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How individual differences in knowledge over-/underconfidence impede dietary consumer decision making under time pressure

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ABSTRACT

In two studies, we identify a novel moderator (objective time pressure) of the relationship between knowledge over-/underconfidence (O/U) and subjective choice quality. Knowledge O/U is an individual difference variable with behavioral correlates in the consumption realm. As a common decision bias, knowledge overconfidence leads consumers to speed up decision making and to deem their decisions more accurate than those who are less knowledge confident. As knowledge-overconfident consumers accelerate decisions, it is tempting to assume that they would be less affected by objective time pressure than less knowledge confident consumers, who often need more decision time. However, we demonstrate that knowledge-overconfident consumers are more prone to suffer from the effects of objective time pressure. Specifically, in a dietary choice setting, objective time pressure positively moderates the relationship between knowledge O/U and subjective time pressure and perceived choice difficulty, respectively. Taking a moderated-mediation approach, we also investigate perceived choice difficulty and subjective time pressure as mediators of the relationship between knowledge O/U and subjective choice quality and find that objective time pressure moderates these mediating effects.

1. Introduction

Consumers' food-related health knowledge can be biased in terms of knowledge confidence, such that some believe that they know more than they do, while others believe that they know less than they do. While some studies have used subjective measures to investigate food-related health knowledge by applying food literacy measures (Palumbo et al., 2019), others have included both subjective and objective food-related health knowledge measures by applying the concept of knowledge over-/underconfidence (O/U) (Fernbach et al., 2019; Hansen & Thomsen, 2013).

Knowledge O/U results from the combination of subjective and objective knowledge. Subjective knowledge refers to individuals' perceptions of their own knowledge, while objective knowledge refers to absolute knowledge measured against objective standards (Alba & Hutchinson, 2000). This distinction allows for three scenarios: individuals can be knowledge underconfident (average objective knowledge exceeds average subjective knowledge), knowledge calibrated (average objective knowledge and average subjective knowledge correspond to each other), or knowledge overconfident (average objective knowledge exceeds average subjective knowledge) (Alba & Hutchinson, 2000). To capture these three scenarios, knowledge O/U is calculated as ranging from −1 (representing the most knowledge underconfident) to +1 (representing the most knowledge overconfident), with 0 representing knowledge calibration (Kidwell et al., 2008). Prior research indicates that knowledge O/U can be a powerful individual difference concept in explaining consumer choice behavior (Pillai & Hofacker, 2020), with impeding effects on choice outcome due to confirmation bias and ill-informed decisions (for a review, see Thaller & Brudermann, 2020).

A notable difference between knowledge-overconfident and knowledge-underconfident individuals is the speed with which they are likely to perform choice tasks, with the former needing less time than the latter to make decisions (Baranski & Petrusic, 1998). Consequently, it is fair to assume that knowledge-overconfident and knowledge-underconfident individuals will respond differently to time pressure. However, although prior research confirms that time pressure can affect the link between individual differences and decision making (Byrne et al., 2015), previous studies have not employed a time limit (i.e., objective time pressure) when investigating relationships between knowledge O/U and subjective choice quality in consumption choice contexts. This is especially unfortunate because time pressure is

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generally considered one of the most common costs of decision making (Fechner et al., 2018; Shugan, 1980) that consumers confront in the modern marketplace (Huseynov & Palma, 2021).

We address this research gap by suggesting objective time pressure as a novel moderator that explains how knowledge O/U may ultimately affect subjective choice quality. Objective time pressure is a choice situation with an impending deadline, whereas subjective time pressure is the cognitive discrepancy between the time available and the time required to perform a task (Hornik, 1984; Suri & Monroe, 2003). Including the concepts of subjective time pressure and perceived choice difficulty, we further propose that objective time pressure positively moderates the relationship between knowledge O/U and subjective time pressure and perceived choice difficulty, respectively. In addition, we propose that perceived choice difficulty and subjective time pressure act as mediators of the relationship between knowledge O/U and subjective choice quality and suggest that objective time pressure moderates these mediating effects.

Our research is based on two studies (including four pretests) within the area of food consumption, as prior research identifies consumer knowledge as an important factor in the study of food consumption (Hansen & Thomsen, 2013) and dietary choices have health implications at the individual level and financial implications for society as a whole (Centers for Disease Control and Prevention, 2021). Thus, food consumption offers a suitable empirical topic for this study. To investigate our research propositions, we carry out four pretests to determine the appropriate levels of objective time pressure. We then apply the selected time pressure conditions in two experimental studies (a two-choice judgment and a six-choice judgment). We use ready-made meals as the product category in both studies.

Our main theoretical contribution is to the knowledge calibration literature in cognitive psychology, which posits that knowledge-overconfident individuals are more efficient decision makers than knowledge-underconfident individuals, as they may act more quickly, ignore information, and use less time to perform certain choice tasks (Baranski & Petrusic, 1998; Baumann et al., 1991; Koriat et al., 1980). While this situation might intuitively lead us to expect knowledge-overconfident consumers to be relatively *less* sensitive to objective time pressure in decision making, our research shows that they are *more* sensitive to objective time pressure than less knowledge confident consumers, ultimately resulting in relatively lower subjective choice quality. In this vein, we find that objective time pressure moderates the effect of knowledge O/U on subjective choice quality in an unexpected way.

2. Theoretical framework and research hypotheses

We use resource-matching theory (Anand & Sternthal, 1989; Jae et al., 2011; Mantel & Kellaris, 2003) and routine theory (Avni-Babad, 2011; Avni-Babad & Ritov, 2003) as a conceptual basis for hypothesizing a series of moderating and moderated mediating effects involving objective time pressure, knowledge O/U, subjective time pressure, perceived choice difficulty, and subjective choice quality. Fig. 1 provides a graphical representation of the proposed effects. Specifically, we suggest that the relationship between knowledge O/U and subjective choice quality is mediated by perceived choice difficulty and subjective time pressure, respectively, and that these mediating effects are moderated by objective time pressure.

Resource-matching theory suggests that the processing of information is most efficient when the level of cognitive resources available matches the level of cognitive resources required to process the information under a certain period (Anand & Sternthal, 1989; Jae et al., 2011; Mantel & Kellaris, 2003). As such, choice difficulty not only constitutes a property of the choice set but also may be influenced by the decision maker's mindset (Cho et al., 2013). Choice difficulty refers to consumers' perceived difficulty in transforming information into knowledge (Hansen & Thomsen, 2013). Drawing on resource-matching

