant. Furthermore, despite work demonstrating that people hold relatively high expectations for their choice quality when exposed to many options (Diehl & Poyner, 2010), our results suggest that individuals may feel relatively incapable of making a good choice throughout the choice overload experience. Specifically, in addition to greater task engagement, our findings indicate that the experience of choosing from many options also leads people to exhibit cardiovascular responses consistent with greater threat. This presumably follows from evaluating low resources and high demands when attempting to come to a good, reasoned decision from among too many options.

Taken together, the current work expands our understanding of the paradox of choice overload. Although much research has focused on its negative downstream outcomes, the motivational states occurring during the choice overload experience are less clear. Using cardiovascular responses from the perspective of the BPSC/T, we found that choosing from many options predicted responses consistent with feeling highly motivated to make a good choice, presumably because this choice could reveal or suggest more information about the self. At the same time, individuals also appear to feel that they cannot realistically make a good selection that adequately represents the self, as they lack the time and ability to reasonably consider all of the available options. This combination of momentary experiences may serve as the basis for negative downstream choice overload outcomes (e.g., poor decision quality). Although future work is needed to explore this possibility, the current research provides novel evidence of the inherent motivational paradox that is choice overload. When selecting from many options, people simultaneously feel they *should*—but will not be able to—make a good, reasoned decision.

References

Anderson, L.K., Taylor, J.R., & Holloway, R.J. (1966). The consumer and his alternatives: An experimental approach. *Journal of Marketing Research*, *3*, 62-67. doi: 10.2307/3149436

Arnold, S.J., Oum, T.H., Tigert, D.J. (1983). Determining attributes in retail patronage: Seasonal, temporal, regional, and international comparisons. *Journal of Marketing Research, 20*, 149-157. doi: 10.2307/3151681

Baumol, W. J., & Ide, E. A. (1956). Variety in retailing. *Management Science*, *3*, 93−101. doi: http://dx.doi.org/10.1287/mnsc.3.1.93

Berger, J., Draganska, M., & Simonson, I. (2007). The influence of product variety on brand perception and choice. *Marketing Science, 26,* 460-472. doi: 10.1287/mksc.1060.0253

Blascovich, J. (2008). Challenge and threat. In A.J. Elliot (Eds.), *Handbook of Approach and Avoidance Motivation* (pp. 481-445). New York: Guilford.

Blascovich, J., Mendes, W. B., Hunter, S. B., & Salomon, K. (1999). Social "facilitation" as challenge and threat. *Journal of Personality and Social Psychology, 77*, 68-77. doi: 10.1037/0022-3514.77.1.68

Blascovich, J., Seery, M.D., Mugridge, C.A., Norris, R.K., & Weisbuch, M. (2004). Predicting athletic performance from cardiovascular indexes of challenge and threat. *Journal of Experimental Social Psychology, 40,* 683-688. doi:10.1016/j.jesp.2003.10.007

Blascovich, J., & Tomaka, J. (1996). The biopsychosocial model of arousal regulation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 28, pp. 1-51). San Diego, CA: Academic Press.

Botti, S., & Hsee, C.K. (2010). Dazed and confused by choice: How the temporal costs of choice freedom lead to undesirable outcomes. *Organizational Behavior and Human Decision Processes, 112*, 161–171. doi: 10.1016/j.obhdp.2010.03.002

Braver, S. L., Thoemmes, F. J., & Rosenthal, R. (2014). Continuously cumulating meta-analysis and replicability. *Perspectives on Psychological Science, 9*, 333–342. doi: 10.1177/1745691614529796

Broniarczyk, S.M., Hoyer, W.D., McAlister, L. (1998). Consumers' perceptions of the assortment offered in a grocery category: The impact of item reduction. *Journal of Consumer Research, 30,* 170-183. doi: 10.2307/3151845

Chan, M. E., & Arvey, R. D. (2012). Meta-analysis and the development of knowledge. *Perspectives on Psychological Science, 7,* 79–92. doi: 10.1177/1745691611429355

Chernev, A. (2003). Product assortment and individual decision processes. *Journal of Personality and Social Psychology, 85,* 151-162. doi: 10.1037/0022-3514.85.1.151

Chernev, A. (2006). Decision focus and consumer choice among assortments. *Journal of Consumer Research, 33,* 50-59. doi: 10.1086/504135

Chernev, A. & Hamilton, R. (2009). Assortment size and option attractiveness in consumer choice among retailers. *Journal of Marketing Research, 46,* 410-420. doi: 10.1509/jmkr.46.3.410

Chernev, A. Bockenhold, U., & Goodman, J. (2015). Choice overload: A conceptual review and meta-analysis. *Journal of Consumer Psychology, 25,* 333-358. doi: 10.1016/j.jcps.2014.08.002

de Wit, F.R., Scheepers, D., & Jehn, K.A. (2012). Cardiovascular reactivity to resistance to opposing viewpoints during intragroup conflict. *Psychophysiology, 49,* 1523-1531. doi: 10.1111/j.1469-8986.2012.01456.x

Diehl, K., & Poyner, C. (2010). Great expectations?! Assortment size, expectations, and satisfaction. *Journal of Consumer Research, 47,* 312-322. doi: 10.1509/jmkr.47.2.312

Dienstbier, R. A. (1989). Arousal and physiological toughness: Implications for mental and physical health. *Psychological Review, 96*, 84-100. doi: 10.1037/0033-295X.96.1.84

Fabrigar, L. R., & Wegener, D. T. (2016). Conceptualizing and evaluating the replication of research results. *Journal of Experimental Social Psychology, 66,* 68–80. doi: 10.1016/j.jesp.2015.07.009

Fowles, D. C., Fisher, A. E., & Tranel, D. T. (1982). The heart beats to reward: The effect of monetary incentive on heart rate. *Psychophysiology, 19*, 506-513. doi: 10.1111/j.1469-8986.1982.tb02577.x

Fukukura, J., Ferguson, M.J., Fujita, K. (2013). Psychological distance can improve decision making under information overload via gist memory. *Journal of Experimental Psychology-General, 142,* 658-665. doi: 10.1037/a0030730

