COGNITIVE LOAD HAS NEGATIVE AFTER EFFECTS ON CONSUMER DECISION MAKING

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Abstract

Concurrent cognitive load has a devastating effect on consumer decision making. Implicit in the theorizing about cognitive load seems to be that this negative effect disappears when the load is removed. Three experiments explored whether cognitive load produces after-effects and showed that various types of prior cognitive load increase the subsequent impact of easily available information on brand choice (study 1), product similarity ratings (study 2), and the quantity of food consumed in a taste test (study 3). Information availability was manipulated by means of a salience manipulation (poster display in study 1 and position of product attribute in study 2), and an accessibility manipulation (study 3).

Several decades of decision research suggest that the level of elaboration is a crucial aspect of consumer decision making (for an overview, see Petty et al. 1994). The decision process is qualitatively different depending on whether consumers analyze the available information in a deep or a shallow way. Research spawned by several theoretical frameworks has provided empirical support for the prevalence of shallow processing under concurrent cognitive load. These theoretical frameworks seem to share the implicit assumption that consumers resume their default level of elaboration when the load is removed (e.g. Payne, Bettman, and Johnson 1988). We do wonder, however, whether the effects of cognitive load on information elaboration cease when the cognitive load is removed. The assumption that the re-adaptation to normal cognitive demand is abrupt and appropriate has gone untested, although its rejection might have important consequences for the way we understand consumer decision making. In practice, consumer choice under load may not be as prevalent as suggested by the popularity of load manipulations in the research lab. Consumers often have the option of deferring choice (Anderson 2003) and have been shown to prefer choice deferral when they have trouble differentiating the available options (Dhar 1996; 1997), for instance when they are under cognitive load. These findings and common observations suggest that consumer decisions are not necessarily made *during* but often *after* these episodes of high cognitive load. Cognitively demanding

situations abound in daily life. People talk when driving, think when watching TV, engage in shopping with nagging children. Therefore, the question whether cognitively demanding situations produce after-effects that are similar or dissimilar to the widely documented concurrent load effects certainly deserves attention. Specifically, we will investigate how information integration during decision making is influenced by an episode of prior cognitive load.

TWO POSSIBLE AFTER-EFFECTS OF COGNITIVE LOAD

In this paper, we focus on the *after-effects* of cognitive load on consumer information processing during decision making. In spite of the widespread use of concurrent load manipulations, very little is known about what happens when the cognitive load is removed. Current academic knowledge is not unequivocal about the effects (if any) one should expect. There are good reasons to suspect a temporal improvement of the level of elaboration following an episode of cognitive load. There are other reasons that allow us to predict a temporal decline. The purpose of the present paper is to investigate whether or not there are after-effects of cognitive load, and in which direction these possible effects go. In addition, we want to provide initial insights in how the hypothesized after-effects arise.

Coping with cognitive load

Rothmund (2003) found that vigilance for task-related stimuli increased after failure and decreased after success. Enhanced vigilance for task related features after failure is akin to enduring goal activation after task failure (Bargh, et al. 2001). Vigilance is defined as a state of enhanced attention to task relevant features that yields improved information integration. Cognitive load has been commonly assumed to deteriorate task performance in general and information integration in particular (e.g. Hinson, Jameson, and Whitney 2003; Shiv and Fedorikhin 1999). Cognitive load could therefore lead to increased likelihood of failure on the primary task. Building on the general relation between cognitive load and underperformance during cognitive load (e.g. Botvinick, et al. 2001), Rothmund's (2003) findings that failure enhances vigilance suggest that the removal of cognitive load may increase vigilance, and hence information integration.

This general prediction is also consistent with Carver and Scheier's (1990) control theory of human motivation. They showed that situations in which people are underperforming trigger coping processes that are meant to repair the underperformance. Finally, the prediction that the removal of load may increase elaboration is also consistent with Solomon's (1980) opponent process theory. This theory suggests that people under high cognitive load gradually generate opponent processes that help them cope with the challenge. When the load is suddenly relaxed, the adaptive opponent process prevails for a while. The result is a temporary opponent state. In case of high cognitive load, the opponent process triggered by an episode of high cognitive load might be motivational in nature. Assuming that episodes of high cognitive load are challenging the cognitive system, they might trigger opponent processes (namely increased vigilance) that help coping with the challenge. According to this dynamic process, removal of cognitive load would temporarily increase vigilance. In sum, there are several reasons to believe that prior cognitive load will temporarily enhance vigilance resulting in enhanced information integration.