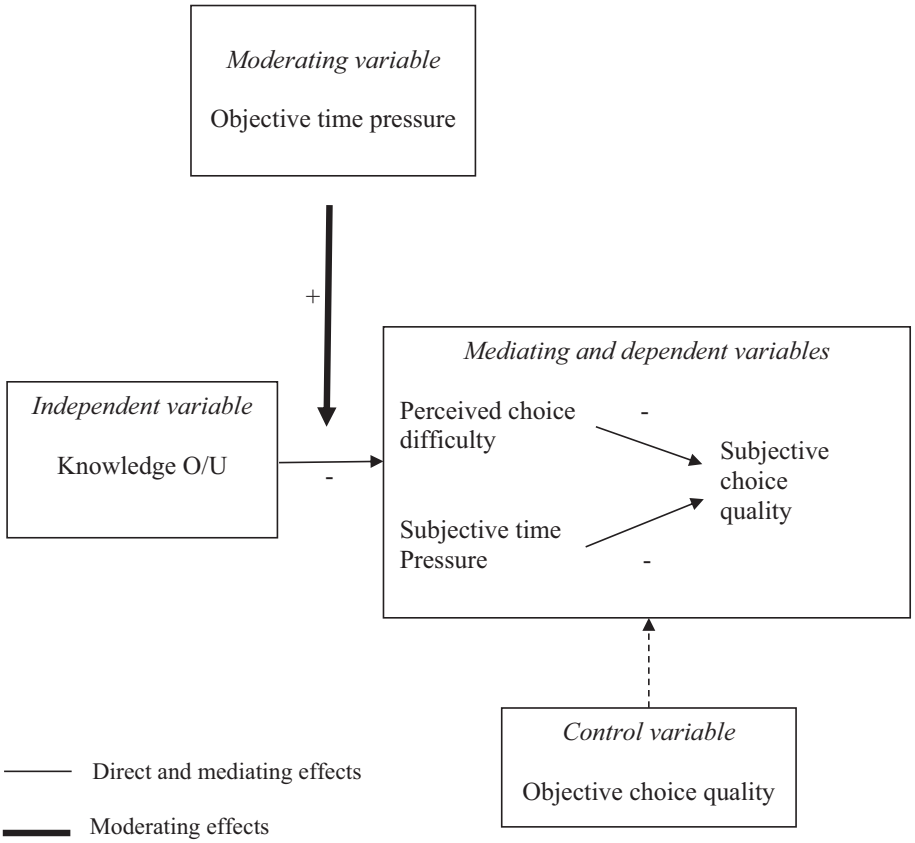

Fig. 1. Conceptual framework.
Note. In testing H1 and H3, knowledge O/U is an independent variable, perceived choice difficulty and subjective pressure are dependent variables, and objective time pressure is a moderating variable. In testing H2 and H4, knowledge O/U is an independent variable, perceived choice difficulty and subjective pressure are mediating variables, subjective choice quality is a dependent variable, and objective time pressure is a moderating variable.

theory, we predict that consumers' perceived difficulty in carrying out a certain choice will increase if they are exposed to a situation in which their available objective knowledge resources fall behind their subjective expectations of their objective knowledge. Time pressure may be such a situation. A reduction in the time available to make choices can cause consumers to be aware that they lack resources in terms of complete relevant decisional information (Dhar & Nowlis, 1999; Payne et al., 1988; Young et al., 2012). However, previous research also suggests that objective knowledge is an important ingredient in offsetting the effect of time pressure on decision making, in that it enables individuals with more objective knowledge to perform more cognitive activities in a certain amount of time without deterioration in performance (Spilker, 1995). Because their objective knowledge is lower than they believe, knowledge-overconfident consumers should be more likely than less knowledge confident consumers to perceive a lack of resources when time pressure is high. This is because objective time pressure may reveal that their objective knowledge is less sufficient to guide their decision than they initially believed, thereby exposing them to the mismatch between their available cognitive resources and the level of cognitive resources required to fully process the information. Along similar lines, when time pressure is high, less knowledge confident consumers may feel positively disconfirmed because their objective knowledge resources prove to be more sufficient to guide their decision than they initially believed. In summary, we expect knowledge-overconfident consumers to feel less resourceful and more uncertain during their evaluation of a decision problem under time pressure than less knowledge confident consumers (Walczuch & Lundgren, 2004). Thus:

H1. . Objective time pressure positively moderates the relationship between knowledge O/U and perceived choice difficulty.

Subjective choice quality refers to consumers' impression of the quality of their choices (Tsai & McGill, 2011). Prior research suggests that both objective knowledge and the combination of objective and subjective knowledge can affect subjective choice quality. In a series of studies, Kruger and Dunning (1999) demonstrated that individuals with low objective knowledge are more likely to overestimate the quality of their choices than individuals with high objective knowledge. They proposed that this is because low ability prevents individuals with low objective knowledge from recognizing when judgments are accurate and when they are erroneous. Fagot and O'Brian (1994), Sinkavich (1995), and Maki et al. (1994) obtained similar findings. Other research, however, has questioned the generalizability of the "Dunning–Kruger effect," suggesting that the discrepancy between self-assessed knowledge and objectively measured knowledge is, at least to some extent, due to other personal factors, such as self-deceptive enhancement and impression management (Gignac, 2018), trait narcissism (Zajenkowski et al., 2020), and self-perception training (e.g., feedback skills) (Gold & Kuhn, 2017), or situational factors, such as when a consumer is rewarded for self-perception accuracy (Shepperd, 1993). According to Gignac and Zajenkowski et al. (2020), while such factors can influence individuals' subjective misinterpretation of their knowledge, they are unrelated to individuals' objective knowledge, thereby contrasting the Dunning–Kruger effect. Other research has also challenged the Dunning–Kruger effect by suggesting that statistical issues, such as regression to the mean, can lead to similar observations of overconfidence (Nuhfer et al., 2016) and that a rational Bayesian inference model may largely explain the miscalibration of confidence (Jansen et al., 2021).

However, to our knowledge, no studies have used moderated-mediation tests to examine the mechanisms through which knowledge O/U affects performance. We suggest that perceived choice difficulty mediates the relationship between knowledge O/U and subjective choice quality and that objective time pressure negatively moderates this relationship. Testing moderated-mediation hypotheses may provide additional insights into the effect of knowledge O/U on subjective choice quality, thereby shedding more light on this relationship. Our suggestion is consistent with (1) previous research that shows a negative relationship between knowledge O/U and perceived choice difficulty (Hoelzl & Rustichini, 2005) and between perceived choice difficulty and subjective choice quality (Park & Lessig, 1981; Rolls et al., 2014) and (2) the expectation that objective time pressure positively moderates the relationship between knowledge O/U and perceived choice difficulty, as outlined previously. Thus:

H2. . Objective time pressure negatively moderates the indirect relationship between knowledge O/U and subjective choice quality through perceived choice difficulty.

Routine theory (Avni-Babad, 2011; Avni-Babad & Ritov, 2003) suggests that individuals develop processes that facilitate decision making in routine versus non-routine situations and that, under time pressure, they are more likely to rely on such routine behavior (Betsch et al., 1998; Wood & Neal, 2009). Consistent with these suggestions, prior research indicates that experience with certain choice environments facilitates decision making within these environments (Beilock et al., 2008; Calderwood et al., 1988). For example, Calderwood et al. (1988) found that experienced chess players were less affected by extreme time pressure in their decision making than less experienced chess players. Therefore, consumers used to dietary decision making in situations they perceive as being time pressured should be more likely to have developed a routine that facilitates decision making under such conditions.