Goh, J. X., Hall, J. A., & Rosenthal, R. (2016). Mini meta-analysis of your own studies: Some arguments on why and a primer on how. *Social and Personality Psychology Compass, 10,* 535–549. doi: 10.1111/spc3.12267

Goodman, J.K., & Malkoc, S.A. (2012). Choosing for here and now versus there and later: The moderating role of psychological distance on assortment size preferences. *Journal of Consumer Research, 39,* 1-19. doi: 10.1086/665047

Greenleaf, E.A., Lehmann, D.R. (1995). Reasons for substantial delay in consumer decision making. *Journal of Consumer Research, 22,* 186-199. doi: 10.1086/209444

Hanoch, Y., Rice, T., Cummings J. & Wood, S. (2009). How much choice is too much? The case of the Medicare Prescription Drug Benefit', *Health Service Research, 44*, 1157–1168. doi: 10.1111/j.1475-6773.2009.00981.x

Hase, A., O'Brien, J., Moore, L. J., & Freeman, P. (2018). The relationship between challenge and threat states and performance: A systematic review. *Sport, Exercise, and Performance Psychology*. http://dx.doi.org/10.1037/spy0000132

Haynes, G. (2009). Testing the boundaries of the choice overload phenomenon: The effect of number of options and time pressure on decision difficulty and satisfaction. *Psychology & Marketing, 26,* 204-212. doi: 10.1002/mar.20269

Iyengar, S. S., & Lepper,M. R. (2000). When choice is demotivating: Can one desire too much of a good thing? *Journal of Personality and Social Psychology*, *79*, 995–1006. doi: 10.1037/0022-3514.79.6.995

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2012). Mind over matter: Reappraising arousal improves cardiovascular and cognitive responses to stress. *Journal of Experimental Psychology: General, 141*, 417-422. doi: 10.1037/a0025719

Kahn, B.E., Moore, W.L., Glazer, R. (1987). Experiments in constrained choice. *Journal of Consumer Research, 14,* 96-113. doi: 10.1086/209096

Kassam, K.S., Koslov, K., Mendes, W.B. (2009). Decisions under distress: Stress profiles influence anchoring and adjustment. *Psychological Science, 20,* 1394-1399. doi: 10.1111/j.1467-9280.2009.02455.x

Kelsey, R.M., & Guethlein, W. (1990). An evaluation of the ensemble averaged impedance cardiogram. *Psychophysiology, 27,* 24-33. doi: 10.1111/j.1469-8986.1990.tb02173.x

Keltner, D., Gruenfeld, D. H., & Anderson, C. (2003). Power, approach and inhibition. *Psychological Review, 110*, 265–284. http://dx.doi.org/10.1037/0033-295X.110.2.265

Lau, S., Hiemisch, A., & Baumeister, R.F. (2015). The experience of freedom in decisions—Questioning philosophical beliefs in favor of psychological determinants. *Consciousness* *and Cognition, 33,* 30-46. doi: 10.1016/j.concog.2014.11.008

Levav, J., & Zhu, R. (2009). Seeking freedom through variety. *Journal of Consumer research, 36,* 600-610. doi: 10.1086/599556

Llabre, M. M., Spitzer, S. B., Saab, P. G., Ironson, G. H., & Schneiderman, N. (1991). The reliability and specificity of delta versus residualized change as measures of cardiovascular reactivity to behavioral challenges. *Psychophysiology, 28*, 701-711. doi: 10.1111/j.1469-8986.1991.tb01017.x

Lupien, S. P., Seery, M. D., & Almonte, J. L. (2012). Unstable high self-esteem and the eliciting conditions of self-doubt. *Journal of Experimental Social Psychology, 48*, 762-765. doi: 10.1016/j.jesp.2012.01.009

Markus, H.R. & Schwartz, B. (2013). Does choice mean freedom and well-being? *Journal of Consumer Research, 37,* 344-355. doi: 10.1086/651242

Moore, L. J., Vine, S. J., Wilson, M. R., & Freeman, P. (2012). The effect of challenge and threat states on performance: An examination of potential mechanisms. *Psychophysiology, 49*, 1417-1425. doi: 10.1111/j.1469-8986.2012.01449.x

Moore, L. J., Vine, S. J., Wilson, M. R., & Freeman, P. (2014). Examining the antecedents of challenge and threat states: The influence of perceived required effort and support availability. *International Journal of Psychophysiology, 93*, 267-273. doi: 10.1016/j.ijpsycho.2014.05.009

Moore, L. J., Wilson, M. R., Vine, S. J., Coussens, A. H., & Freeman, P. (2013). Champ or chump?: Challenge and threat states during pressurized competition. *Journal of Sport & Exercise Psychology, 35*, 551-562.

Moore, L. J., Young, T., Freeman, P., & Sarkar, M. (2018). Adverse life events, cardiovascular responses, and sports performance under pressure. *Scandinavian Journal of Medicine & Science in Sports, 28*, 340-347. doi:10.1111/sms.12928

O'Connor, K. M., Arnold, J. A., & Maurizio, A. M. (2010). The prospect of negotiating: Stress, cognitive appraisal, and performance. *Journal of Experimental Social Psychology, 46*, 729-735. doi:10.1016/j.jesp.2010.04.007.

Polman, E. (2012). Effects of self-other decision making on regulatory focus and choice overload, *Journal of Personality and Social Psychology, 102,* 980-993. doi: 10.1037/a0026966

Redden, J., & Hoch, S.J. (2009). The presence of variety reduces perceived quantity. *Journal of Consumer Research, 36,* 406-417. doi: 10.1086/598971

Reed, D.D., Digennaro Reed, F.D., Chock, J., & Brozyna, G.A. (2011). The "tyranny of choice": Choice overload as a possible instance of effort discounting. *The Psychological Record, 61,* 547-560.