Recovering from cognitive load

The self-control strength model (Muraven, Tice, and Baumeister 1998; see also Baumeister 2002) challenges this view and suggests a negative information processing after-effect of cognitive load. This model states that exerting self-control decreases self-control capacity in subsequent but otherwise unrelated situations that require self-control (an effect that was called *ego depletion*, Muraven et al. 1998). Consumers are believed to rely on their scarce self-control resources in any situation that urges them to actively alter their behavior, their cognitions, or their emotions (Baumeister 2002; Muraven and Baumeister 2000). Applying the self-control strength model to cognitive load implies that typical cognitive load manipulations rely on scarce self-control resources. At first sight, the typical load manipulation does not seem to meet the definition of self-control. Rehearsing a seven digit number (e.g. Shiv and Fedorikhin 1999) does not require active alteration of normal cognitive processes. However, load manipulations are typically combined with another simultaneous task. For instance, participants do not only have to rehearse a seven digit number, they also have to make a consequential food choice (Shiv and Fedorikhin 1999) or integrate present and future utility expectation when deciding how much a delayed amount of

money is worth to them in the present (Hinson et al. 2003). Such dual tasks pose strategic sharing problems, the solution of which requires the intervention of the central executive (e.g. Cinan 2003). Without intervention, one task would dominate at the cost of the other. The central executive ensures that the attention is not diverted from the digits too long when attention is focused on the choice. So although cognitive load in itself might not be demanding, successful continuation of the primary task probably does require the support of scarce self-control.

The self-control strength model further suggests that the information integration for consumer decision making also relies on scarce self-control resources. Indeed, Baumeister et al. (1998) showed that active choice making has depleting effects, while Schmeichel, Vohs, and Baumeister (2003) found that intellectual performance declines after a standard depletion manipulation. Based on this reasoning, it seems reasonable to assume that information integration becomes less elaborate in a state of depletion. Assuming that both performing a task under cognitive load and consumer decision making rely on scarce self-control resources, the self-control strength model allows us to predict that prior cognitive load will reduce the level of elaboration in consumer decision making.

In sum, there are good reasons to suspect that cognitive load produces after-effects on decision making. We specifically look at consumer's vulnerability to highly salient cues in their decision making. As outlined above, different theories allow divergent predictions. The present paper attempts to find out which effect prevails and which process is responsible. In study 1, we test whether prior cognitive load influences the impact of salient product features on product choice. In Study 2, we zoom in on the information integration that is assumed to underlie product choice and investigate whether prior load influences the relative impact of salient product features on information integration. We investigate the degree of information integration unobtrusively by using multidimensional scaling of product similarity ratings. In study 3 we seek generalization to a consumption situation. We manipulate the accessibility of an appetizing cue by means of an arousal manipulation, and explore whether the behavioral impact of this cue on consumption behavior is affected by the prior load manipulation.

STUDY 1

Participants had to make a series of product choices in a simulated store. They had to choose one brand out of a set of brands for several product categories. One of the brands (varied across participants) was made salient by means of a poster display. The brand share informed us about the impact of the salient cue. We manipulated prior cognitive load by means of an information search task on the internet under time pressure. The major aim of this study was to explore whether the impact of the poster was influenced by the level of prior load. According to the theoretical analyses outlined above, the poster display's impact on brand choice could either increase or decrease following high prior load.

Method

Participants. Participants were 127 undergraduate students. Fifty-six volunteered and received a piece of candy as a reward. Seventy-one participated in a series of unrelated studies including the present study and received a fee in return. The nature of the reward did not exert any main or interaction effect and is ignored in the remainder. Seventy-three participants were women (57%). Gender did not exert any main or interaction effect and is ignored in the remainder.

General Overview. Participants went through two phases. In the first phase they received one of three cognitive load treatments (see below). In the second phase, they had to visit a simulated store and buy products from a shopping list. For each product category, there were two or three brands available. For two of the product categories, one brand was designated the target brand. For each participant, one of the target brands was displayed on a poster, whereas the other target brand was not. We recorded participants' brand choice for these two product categories.

Material. We used a simulated lab store. In that store, fifteen product categories (all fast moving consumer goods) were displayed on different shelves. For each product category, there were two or three brands (unavailable on the local market). For each brand, there were two or three SKUs.

The store was separated from the rest of the lab. The shelves with the products were on the right side of the entering direction. In front of the participants and to their left, there were screens of 2.10m in height, each displaying the same poster depicting the package of one of the brands in one of the two target product categories.

Procedure. Participants came to the lab one by one (separated by 20 minutes). Upon arrival, participants were randomly assigned to one of the three cognitive load conditions.

In the *high prior load condition*, people received the URL for three websites of car brands. Their task was to visit them all in five minutes and collect as much information as possible, in preparation of a memory test. They had 2 minutes to complete the memory test. These participants were under cognitive load during 7 minutes.

There were two control conditions. In the *low prior load condition*, participants received the same URLs and were asked to explore these sites. They were given 7 minutes to explore the sites. In the *no prior load condition*, participants waited quietly for 7 minutes before moving on to phase 2. We needed both control conditions to rule out that the nature of the cognitive activity (browsing information about cars) by itself had the after-effect.