Furthermore, because high confidence can impart a false sense of security, leading to premature closure and non-perception of alternatives (Arkes et al., 1986), knowledge-overconfident individuals are likely to act more quickly when facing a choice situation than less knowledge confident individuals (Baumann et al., 1991). Therefore, given the same amount of time for dietary shopping, knowledge-overconfident consumers should experience time pressure in food choice situations less often than knowledge-underconfident consumers, as they will act more quickly than knowledge-underconfident consumers, who need more time to make their dietary choices. Consequently, we propose that knowledge-overconfident consumers are relatively less used to experiencing time pressure when choosing food items. As such, when they actually *do* confront such time pressure, we argue that they will be less able to handle it than less knowledge confident consumers. Following from this, we posit that consumers who are less used to experiencing time-pressured environments (i.e., dietary knowledge-overconfident consumers) will be more affected by objective time pressure. Thus:

H3. . Objective time pressure positively moderates the relationship between knowledge O/U and subjective time pressure.Research has found a negative relationship between the amount of time spent on a decision and an individual's confidence in that decision (Petrusic & Baranski, 2009; Young et al., 2012). However, there is a significant difference between time consumption and time pressure, with prior research on time pressure indicating that individuals have greater confidence in their performance when subjective time pressure is low rather than high (Van der Kleij et al., 2009). We suggest that objective time pressure negatively moderates the indirect relationship between knowledge O/U and subjective choice quality through subjective time pressure. This is consistent with our prediction that objective time pressure will positively moderate (1) the relationship between knowledge O/U and subjective time pressure and (2) the expected negative relationship between perceived subjective time pressure and subjective choice quality. Thus:

H4. . Objective time pressure negatively moderates the indirect relationship between knowledge O/U and subjective choice quality through subjective time pressure.

3. Study 1

We initially conducted a two-choice judgment experiment (Study 1), followed by a six-choice experiment (Study 2). Two-choice judgments have important analogues in the real world, as people must often choose between two alternatives (Klayman et al., 2009). The study exposed respondents to two ready-made meal Nutrition Facts Panels (see Appendix A: https://osf.io/j5vkq/) and instructed them to choose the meal they believed represented the healthier choice. We chose ready-made meals as the product category because the choice quality of these products is objectively assessable. Moreover, a series of 16 semi-structured in-depth interviews indicated that this food product category is associated with a sufficient degree of choice difficulty and thus represents a choice task in which knowledge resources are likely to affect choice outcome.

3.1. Pretests

We followed the procedure Suri and Monroe (2003) suggest and conducted two pretests to develop the manipulations of objective time pressure. The purpose of pretest 1 was to determine the average time required to choose the perceived healthier ready-made meal. Pretest 2 tested the appropriateness of the time pressure conditions. The results led to the selection of 15 s for the low time pressure condition and 10 s for the high time pressure condition. Appendix B (https://osf.io/j5vkq/) provides further details on the pretests.

3.2. Methodology

In Study 1, we use multivariate analysis of variance (MANOVA) to estimate the results. We performed an a priori power analysis using G*Power 3.1 to determine minimum sample size. In the analysis, we assume a medium effect size (f^2) of 0.15 (Steyn & Ellis, 2009), a statistical power of 0.95, an alpha of 0.05, two experimental groups (i.e., low vs. high time pressure), and three dependent variables (i.e., perceived choice difficulty, subjective time pressure, and subjective choice quality). The obtained results suggested a total sample size of at least 120 respondents.

To test the proposed hypotheses, we conducted a computer-simulated online choice experiment that manipulated objective time pressure at two levels: low and high. The market research agency Epinion undertook the data collection using its online consumer panel, which is among the largest online research panels in Denmark, serving both qualitative and quantitative studies. From this panel, Epinion draws and contacts individuals who are relevant for the specific research project (e.g., to ensure specified age and/or gender distributions). The respondents included in our studies all came from Epinion's online consumer panel and had balanced age, gender, and education levels. No individuals took part in more than one study.

For Study 1, 280 individuals drawn from Epinion's online panel were contacted by email. The respondents were selected with a survey algorithm, which worked to reflect the distribution of age, gender, and educational background in the population. The 280 consumers were asked to respond to the screening question: "Do you regularly do your own food shopping?" (yes/no). One hundred ninety-eight questionnaires were received from respondents, for a response rate of 70.7%. Of the respondents, 65 answered "no" to the screening question, which left us with 133 respondents for Study 1.

The experiment instructed respondents to choose the healthier ready-made meal (among the two ready-made meal Nutrition Facts Panels) within *X* (the manipulated) seconds. We removed one respondent who failed to complete the choice within the manipulated time from the dataset. In total, 132 respondents fulfilled all experimental requirements, with 70 respondents randomly assigned to the low time pressure condition. Of the final sample, 56.0% of respondents were female, and the average age was 50.4 years, with a range of 22–76 years. All respondents received a monetary payment and participated in a lottery in which they could win an additional payment. In the experiment, 69.7% chose the ready-made meal chili con carne (correct choice) and 30.3% chose meatballs (incorrect choice). Chili con carne was the only ready-made meal objectively assigned with the highest "health recommendation" in the official Danish three-level food health classification "Eat." Thus, chili con carne represented the healthier choice (i.e., "correct" choice) in the study.

We conducted randomization checks for age, gender (with contrast coding: −1 = male, 1 = female), and educational background. We treated educational background as a categorical variable using eight categories. Studies indicate that age and educational background are related to dietary choice quality (e.g., Begley et al., 2019) and that women are more likely than men to maintain a healthful diet (e.g., Arganini et al., 2012). The results of the randomization checks showed no apparent differences in age (low time pressure: $M = 49.4$, $SD = 12.8$; high time pressure: $M = 51.5$, $SD = 11.8$; t-value = 1.01, $df = 130$, $p = .31$), gender (low time pressure: female 58.6%; high time pressure: female 51.6%; $\chi^2 = 0.64$, $df = 1$, $p = .42$), or educational background ($\chi^2 = 6.73$, $df = 7$, $p = .46$) between experimental groups. Given these results, we do not take age, gender, or educational background further into account in Study 1.

3.3. Measurements

We measured the knowledge accuracy (objective knowledge) part of the *knowledge O/U* construct with a series of 15 ready-made meal knowledge items (see Appendix C: https://osf.io/j5vkq/). We developed the items from a 20-item pool, derived partly from Andrews et al.'s (1998) 15-item nutritional knowledge scale and partly from official dietary recommendations issued by health authorities. All items were true/false statements. Additionally, for each of their answers, respondents indicated the degree of confidence (subjective knowledge) in that their answer was correct on a restricted scale ranging from 50% to 100% (Pillai & Hofacker, 2007). In binary choices, the confidence percentages cannot not be below 50% as otherwise the respondent would have chosen the alternative option. We measured knowledge O/U as the difference between the mean of the probability responses and the overall mean proportion correct (Kidwell et al., 2008), meaning that a completely knowledge-underconfident consumer would score −1 on the scale while a completely knowledge-overconfident consumer would score +1. Consumers with no difference between the mean of the probability responses and the overall mean proportion correct would score 0, meaning that they are knowledge calibrated (i.e., neither knowledge under- nor overconfident). For *subjective time pressure*, we adapted the three-item perceived time pressure scale from Suri and Monroe (2003), as also used in the pretest. A sample item is "How would you characterize the time available for choosing a ready-made meal?" (1 = "more than adequate time available"; 7 = "not adequate time available"). We adapted the Zhang and Mittal (2005) and Chatterjee and Heath (1996) three-item decision difficulty scale to measure *perceived choice difficulty*. A sample item is "How difficult do you think it was to single out the healthier ready-made meal?" (1 = "not at all difficult"; 7 = "very difficult"). Three items adapted from Widing and Talarzyk's (1993) perceived decision quality scale measured respondents' *subjective choice quality*. A sample item is "I have great confidence that I have chosen the healthier ready-made meal" (1 = "totally disagree"; 7 = "totally agree"). Appendix C (https://osf.io/j5vkq/) provides all the items for each construct. *Objective choice quality* was a binary (control) variable with contrast coding (−1 if incorrect choice of ready-made meal; 1 if correct choice of ready-made meal).