Scheepers, D., de Wit, F., Ellemers, N., & Sassenberg, K. (2012). Social power makes the heart work more efficiently: Evidence from cardiovascular markers of challenge and threat. *Journal of Experimental Social Psychology, 48*, 371-374. doi: 10.1016/j.jesp.2011.06.014

Scheibehenne, B., Greifeneder, R., & Todd, P.M. (2010). Can there ever be too many options? A meta-analytic review of choice overload. *Journal of Consumer Research, 37*, 409-425. doi: 10.1086/651235

Schram, A., & Sonnemans, J. (2011). How individuals choose health insurance: An experimental analysis. *European Economic Review, 55*, 799-819. doi: 10.1016/j.euroecorev.2011.01.001

Schwartz, B. (2010), 'Be careful what you wish for: The dark side of freedom'. in R. M. Arkin, K. C. Oleson and P. J. Carroll (eds), Handbook of the uncertain self: Perspectives from social and personality psychology, New York: Psychology Press, 62–77.

Schwartz, B. (2004). *The paradox of choice*. New York: HarperCollins.

Schwartz, B. (2016), The paradox of choice: Why more is less, (rev. ed.). New York: Ecco.

Schwartz, B., & Cheek, N. N. (2017). Choice, freedom, and well-being: Considerations for public policy. *Behavioural Public Policy, 1*, 106-121. doi: 10.1017/bpp.2016.4

Schwartz, B., Ward, A., Monterosso, J., Lyubomirsky, S., White, K., & Lehman, D. R. (2002). Maximizing versus satisficing: Happiness is a matter of choice. *Journal of Personality and Social Psychology, 83*, 1178–1197. doi: 10.1037/0022-3514.83.5.1178

Seery, M. D. (2011). Challenge or threat? Cardiovascular indexes of resilience and vulnerability to potential stress in humans. *Neuroscience and Biobehavioral Reviews, 35*, 1603-1610. doi: 10.1016/j.neubiorev.2011.03.003

Seery, M.D. (2013). The biopsychosocial model of challenge and threat: Using the heart to measure the mind. *Social and Personality Psychology Compass, 7*, 637-653. doi: 10.1111/spc3.12052

Seery, M. D., Blascovich, J., Weisbuch, M., & Vick, S. B. (2004). The relationship between self-esteem level, self-esteem stability, and cardiovascular reactions to performance feedback. *Journal of personality and social psychology*, *87*, 133-145. doi: 10.1037/0022-3514.87.1.133

Seery, M. D., Kondrak, C. L., Streamer, L., Saltsman, T., & Lamarche, V. M. (2016). Preejection period can be calculated using R peak instead of Q. *Psychophysiology, 53*, 1232-1240. doi: 10.1111/psyp.12657

Seery, M. D., Leo, R. J., Lupien, S. P., Kondrak, C. L., & Almonte, J. L. (2013). An upside to adversity? Moderate cumulative lifetime adversity is associated with resilient responses in the face of controlled stressors. *Psychological Science, 24*, 1181-1189. doi: 10.1177/0956797612469210

Seery, M. D., & Quinton, W. J. (2016). Understanding resilience: From negative life events to everyday stressors. In J. M. Olson & M. P. Zanna (Eds.), *Advances in experimental social psychology* (Vol. 54, pp. 181-245). Cambridge, MA: Academic Press.

Seery, M. D., Weisbuch, M., & Blascovich, J. (2009). Something to gain, something to lose: The cardiovascular consequences of outcome framing. *International Journal of Psychophysiology, 73*, 308-312. doi:10.1016/j.ijpsycho.2009.05.006

Sela, A., Berger, J., & Liu, W. (2009). Variety, vice, and virtue: How assortment size influences option choice. *Journal of Consumer Research, 35,* 941-951. doi: 10.1086/593692

Sherwood, A., Allen, M. T., Fahrenberg, J., Kelsey, R. M., Lovallo, W. R., & van Doornen, L. J. (1990). Methodological guidelines for impedance cardiography. *Psychophysiology, 27*, 1-23. doi: 10.1111/j.1469-8986.1990.tb02171.x

Shimizu, M., Seery, M. D., Weisbuch, M., & Lupien, S. P. (2011). Trait social anxiety and physiological activation: Cardiovascular threat during social interaction. *Personality and Social Psychology Bulletin, 37*, 94-106. doi:10.1177/0146167210391674

Shiner, R.L. (2015). Maximizers, satisficers, and their satisfaction with and preferences for reversible versus irreversible decisions. *Social Psychological and Personality Science, 6*, 896-903. doi: 10.1177/1948550615595271

Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics* (3rd ed.). New York: HarperCollins.

Tanius, B., Wood, S., Hanoch, Y., & Rice, T. (2009). Aging and choice: Application to Medicare Part D. *Judgment and Decision-Making, 4*, 92–101.

Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology, 65*, 248-260. doi: 10.1037/0022-3514.65.2.248

Tomaka, J., Blascovich, J., Kibler, J., & Ernst, J. M. (1997). Cognitive and physiological antecedents of threat and challenge appraisal. *Journal of Personality and Social Psychology, 73*, 63-72. doi: 10.1037/0022-3514.73.1.63

Turner, M. J., Jones, M. V., Sheffield, D., Barker, J. B., & Coffee, P. (2014). Manipulating cardiovascular indices of challenge and threat using resource appraisals. *International Journal of Psychophysiology, 94*, 9-18. doi: 10.1016/j.ijpsycho.2014.07.004

Turner, M. J., Jones, M. V., Sheffield, D., Slater, M. J., Barker, J. B., & Bell, J. J. (2013). Who thrives under pressure? Predicting the performance of elite academy cricketers using the cardiovascular indicators of challenge and threat states. *Journal of Sport & Exercise Psychology, 35*, 387-397.