3.4. Results

3.4.1. Validation of manipulation and measurements

We used maximum likelihood estimation with a combination of

AMOS 24 and SPSS 24 to carry out the measurement analyses. The results suggested that (1) our experimental manipulations worked as intended since respondents in the low time pressure condition perceived time pressure as lower than respondents in the high time pressure condition ($M_{\text{low time pressure}} = 3.37$ ($SD = 1.25$); $M_{\text{high time pressure}} = 4.94$ ($SD = 1.50$); $t = 6.53$, $df = 130$, $p < .01$) and (2) our measurements were reliable and valid. The procedure and the results are available in Appendix D (https://osf.io/j5vkq/).

3.4.2. Objective time pressure and knowledge O/U as predictors of perceived choice difficulty and subjective time pressure (H1 and H3)

First, we conducted a MANOVA with objective time pressure, knowledge O/U, and their interaction term as independent variables. We formed an index for each of the three dependent variables by averaging their items (Brockman & Morgan, 2006). We mean-centered the continuous dependent variables and the knowledge O/U variable before entering them into the analysis. The results suggest that the objective time pressure × knowledge O/U interaction significantly influenced the dependent variables (Wilks's $\lambda = 0.94$; $F(3, 126) = 2.87$, $p = .04$; $\eta^2 = 0.06$). The main effects of the objective time manipulation (Wilks's $\lambda = 0.89$; $F(3, 126) = 5.40$, $p < .01$; $\eta^2 = 0.11$) and knowledge O/U (Wilks's $\lambda = 0.86$; $F(3, 126) = 6.69$, $p < .01$; $\eta^2 = 0.14$) were also both significant.

Second, we ran a separate analysis of variance (ANOVA) for each of the dependent variables. Objective time pressure, knowledge O/U, and their interaction term served as independent variables. The objective time pressure × knowledge O/U interaction had a significant, positive effect on perceived choice difficulty ($F(1, 128) = 6.71$, $p = .01$; $\eta^2 = 0.05$). As expected, this interaction also had a significant, positive effect on subjective time pressure ($F(1, 128) = 6.85$, $p = .01$; $\eta^2 = 0.05$). Though not hypothesized, we also found that the objective time pressure × knowledge O/U interaction had a significant, positive effect on subjective choice quality ($F(1, 128) = 3.95$, $p = .05$; $\eta^2 = 0.03$). Fig. 2 displays the significant interaction effects on perceived choice difficulty, subjective time pressure, and subjective choice quality, respectively.

With regard to the hypotheses, only consumers with high knowledge-O/U scores (i.e., scores above the median = 0.21) experienced a marginal difference in perceived choice difficulty under increased time pressure (low knowledge-O/U scores: $M_{\text{low time pressure}} = 4.11$ ($SD = 1.18$), $M_{\text{high time pressure}} = 3.76$ ($SD = 1.28$); $t = -1.15$, $df = 64$ $p = .26$; high knowledge-O/U scores: $M_{\text{low time pressure}} = 3.52$ ($SD = 1.60$), $M_{\text{high time pressure}} = 4.13$ ($SD = 1.38$; $t = 1.65$, $df = 64$, $p = .10$; Fig. 2, panel A). These results indicate that consumers with high knowledge-O/U scores experienced marginally greater perceived choice difficulty under an increase in time pressure than consumers with low knowledge-O/U scores (i.e., scores below the median = 0.21). Thus, H1 is marginally supported.

Both consumers with high and low knowledge-O/U scores experienced higher subjective time pressure when objective time pressure was high rather than low (low knowledge-O/U scores: $M_{\text{low time pressure}} = 3.44$ ($SD = 1.18$), $M_{\text{high time pressure}} = 4.46$ ($SD = 1.48$); $t = 3.11$, $df = 64$, $p < .01$; high knowledge-O/U scores: $M_{\text{low time pressure}} = 3.29$ ($SD = 1.34$), $M_{\text{high time pressure}} = 5.35$ ($SD = 1.41$); $t = 6.09$, $df = 64$, $p < .01$; Fig. 2, panel B). These results indicate that consumers with high knowledge-O/U scores experienced greater subjective time pressure under an increase in time pressure than consumers with low knowledge-O/U scores. Thus, H3 is supported.

In terms of the effect of objective time pressure × knowledge O/U interaction on subjective choice quality, neither consumers with low nor high knowledge-O/U scores experienced any change in subjective choice quality in response to the objective time pressure manipulation (low knowledge-O/U scores: $M_{\text{low time pressure}} = 4.10$ ($SD = 1.30$), $M_{\text{high time pressure}} = 4.16$ ($SD = 1.51$); $t = 0.18$, $df = 64$, $p = .86$; high knowledge-O/U scores: $M_{\text{low time pressure}} = 4.70$ ($SD = 1.39$), $M_{\text{high time pressure}} = 4.41$ ($SD = 1.28$); $t = 0.86$, $df = 64$, $p = .86$). Instead, further analyses indicated that respondents with low (vs. high) knowledge-O/U scores experienced a marginally lower subjective choice quality in the low time pressure condition (low time pressure: $M_{\text{low knowledge-O/U scores}} = 4.10$ ($SD = 1.30$), $M_{\text{high knowledge-O/U scores}} = 4.70$ ($SD = 1.39$); $t = 1.86$, $df = 64$, $p = .07$; high time pressure: $M_{\text{low knowledge-O/U scores}} = 4.16$ ($SD = 1.51$), $M_{\text{high knowledge-O/U scores}} = 4.41$ ($SD = 1.28$); $t = 0.71$, $df = 64$, $p = .48$; Fig. 2, panel C).

3.4.3. Supplementary analysis on objective choice quality

To determine whether our results are consistent in terms of whether respondents actually chose the healthier ready-made meal, we conducted another ANOVA that also included objective choice quality (incorrect choice of ready-made meal = −1; correct choice of ready-made meal = 1) for each of the three dependent variables. We included the main effect of choice quality and its two- and three-way interactions with knowledge O/U and objective time pressure, respectively, in the analyses. The objective time pressure × knowledge O/U interaction still showed a marginally significant effect on perceived choice difficulty ($F(1, 124) = 3.61$, $p = .06$; $\eta^2 = 0.03$) and a significant effect on subjective time pressure ($F(1, 124) = 6.29$, $p = .01$; $\eta^2 = 0.05$). The effect of the objective time pressure × knowledge O/U interaction on subjective choice quality turned marginally significant ($F(1, 124) = 2.93$, $p = .09$; $\eta^2 = 0.02$).

3.4.4. Objective time pressure as moderator of the indirect relationships between knowledge O/U and subjective choice quality through perceived choice difficulty and subjective time pressure (H2 and H4)

We used Hayes' (2018) PROCESS macros for SPSS (10,000 iterations) to test hypotheses H2 and H4. Model 7 was chosen because it estimates the moderated indirect effects of a predictor (knowledge O/U) on an outcome (subjective choice quality) via parallel mediators (perceived choice quality and subjective time pressure), and it changes across moderator levels (objective time pressure). The index of moderated mediation (IMM) suggested that the indirect effect of knowledge O/U on subjective choice quality through perceived choice difficulty was lower in the high ($\beta = -0.06$; 95% CI [−0.18, 0.05]) than low ($\beta = 0.20$; 95% CI [0.06, 0.35]) time pressure condition (IMM estimate = −0.26, boot $SE = 0.09$; 95% CI = [−0.45, −0.09]). Hence, H2 was supported. The indirect effect of knowledge O/U on subjective choice quality through subjective time pressure was non-significant in both the high ($\beta = -0.02$; 95% CI [−0.06, 0.02]) and the low ($\beta = 0.01$; 95% CI [−0.01, 0.05]) time pressure condition (IMM estimate: −0.03, boot $SE = 0.03$; 95% CI = [−0.10, 0.03]), although the difference between effects was in the expected direction. Thus, H4 was not supported. Fig. 3 displays the moderated mediation results.

3.5. Discussion

The results of Study 1 show support for our proposition that when exposed to objective time pressure, knowledge-overconfident individuals perceive higher time pressure. The results also provide marginal support for our proposition that when exposed to objective time pressure, knowledge- overconfident individuals perceive greater choice difficulty than less knowledge confident individuals. These moderating effects were consistent regardless of whether respondents chose the healthier ready-made meal or not. The results of Study 1 also provide support for the predicted indirect effect of perceived choice difficulty when the indirect effect was moderated by objective time pressure.

4. Study 2

4.1. Pretests

The purpose of Study 2 was to replicate Study 1 but for a six-choice judgment. This is in accordance with previous research suggesting that consumers may consider a certain range of options before making a decision (e.g., Aurier et al., 2000). As in Study 1, we conducted two pretests to develop the manipulations of time pressure. The purpose of

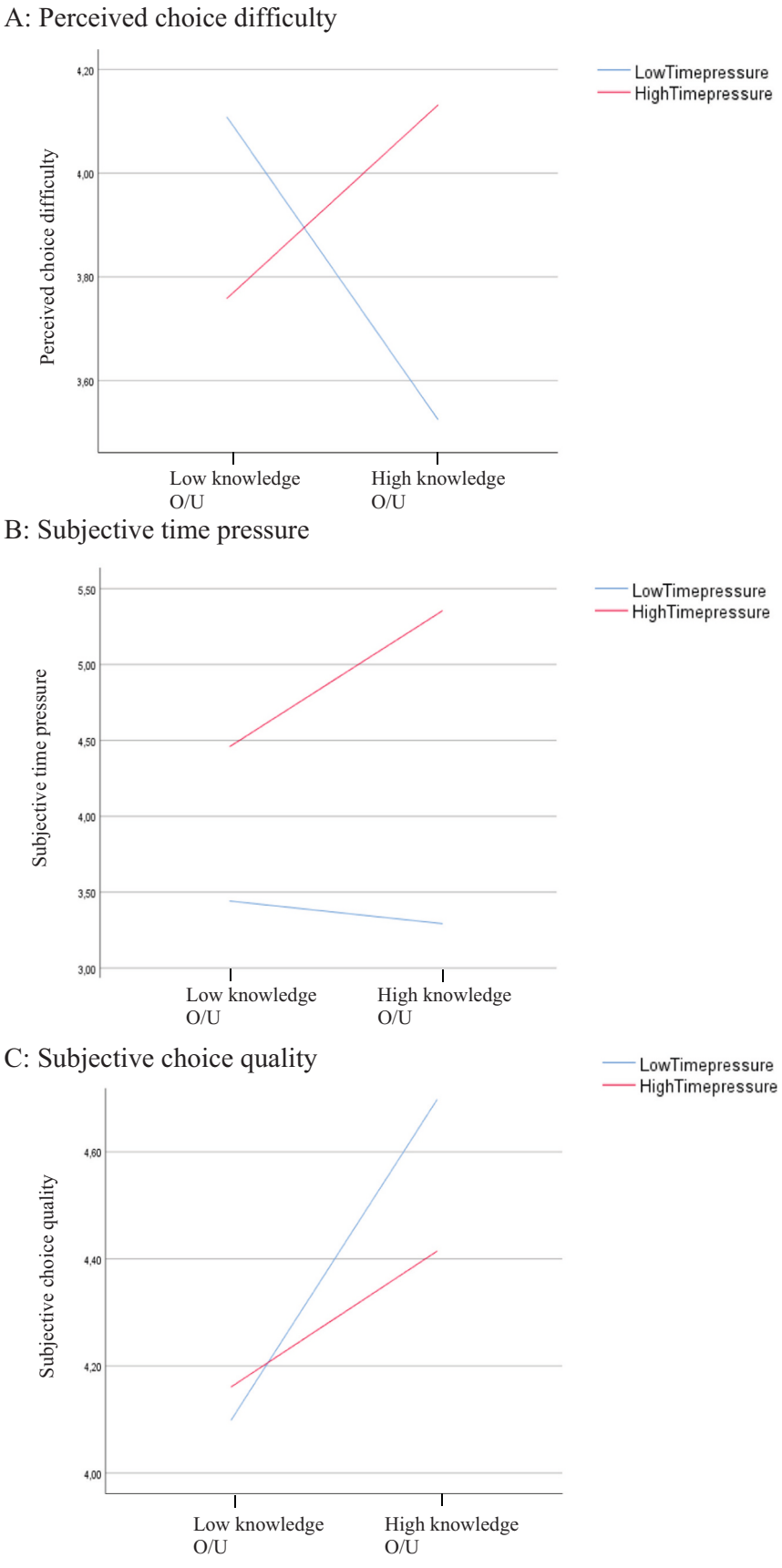

Fig. 2. Study 1: Interaction between knowledge O/U and time pressure.
Note. Median splits created the low knowledge O/U versus high knowledge O/U groups.