Vine, S. J., Freeman, P., Moore, L. J., Chandra-Ramanan, R., & Wilson, M. R. (2013). Evaluating stress as a challenge is associated with superior attentional control and motor skill performance: Testing the predictions of the biopsychosocial model of challenge and threat. *Journal of Experimental Psychology: Applied, 19*, 185-194. doi: 10.1037/a0034106

Vohs, K.D., Schmeichel, B.J., Nelson, N.M., Baumeister, R.F., Twenge, J.M., & Tice, D.M. (2008). Making choices impairs subsequent self-control: A limited-resource account of decision-making, self-regulation, and active initiative. *Journal of Personality and Social Psychology, 94,* 883-898. doi: 0.1037/0022-3514.94.5.883

Weisbuch-Remington, M., Mendes, W. B., Seery, M. D., & Blascovich, J. (2005). The nonconscious influence of religious symbols in motivated performance situations. *Personality and Social Psychology Bulletin, 31*, 1203-1216. doi: 10.1177/0146167205274448

Wood, S., Hanoch, Y., Barnes, A., Liu, P.J., Cummings, J., & Bhattacharya, C. (2011). Numeracy and Medicate Part D: The importance of choice and literacy for numbers in optimizing decision making for Medicare's prescription drug program. *Psychology of Aging, 26,* 295-307. doi: 10.1037/a0022028

Zanstra, Y. J., Johnston, D. W., & Rasbash, J. (2010). Appraisal predicts hemodynamic reactivity in a naturalistic stressor. *International Journal of Psychophysiology,77*, 35-42. doi: 10.1016/j.ijpsycho.2010.04.00.

Footnotes

1. For all experiments, we report all measures, manipulations, and exclusions. Additional questionnaires administered at the beginning of Experiments 1 and 2 were the following: Maximization Scale, Need for Cognition Scale-Short Form, Almost Perfect Scale-Revised, Subjective Happiness Scale, Life Orientation Test-Revised, and the Free Will and Determinism Scale-Plus (only Experiment 2).
2. To assess the extent to which profiles were comparably appealing across the 4- and 15-option conditions, a separate sample of 40 participants evaluated how likely they would be to hang out and become friends with the individuals in each profile, as well as the degree to which they would enjoy a conversation or a meeting with each individual (α = .95). Participants responded to all four items on a scale of 1 = *Not at all* to 7 = *Very much*. The mean composite ratings for the majority of profiles were at or just above the mid-point of this scale (range = 3.94 – 5.06). Paired t-test analyses revealed no significant difference between the mean evaluation for the profiles presented in the 4-option condition and the mean evaluation for the profiles presented in the 15-option condition, $t(39) = -0.30$, $p = .77$, $\eta_p^2 = .002$, 90% CI [0, .072]. Importantly, we also found that the standard deviation of composite ratings across profiles within each set did not significantly differ, $t(39) = 1.21$, $p = .23$, $\eta_p^2 = .036$, 90% CI [0, .167]. Taken together, these pilot data suggest that the two choice sets were comparable in terms of not only how positive and appealing the profiles seemed, but how varied these evaluations were across profiles.
3. Although all participants were encouraged to spend the full 3-min profile-viewing period speaking aloud, we considered the possibility that condition could have affected speaking

activity (e.g., if participants in the 4-option condition spoke less than others), which in turn could plausibly affect cardiovascular responses. Four total independent coders (two coders per experiment) were asked to assess the degree to which participants spoke during the task on a scale of 0 to 3, with 0 representing "the participant was not speaking and/or did not seem to understand the task" and 3 representing "the participant is speaking throughout the task and is speaking on topic." With one exception, coders' responses on this item (Experiment 1: $r = .609$, $p < .001$; Experiment 2: $r = .403$, $p < .001$) did not differ as a function of condition in either experiment, ts < 1.58, ps > .116, the exception being that participants in the 15-option, final choice condition in Experiment 1 were rated as speaking more than those in the 15-option, reversible choice condition, $t(78) = 2.13$, $p = .037$ (audio/video data were lost for a total of 25 participants in Experiment 1 due to equipment malfunction). Importantly, including coders' ratings as a covariate in all analyses did not affect the significance levels or the pattern of responses in the meta-analytic results. This suggests that differences in speaking activity cannot account for the observed findings.

4. Across all cardiovascular indices and across both studies, mixed-effects ANOVA models revealed no significant interactions between profile-viewing minute (i.e., minutes 1, 2, and 3 of the profile-viewing period) and condition in terms of task engagement, Fs < 1.54, ps > .165, or challenge/threat, Fs < 1.50, ps > .177 (with and without including engagement as a covariate). Thus, in order to maximize reliability of our cardiovascular measures and to simplify interpretations, we tested the average of the three profile minutes in all analyses.

5. Using mixed-effects ANOVA models, we found a significant interaction between time period (i.e., profile-viewing period vs. decision period) and condition for task engagement in Experiment 1, $F(3, 94) = 3.37$, $p = .022$, such that task engagement was significantly higher during profile-viewing than during the decision period across all study conditions, Fs > 7.22, ps < .009, except for the 15-option, reversible choice condition, $F(1, 94) = .210$, $p = .649$. Similarly, in Experiment 2, we found a significant interaction between time period (i.e., profile-viewing period vs. decision period) and condition for task engagement, $F(3, 121) = 2.95$, $p = .036$, such that task engagement was significantly higher during the profile-viewing period than in the decision period for those in the 15-option, final choice and 4-option conditions, Fs > 6.77, ps < .010, but not for those in the rating and 15-option, reversible choice conditions, Fs < .050, ps > .828. In sum, these analyses do not seem to have clear implications for interpreting our primary results, and thus, we elected to not examine differences across time in the meta-analysis.
6. Using mixed-effects ANOVA models, we found no significant interaction between time period and condition when predicting challenge/threat responses in isolation in Experiment 1 (i.e., without including engagement as a covariate in the model), $F(3, 94) = 1.50$, $p = .219$. When including engagement as a covariate, a significant interaction emerged, $F(3, 93) = 3.34$, $p = .023$, such that participants in the 4-option condition exhibited greater threat during the decision period than the profile-viewing period, $F(1, 93) = 4.75$, $p = .032$, whereas participants in the rating condition exhibited greater threat during the profile-viewing period, $F(1, 93) = 8.19$, $p = .005$. For the 15-option, final choice and 15-option, reversible choice conditions, there were no significant differences between challenge/threat responses across time periods, Fs < .66, p > .42. In Experiment

2, we found no significant interactions between time period and condition when predicting challenge/threat responses (with and without including engagement as a covariate), *F*s < 1.12, *p*s > .346. In sum, these analyses do not seem to have clear implications for interpreting our primary results, and thus, we elected to not examine differences across time in the meta-analysis.