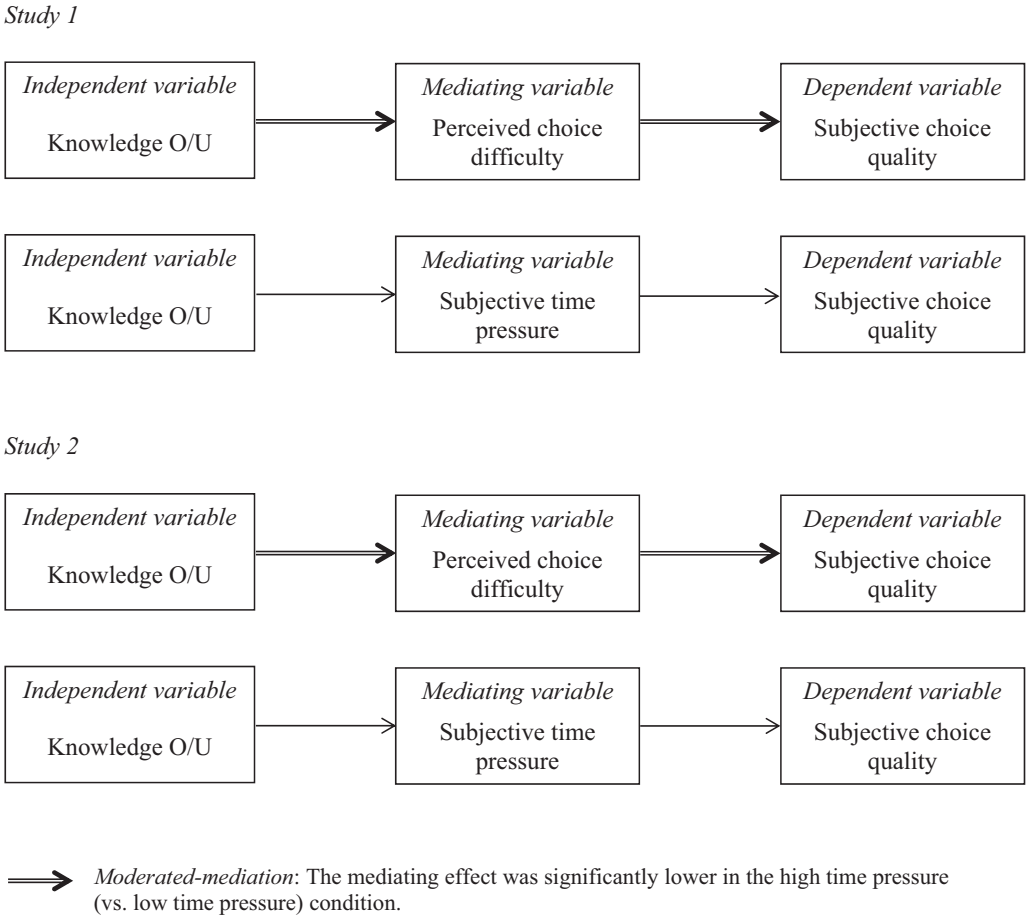

Fig. 3. Moderated mediation results.
Note. In the analyses, the direct relationship between knowledge O/U and subjective choice quality was accounted for. No significant mediating effects were found for either the Study 1 or Study 2 samples (see Appendix E: https://osf.io/j5vkq/).

the first pretest was to determine the average time required to choose the perceived healthiest ready-made meal, whereas the second pretest tested the appropriateness of the time pressure conditions. The results led to the selection of 25 s for the low time pressure condition and 15 s for the high time pressure condition. The selection of time pressure conditions was based on the same criteria as in Study 1. Appendix B (https://osf.io/j5vkq/) provides further details on the pretests.

4.2. Methodology

We again used MANOVA to estimate the results. As in Study 1, the a priori power analysis suggested a total sample size of at least 120 respondents. To test the validity of the proposed hypotheses in a six-choice situation, we followed a procedure that was similar to that used in Study 1. We drew a stratified random sample of 298 consumers from Epinion's online panel, which reflected the distribution of age, gender, and educational background in the population. These 298 consumers were contacted by email and asked to respond to the screening question: "Do you regularly do your own food shopping?" (yes/no). Two hundred fifteen questionnaires were received from respondents, for a 72.1% response rate. Of the respondents, 57 answered "no" to the screening question, which left us with 158 respondents for Study 2.

In the experiment, respondents were instructed to choose the healthiest ready-made meal (among six ready-made meal Nutrition Facts Panels; see Appendix A: https://osf.io/j5vkq/) within X (the manipulated) seconds. We removed three respondents who failed to complete the choice within the manipulated time from the dataset. In total, 155 respondents fulfilled all experimental requirements, with 76 respondents randomly assigned to the low objective time pressure condition. In the final sample, 65.2% of respondents were female, and the average age was 48.9 years, with a range of 23–81 years. All respondents received a monetary payment and participated in a lottery in which they could win an additional payment. In the experiment, 61.3% of respondents chose the ready-made meal chili con carne (correct choice). By contrast, 3.9% chose meatballs, 18.6% beef with potatoes, 5.2% chicken spring rolls, 0.05% potato hash, and 11.0% pasta with vegetables, ham, and cheese.

We again conducted randomization checks for age, gender, and educational background. The results showed no apparent differences in age (low time pressure: $M = 48.4$, $SD = 11.6$; high time pressure: $M = 49.4$, $SD = 11.6$; t-value $= 0.56$, $df = 153$, $p = .56$), gender (low time pressure: female 67.9%; high time pressure: female 62.3%; $\chi^2 = 0.54$, $df = 1$, $p = .46$), or educational background ($\chi^2 = 8.91$, $df = 7$, $p = .26$) between experimental groups. Given these results, we do not consider age, gender, or educational background further in Study 2.

4.3. Measurements

The measurements of perceived choice difficulty, subjective time pressure, subjective choice quality, and objective choice quality and the measurement and calculation of knowledge O/U were identical to the measures and procedure used in Study 1.

4.4. Results

4.4.1. Validation of manipulation and measurements

As in Study 1, we used maximum likelihood estimation with a combination of AMOS 24 and SPSS 24 to carry out the measurement analyses. The results suggested that (1) our experimental manipulations worked as intended since respondents in the low time pressure condition perceived time pressure as lower than respondents in the high time pressure condition ($M_{\text{low time pressure}} = 3.08$ ($SD = 1.43$), $M_{\text{high time pressure}} = 4.75$ ($SD = 1.71$); $t = 6.59$, df = 153, $p < .01$) and (2) our measurements were reliable and valid. The procedure and results are available in Appendix D (https://osf.io/j5vkq/).

4.4.2. Objective time pressure and knowledge O/U as predictors of perceived choice difficulty and subjective time pressure (H1 and H3)

To test the overall influence of the time pressure manipulation on the dependent variables (perceived choice difficulty, subjective time pressure, and subjective choice quality), we conducted a MANOVA with objective time pressure, knowledge O/U, and their interaction term as independent variables. We formed an index for each of the three dependent variables by averaging their items. We mean-centered the continuous dependent variables and the knowledge O/U variable before entering them into the analysis.

The results indicated that the objective time pressure × knowledge O/U interaction significantly affected the dependent variables (Wilks's $\lambda = 0.94$; $F(3, 149) = 3.43$, $p = .02$; $\eta^2 = 0.07$). In addition, the main effect of knowledge O/U (Wilks's $\lambda = 0.94$; $F(3, 149) = 3.27$, $p = .02$; $\eta^2 = 0.06$) was significant. Next, to test H1 and H3, we conducted separate ANOVAs for perceived choice difficulty and subjective time pressure. Objective time pressure, knowledge O/U, and their interaction term served as independent variables. As expected, the objective time pressure × knowledge O/U interaction had a significant effect on perceived choice difficulty ($F(1, 151) = 6.37$, $p < .01$; $\eta^2 = 0.04$). In addition, the main effect of knowledge O/U was significant ($F(1, 151) = 6.58$, $p = .01$; $\eta^2 = 0.04$). Also consistent with our predictions, the objective time pressure × knowledge O/U interaction had a significant effect on subjective time pressure ($F(1, 151) = 5.83$, $p = .02$; $\eta^2 = 0.04$). No other main effects were significant. Similar to Study 1, we also found that the non-hypothesized objective time pressure × knowledge O/U interaction had a significant, positive effect on subjective choice quality ($F(1, 128) = 6.73$, $p = .01$; $\eta^2 = 0.04$). Fig. 4 displays the significant interaction results.