7. Although we included all 13 items (α = .87) used in Study 3 in the meta-analysis, the difference between the 15-option, final choice condition and the 4-option condition was also significant when only including the 9-item measure (α = .79) used in all three samples, r = -.090, z = -2.00, p = .046, 95% CI [-.178, -.002].
8. Although the meta-analysis revealed no significant differences in post-decisional outcomes between the 15-option, final choice condition and the rating condition, no work to our knowledge has used rating many options as a control task when assessing post-decisional evaluations after choice overload (see Vohs et al., 2008, for an example assessing subsequent self-regulation). Thus, we cannot speak to whether this null finding is consistent with other work examining choice overload response.

Table 1

Correlations and Descriptive Statistics (Experiment 1)

Measure	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Profile-viewing period													
1. Challenge/threat index	--												
2. TPR reactivity	-.838***	--											
3. CO reactivity	.838***	-.405***	--										
4. Task engagement index	.265**	-.059	.385***	--									
5. HR reactivity	.021	.176	.212*	.833***	--								
6. VC reactivity	.419***	-.274*	.428***	.833***	.386***	--							
Decision period													
7. Challenge/threat index	.771***	-.659***	.633***	.252*	.043	.376***	--						
8. TPR reactivity	-.654***	.828***	-.269**	-.040	.171	-.238*	-.834***	--					
9. CO reactivity	.633***	-.272***	.788***	.379***	.243*	.389***	.834***	-.392***	--				
10. Task engagement index	.022	.156	.192	.791***	.695***	.622***	.131	.104	.323**	--			
11. HR reactivity	-.158	.310*	.045	.538***	.730***	.165	-.131	.319**	.112	.795***	--		
12. VC reactivity	.193	-.062	.260**	.720***	.375***	.823***	.332**	-.153	.402***	.795***	.264**	--	
13. Self-reported choice overload	-.135	.185	-.041	.081	.153	-.019	-.127	.185	-.026	.073	.101	.015	--
M	0	173.545	-.862	0	6.375	3.856	0	163.915	-.950	0	2.815	3.600	3.016
SD	1	187.570	1.571	1	6.160	7.083	1	183.037	1.502	1	6.281	7.680	0.982

Note. TPR = total peripheral resistance, CO = cardiac output, HR = heart rate, VC = ventricular contractility. Values reflect the subsample (N = 97) with no missing data across tasks and therefore differ slightly from task-specific values reported in the text.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 2

Correlations and Descriptive Statistics (Experiment 2)

Measure	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Profile-viewing period													
1. Challenge/threat index	--												
2. TPR reactivity	-.906***	--											
3. CO reactivity	-.906***	-.641***	--										
4. Task engagement index	.154	.044	.322***	--									
5. HR reactivity	-.030	.151	.096	.847***	--								
6. VC reactivity	.290***	-.076	.450***	.847***	.435***	--							
Decision period													
7. Challenge/threat index	.823***	-.715***	.776***	.199*	.044	.293***	--						
8. TPR reactivity	-.740***	.794***	-.547***	-.078	.006	-.138	-.905***	--					
9. CO reactivity	.748***	-.499***	.856***	.282***	.086	.392***	.905***	-.636***	--				
10. Task engagement index	.135	.053	.298***	.810***	.705***	.668***	.292***	-.134	.394***	--			
11. HR reactivity	-.021	.114	.076	.587***	.778***	.216*	.072	-.003	.128	.795***	--		
12. VC reactivity	.236**	-.029	.399***	.701***	.342***	.846***	.392***	-.210*	.498***	.795***	.263**	--	
13. Self-reported choice overload	.147	-.140	.126	.131	.125	.096	.218*	-.219*	.175	.159	.043	.210	--
M	0	180.456	-0.631	0	7.842	6.452	0	213.447	-0.863	0	7.869	4.371	3.129
SD	1	202.107	1.630	1	6.038	8.464	1	218.111	1.762	1	6.140	8.592	1.066

Note. TPR = total peripheral resistance, CO = cardiac output, HR = heart rate, VC = ventricular contractility. Values reflect the subsample (N = 125) with no missing data across tasks and therefore differ slightly from task-specific values reported in the text.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 3

Unadjusted Means and Standard Deviations by Condition (Experiments 1-3)

Measure	Experiment	15-option; Final *M* (*SD*)	4-option; Final *M* (*SD*)	15-option; Rating *M* (*SD*)	15-option; Reversible *M* (*SD*)
Profile-viewing period					
Task engagement index	1	0.43 (1.30)	-0.22 (0.71)	-0.02 (1.09)	-0.17 (0.69)
	2	0.26 (1.10)	-0.18 (0.90)	-0.25 (0.96)	0.18 (0.99)
HR reactivity	1	9.73 (7.51)	4.99 (4.51)	5.76 (6.34)	5.35 (4.07)
	2	9.31 (5.95)	6.89 (5.51)	6.03 (6.82)	8.96 (5.25)
VC reactivity	1	5.11 (9.05)	2.94 (5.57)	4.46 (7.12)	3.14 (6.33)
	2	7.95 (9.49)	5.02 (8.04)	5.20 (6.05)	7.25 (9.58)
Challenge/threat index	1	-0.07 (1.14)	0.18 (1.02)	-0.09 (0.96)	-0.002 (0.93)
	2	-0.29 (0.76)	0.13 (0.83)	0.12 (0.88)	-0.003 (1.34)
TPR reactivity	1	199.95 (227.69)	132.10 (171.31)	202.86 (196.98)	164.43 (145.19)
	2	226.57 (167.79)	143.04 (134.91)	138.16 (177.49)	211.69 (211.69)

CO reactivity	1	-0.85 (1.83)	-0.76 (1.77)	-0.88 (1.31)	-0.97 (1.68)
	2	-1.09 (1.29)	-0.53 (1.56)	-0.61 (1.35)	-0.38 (2.02)
n	1	24	24	30	26
	2	28	32	32	36
Decision period					
Task engagement index	1	0.38 (1.16)	-0.41 (0.61)	-0.10 (1.04)	0.13 (0.97)
	2	0.16 (1.17)	-0.39 (0.71)	-0.10 (0.86)	0.33 (1.10)
HR reactivity	1	5.93 (7.17)	0.19 (4.42)	1.64 (6.30)	3.65 (5.73)
	2	8.29 (6.82)	6.59 (5.33)	7.24 (6.37)	9.29 (6.03)
VC reactivity	1	4.45 (8.43)	1.76 (5.85)	3.76 (8.20)	4.20 (7.92)
	2	6.00 (9.37)	0.88 (6.66)	3.81 (5.57)	6.87 (10.76)
Challenge/threat index	1	-0.28 (1.20)	0.29 (0.80)	0.12 (0.76)	-0.14 (1.16)
	2	-0.32 (0.93)	0.01 (0.77)	0.25 (0.91)	-0.01 (1.25)

TPR reactivity	1	222.39 (233.20)	112.90 (152.59)	144.13 (142.48)	178.26 (192.98)
	2	282.00 (193.35)	200.74 (157.91)	146.30 (186.37)	235.53 (288.30)
CO reactivity	1	-1.17 (1.96)	-0.63 (1.13)	-0.82 (1.10)	-1.17 (1.73)
	2	-1.31 (1.79)	-0.94 (1.47)	-0.59 (1.62)	-0.71 (2.08)
n	1	22	21	29	25
	2	26	32	32	35
Post-decision					
Self-reported overload	1	3.07 (1.00)	2.73 (0.99)	2.87 (0.83)	3.35 (0.97)
9-item measure	2	2.99 (1.04)	2.83 (1.11)	3.49 (1.19)	3.16 (0.81)
	3	3.41 (2.05)	3.15 (1.85)	3.16 (1.80)	3.47 (2.05)
4-item measure	3	5.12 (0.33)	3.58 (0.29)	4.10 (0.29)	5.31 (0.33)
n	1	24	24	30	26
	2	28	32	32	36
	3	58	71	75	58

Table 4
Summary of ANOVA/ANCOVA Analyses for Experiments 1-3

Measure	Experiment	15-option; Final VS 4-option		15-option; Final VS Rating		15-option, Final VS 15-option; Reversible	
		F	η_p^2	*F*	η_p^2	*F*	η_p^2
<u>Profile-viewing period</u>							
Task Engagement	1	5.34*	.051	2.82†	.027	4.71*	.044
	2	3.03†	.024	4.08*	.032	0.12	.001
HR reactivity	1	8.01**	.074	6.25*	.058	7.13**	.067
	2	2.89†	.023	5.06*	.040	0.09	.000
VC reactivity	1	1.10	.011	0.12	.001	0.96	.009
	2	2.53	.020	2.25	.018	0.30	.002
Challenge/threat index	1	5.67*	.058	3.13	.033	0.46	.005
	2	3.82†	.030	3.80†	.030	1.44	.011
TPR reactivity	1	1.96	.019	0.01	.000	0.67	.007

	2	3.84†	.031	4.16*	.034	0.74	.006
CO reactivity	1	1.60	.014	0.42	.004	0.40	.004
	2	4.84*	.039	4.41*	.036	4.45*	.036
Decision period							
Task Engagement	1	7.16**	.072	3.12†	.032	0.77	.008
	2	4.57*	.036	1.08	.009	0.44	.004
HR reactivity	1	9.80**	.095	6.35*	.064	1.69	.018
	2	1.10	.009	0.42	.003	0.40	.003
VC reactivity	1	1.30	.014	0.10	.001	0.01	.000
	2	5.38*	.043	0.98	.008	0.16	.001
Challenge/threat index	1	5.67*	.058	3.13	.033	0.46	.005
	2	4.04*	.033	7.00*	.055	1.07	.009
TPR reactivity	1	3.13†	.033	1.99	.021	0.61	.007
	2	3.24†	.026	6.71*	.053	0.52	.004

CO reactivity	1	5.15*	.053	2.49	.027	0.12	.001
	2	3.31†	.027	4.67*	.037	1.35	.011
Post-decision							
Self-reported	1	1.56	.015	0.64	.006	1.06	.011
Choice overload	2	0.35	.003	3.42†	.027	0.45	.004
	3	7.54**	.028	4.45*	.017	0.15	.000

Note. †$p < .1$ *$p < .05$. **$p < .01$. ***$p < .001$.