Regarding the hypotheses, consumers with low knowledge-O/U scores (i.e., consumers with scores below the median = 0.23) showed no difference in perceived choice difficulty under increased objective time pressure ($M_{\text{low time pressure}} = 3.70$ ($SD = 1.42$), $M_{\text{high time pressure}} = 4.11$ ($SD = 1.19$); $t = 1.34$, $df = 76$, $p = .18$). By contrast, consumers with high knowledge-O/U scores (i.e., consumers with scores above the median = 0.23) experienced an increase in perceived choice difficulty under increased objective time pressure ($M_{\text{low time pressure}} = 2.74$ ($SD = 1.25$), $M_{\text{high time pressure}} = 4.06$ ($SD = 1.58$); $t = 4.04$, $df = 75$, $p < .01$; Fig. 4, panel A). Thus, in support of H1, the results show that consumers with high knowledge-O/U scores experienced greater perceived choice difficulty than consumers with low knowledge-O/U scores in response to an increase in objective time pressure.

In addition, both consumers with low and high knowledge-O/U scores experienced higher subjective time pressure when objective time pressure was high rather than low (low knowledge-O/U scores: $M_{\text{low time pressure}} = 3.31$ ($SD = 1.40$), $M_{\text{high time pressure}} = 4.61$ ($SD = 1.79$); $t = 3.60$, $df = 76$, $p < .01$; high knowledge-O/U scores: $M_{\text{low time pressure}} = 2.83$ ($SD = 1.45$), $M_{\text{high time pressure}} = 4.88$ ($SD = 1.65$); $t = 5.79$, $df = 75$, $p < .01$; Fig. 4, panel B). However, the increase in subjective time pressure was greater for consumers with high knowledge-O/U scores than for consumers with low knowledge-O/U scores. Thus, H3 is supported.

In terms of the significant effect of objective time pressure × knowledge O/U interaction on subjective choice quality, both consumers with low and high knowledge-O/U scores experienced lower subjective choice quality when objective time pressure was high rather than low (low knowledge-O/U scores: $M_{\text{low time pressure}} = 4.72$ ($SD = 1.65$), $M_{\text{high time pressure}} = 3.68$ ($SD = 1.24$); $t = 3.11$, $df = 76$, $p < .01$; high knowledge-O/U scores: $M_{\text{low time pressure}} = 5.28$ ($SD = 1.30$), $M_{\text{high time pressure}} = 3.78$ ($SD = 1.65$); $t = 4.42$, $df = 75$, $p < .01$; Fig. 4, panel C).

4.4.3. Supplementary analysis on objective choice quality

To investigate whether our results are consistent in terms of whether or not respondents actually chose the healthiest ready-made meal, we conducted another ANOVA that also included objective choice quality (incorrect choice of ready-made meal = −1; correct choice of ready-made meal = 1) for both perceived choice difficulty and subjective time pressure. We included the main effect of objective choice quality and its two- and three-way interactions with knowledge O/U and objective time pressure in the analyses. The objective time pressure × knowledge O/U interaction now had marginally significant effects on perceived choice difficulty ($F(1, 147) = 3.35$, $p = .07$; $\eta^2 = 0.02$) and subjective time pressure ($F(1, 147) = 3.26$, $p = .07$; $\eta^2 = 0.02$), suggesting some degree of relationship between the interaction effects and objective choice quality. However, the three-way interaction effect was not significant ($p > .75$) in either of the analyses. The objective time pressure × knowledge O/U interaction still had a significant effect on subjective choice quality ($F(1, 147) = 4.71$, $p = .03$; $\eta^2 = 0.03$).

4.4.4. Objective time pressure as moderator of the indirect relationships between knowledge O/U and subjective choice quality through perceived choice difficulty and subjective time pressure (H2 and H4)

Similar to Study 1, we used Hayes' (2018) PROCESS macros for SPSS (10,000 iterations) to test hypotheses H2 and H4. H2 is supported since the indirect effect of knowledge O/U on subjective choice quality through perceived choice difficulty was lower when objective time pressure is high (β = 0.01; 95% CI [−0.14, 0.12]) rather than low (β = 0.21; 95% CI [0.09, 0.35]); IMM estimate = −0.21, boot $SE = 0.10$; 95% CI = [−0.43, −0.04]. Rejecting H4, the indirect effect of knowledge O/U on subjective choice quality through subjective time pressure was non-significant in both the high (β = −0.02; 95% CI [−0.08, 0.01]) and low (β = 0.02; 95% CI [−0.01, 0.07]) time pressure conditions, although the difference between effects was in the expected direction; IMM estimate = −0.04, boot $SE = 0.04$; 95% CI = [−0.13, 0.01]. Fig. 3 displays the moderated mediation results.

4.5. Discussion

Study 2 provides empirical support for the notion that objective time pressure positively moderates the relationships between knowledge O/U and perceived choice difficulty and subjective time pressure, respectively. The results also show support for the predicted underlying role (indirect effect) of perceived choice difficulty when the indirect was moderated by objective time pressure.

5. General discussion

Because knowledge-overconfident consumers are likely to overrate the trustworthiness of their knowledge-based assumptions in decisions, they may underrate any uncertainty linked to those decisions (Simon et al., 1999). Therefore, they may erroneously conclude that they are on top of things and are good decision makers, unless they are faced with circumstances that alter this view. In this study, we argue that objective time pressure may be such a circumstance. Notably, objective time pressure reflects modern marketplace characteristics, as consumers are often faced with an impending deadline when carrying out their choices (Huseynov & Palma, 2021).

As main findings, this study shows that when we include the moderating effect of objective time pressure, we uncover a significantly