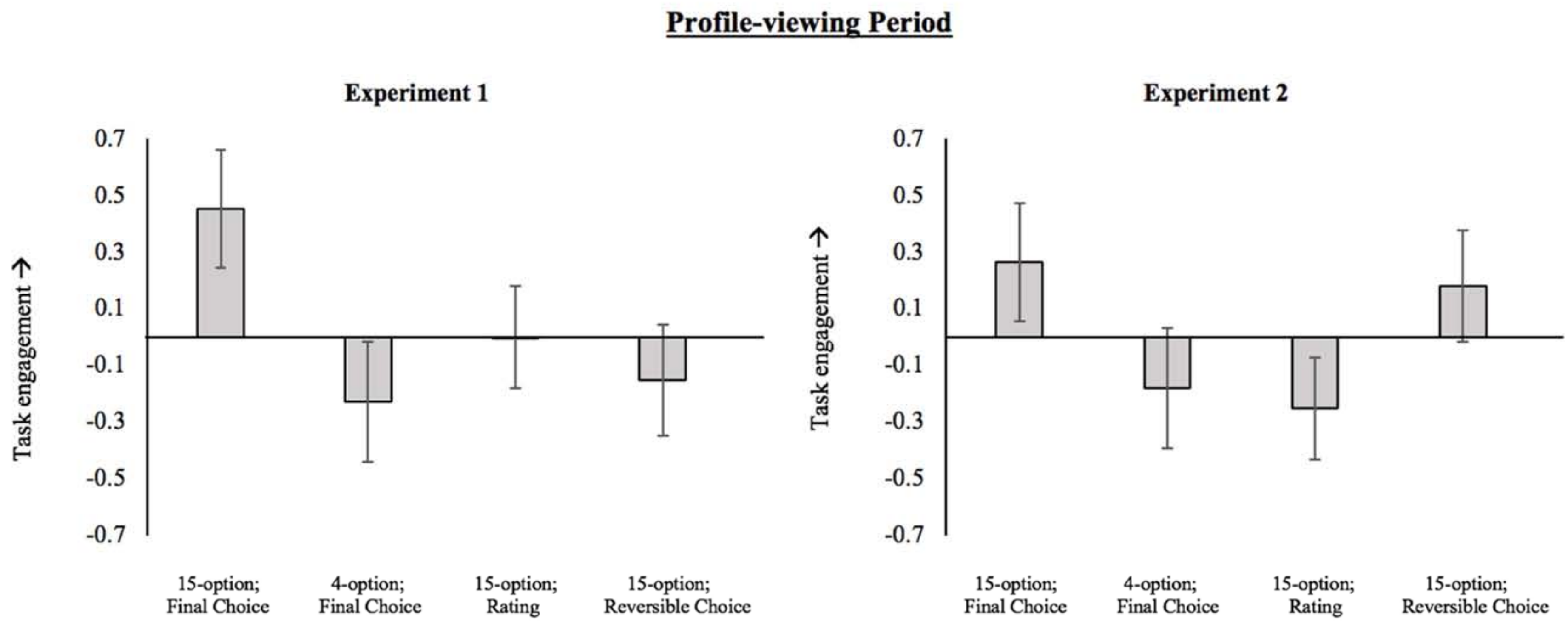

Figure 1. Task engagement cardiovascular reactivity index scores during the profile-viewing period in Experiments 1 and 2. Error bars indicate standard errors.

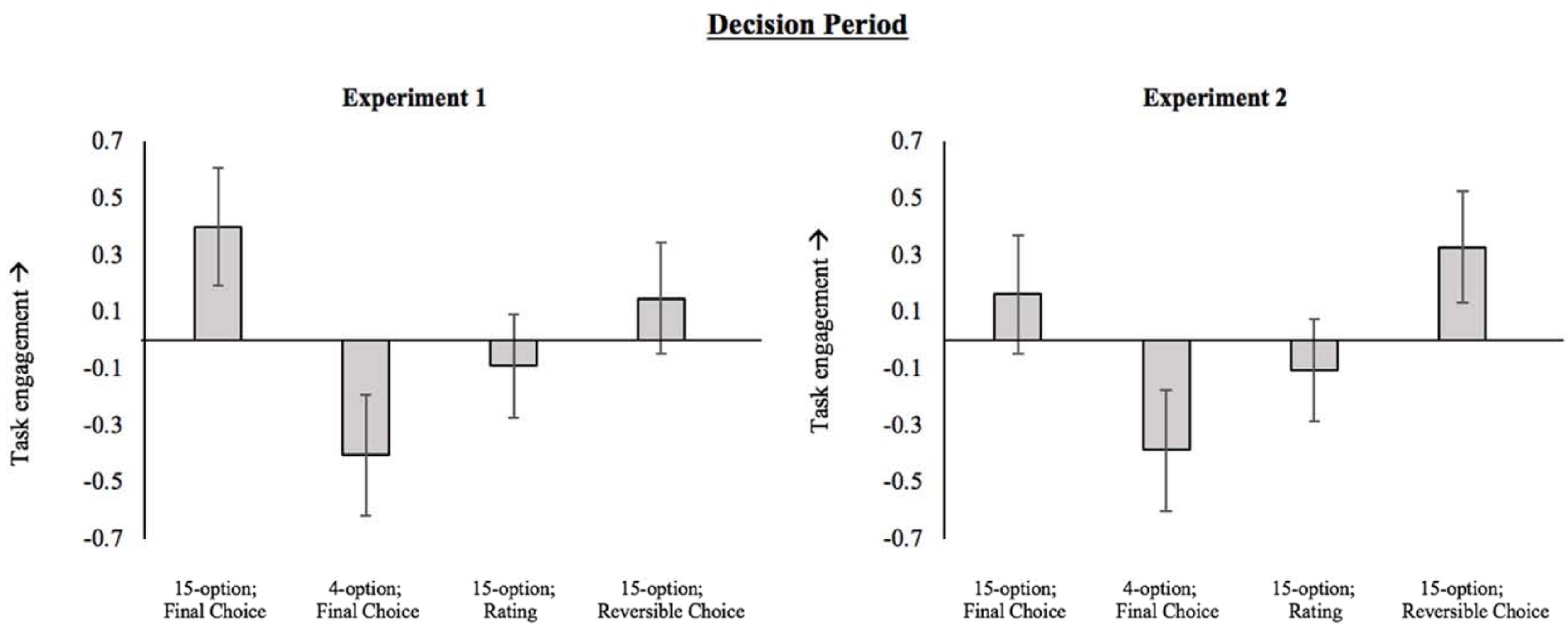

Figure 2. Task engagement cardiovascular reactivity index scores during the decision period in Experiments 1 and 2. Error bars indicate standard errors.