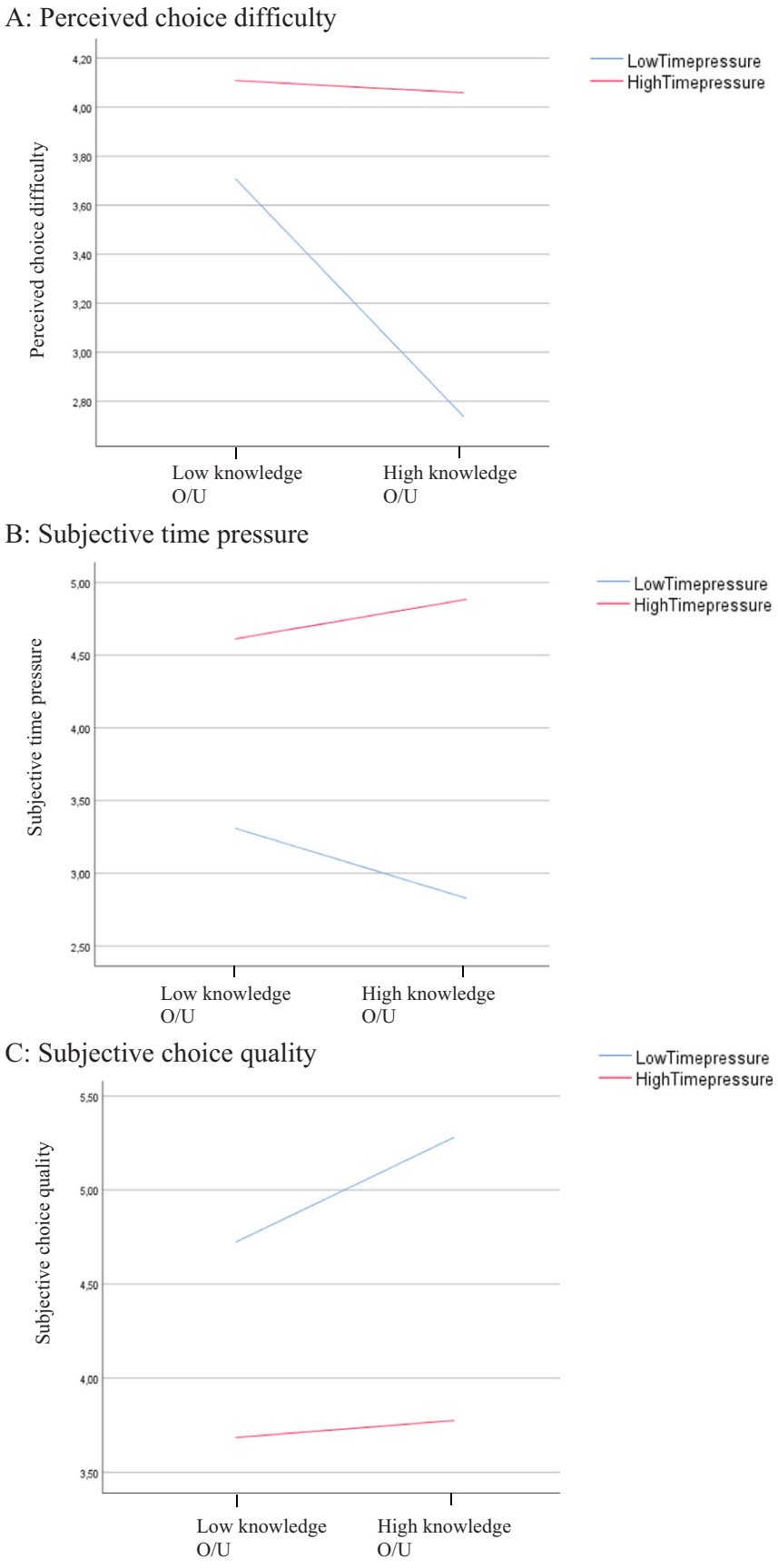

Fig. 4. Study 2: Interaction between knowledge O/U and time pressure.
Note. Median splits created the low knowledge O/U versus high knowledge O/U groups.

better explanation of the relationship between consumer knowledge O/U and subjective time pressure and perceived choice difficulty, respectively. Specifically, the results of Studies 1 and 2 indicate that objective time pressure positively moderates the relationship between knowledge O/U and subjective time pressure and between knowledge O/U and perceived choice difficulty. In addition, the results indicate that objective time pressure moderates the indirect effect of knowledge O/U on subjective choice quality through perceived choice difficulty. However, whereas research in cognitive psychology proposes that knowledge-overconfident individuals are likely to ignore evidence that may lead to unwanted or disconfirming outcomes in favor of confirming evidence (Koriat et al., 1980), our study suggests that when introducing a circumstance that cannot be easily disregarded (i.e., objective time pressure), knowledge-overconfident individuals tend to suffer *more* (i.e., higher perceived choice difficulty, which in turn leads to lower subjective choice quality) than less knowledge confident individuals.

To date, few empirical studies have investigated how contextual variables moderate the impact of knowledge O/U on other psychographic variables. Against this backdrop, our research adds to the knowledge O/U paradigm by suggesting how knowledge O/U, subjective time pressure, perceived choice difficulty, and subjective choice quality interact with objective time pressure. When taken together, the findings suggest that knowledge overconfidence is less effective in reducing perceived time pressure and perceived choice difficulty when consumers are faced with objective time pressure. Under such conditions, subjective time pressure and perceived choice difficulty should be reduced at the point of purchase. For example, in the realm of healthful food shopping, research suggests that subjective time pressure can be reduced by promoting more health-oriented lifestyles worth making time for (Divine & Lepisto, 2005). Perceived choice difficulty is particularly important because this condition may reduce subjective choice quality. Perceived choice difficulty could be reduced by promoting a few salient health attributes, which may make the selection decision easier by avoiding difficult trade-offs (Dhar & Nowlis, 1999). Furthermore, healthful dietary choices under time pressure could be simplified by various means of nudging, such as by making healthful food items more salient in the choice situation (Blom et al., 2021) or by priming consumers through visibility, accessibility, and availability of more healthful dietary choices (Wilson et al., 2016). Our results suggest that such initiatives are especially important for knowledge-overconfident consumers with an impending deadline.

However, according to previous research (Arkes et al., 1987), debiasing knowledge-overconfident consumers is possible. For example, consumers' subjective and objective dietary knowledge can be assessed through brief quizzes. The test results can debias consumers and improve their performance by informing them about their current levels of knowledge O/U and by giving them feedback on false answers (Renner & Renner, 2001), ideally combined with information on the effects of time pressure and the importance of a healthful diet.

Future research might try to replicate our experimental study in a natural shopping environment and include the potential influence of other people in food shopping, as these factors may affect the moderating influence of individual time constraints on the impact of individual consumer knowledge O/U on subjective time pressure, perceived choice, and subjective choice quality. For example, social facilitation theory (e.g., Bond & Titus, 1983) suggests that the mere presence of other people can influence task performance and the speed with which an individual performs a certain task, which in turn may be related to perceived choice difficulty and perceived time pressure. This is supported by empirical research indicating that the presence of an employee during a self-service transaction positively influences consumers' perceived time pressure (Collier et al., 2015).

In addition, we encourage future research to explore how objective time pressure may affect respondents' specific decision-making processes (e.g., varying engagement in specific parts of the presented information, application of heuristics) depending on their level of knowledge O/U. This is important because previous research suggests that the use of choice heuristics can lower perceived choice difficulty and reduce perceived time pressure (e.g., Payne et al., 1988). Specifically, such issues can be explored by employing additional techniques (e.g., eye-tracking or virtual reality techniques) that can monitor respondents' decision-making processes in the manipulated choice situations. Finally, future research might systematically manipulate a wider range of choice conditions to test for the robustness of the moderating and mediating effects obtained in this study of two choice situations (a two- vs. six-choice situation).

6. Conclusion

A key contribution of this research is that the inclusion of objective time pressure as a moderating variable advances understanding of how knowledge O/U may ultimately affect subjective choice quality. Specifically, we find that knowledge-overconfident consumers are more sensitive to objective time pressure than less knowledge confident consumers. Across two experimental studies, the results indicate that objective time pressure (1) positively moderates the relationship between knowledge O/U and subjective time pressure and perceived choice difficulty, respectively, and (2) moderates the indirect effect of knowledge O/U on subjective choice quality through perceived choice difficulty.

CRediT authorship contribution statement

Torben Hansen: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing.

Thyra Uth Thomsen: Conceptualization; Data curation; Investigation; Methodology; Project administration; Resources; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing.

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