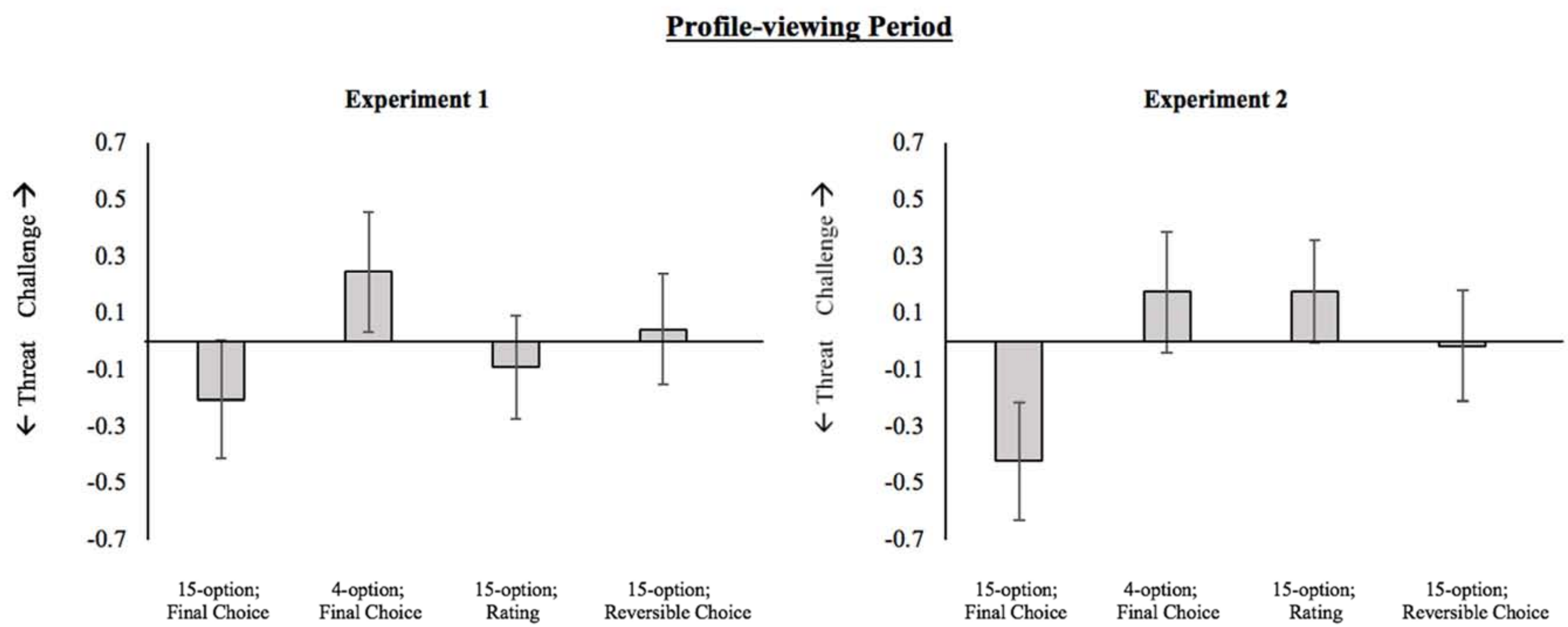

Figure 3. Challenge/threat cardiovascular reactivity index scores during the profile-viewing period in Experiments 1 and 2. Error bars indicate standard errors.

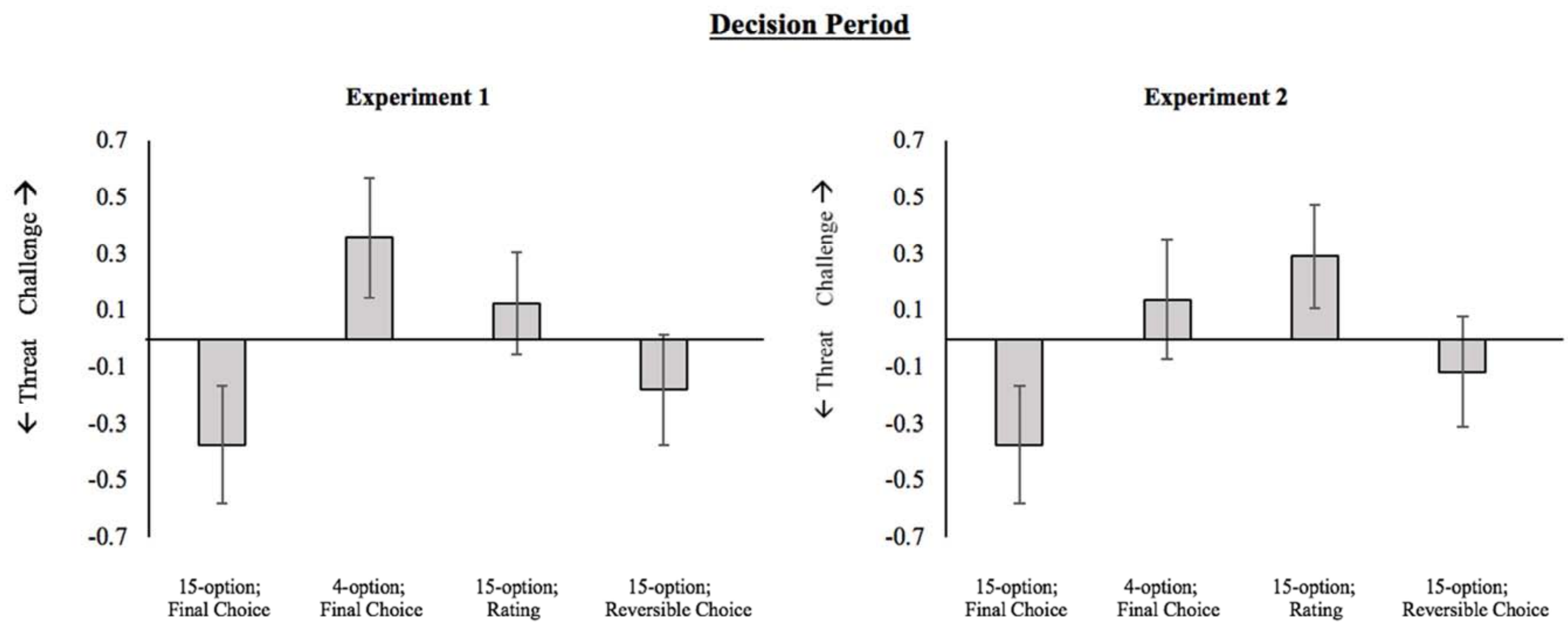

Figure 4. Challenge/threat cardiovascular reactivity index scores during the decision period in Experiments 1 and 2. Error bars indicate standard errors.

- We assessed cardiovascular measures of engagement and threat during a choice task
- Participants either selected from many or few options, or rated many options
- Selecting from many options simultaneously predicted greater engagement and threat
- The current work suggests a novel motivational account of choice overload