Immediately afterwards, participants were invited to shop in a simulated store. The product categories of interest for this study were muesli and noodles. For the muesli, two brands were available. For the noodles, there were three. A pretest ($n = 30$ from the same population) showed that for the brands “Beginners” (muesli) and “Nivo” (noodles), baseline preferences were intermediate, which allows changes in both directions. The two brands were used as ‘target’ brands in their respective categories. On the poster displayed in the store, either the target brand for muesli or the target brand for noodles was shown. The posters were interchanged after every sixth participant.

Results and discussion

We subjected brand choice (yes or no) to a repeated logistic regression (Proc genmod in SAS®) with the three levels of prior load (between subjects), the poster display (present versus absent, within subjects) and their interaction as explanatory variables. Table 1 shows the market share for the two target brands.

TABLE 1. MARKET SHARE OF THE TARGET BRANDS AS A FUNCTION OF PRIOR LOAD AND DISPLAY (YES OR NO)

	<i>n</i>	Brand choice	
		Displayed brand	Non-displayed brand
High prior load	43	46.5% ^a	18.6% ^d
Low prior load	42	23.8% ^b	28.6% ^e
No prior load	42	26.2% ^c	26.8% ^f

a-f. these characters identify the cells

The interaction contrast between prior load and the two control conditions combined (cell combination: $a+(e+f)/2-d-(b+c)/2$) was significant: $\chi^2 (df=1) = 5.07, p = .024$. We further found that the displayed brand was chosen more often in the high prior load condition than in the low prior load condition (cell combination a-b), $\chi^2 (df=1) = 4.70, p = .03$ or in the no prior load condition (cell combination a-c), $\chi^2 (df=1) = 3.72, p = .054$. The contrast between both control conditions (cell combination b-c) was not significant ($\chi^2 (df=1) = 0.06$, NS). Within the high prior load condition, the effect of display (cell combination a – d) was significant: $\chi^2 (df = 1) = 5.54, p = 0.019$. Within the low and no prior load condition, the effect of display was not significant ($\chi^2 < 0.21$, NS).

To check whether the prior load effect was similar for both product categories, we subjected brand choice to a logistic regression with prior load, product category and their interaction as predictors (within the condition with display). Although the target brand was overall chosen more often for muesli ($p = 0.48$) than for noodles ($p = .16$), $\chi^2 = 15.81, p < .0001$, the effect of poster display on target choice did not significantly

differ across the two product categories, $\chi^2 = 0.37$, NS, suggesting that the prior load effect was generalizable over products.

This is the first study to show that prior load increases the influence of salient situational cues, such as a supporting poster display, on consumers' choice. The effect appears similar to the effect of concurrent load. In the absence of preceding cognitive load, the poster had no effect: The target brands were chosen as often in the control conditions with poster display as in the conditions without poster display. These data therefore suggest that prior cognitive load negatively affects the level of elaboration. This is consistent with Baumeister's (2002) self-control strength model, but not with the view that load triggers coping processes that produce higher vigilance (e.g. Solomon 1980).

STUDY 2

The aim of Study 2 was to gain more insight in how prior cognitive load influences information integration during decision making. To measure the level of elaboration, we asked participants to evaluate similarity among a set of products (e.g. Nosofsky 1986). We used INDSCAL to derive the number of dimensions underlying the similarity judgments, and the weight each individual assigned to each dimension. In this study we preferred similarity ratings to actual choices because similarity ratings are more sensitive to the objectively given product characteristics than preference ratings. The latter trigger subjective evaluations that go beyond the objectively given information (e.g., Creusen and Schoormans 1997). As our purpose is to find how prior load influences information processing, similarity ratings are better suited for this study.

Participants were shown pairs of laptops and had to judge their pairwise similarity. For each judgment, pictures of two laptops appeared next to one another on a computer screen. Below the picture, the laptops were described using five relevant product features. We manipulated the salience of the product attribute information by manipulating the order of the product features. According to the hypothesis that cognitive load reduces subsequent elaboration, participants that have been engaged in a demanding task before making similarity judgments should put relatively more weight on the most salient product dimension (i.e. the first attribute appearing on the list) than participants that have not been engaged in a demanding task before.

Method

Participants. This study took about 25 minutes and was followed by unrelated studies. Participants received a participation fee in exchange. They were 131 male students of several majors with ages between 18 and 23.

Material. In a pretest ($n = 31$) participants evaluated a set of 32 laptops resulting from the combination of a list of five product attributes with two quality levels each (high and low). The attributes were processing speed, memory size, external reading device [DVD or CDR], standard software package, and screen size. We selected a set of nine laptops with widely differing evaluations and we matched the nine selected combinations with laptop pictures. This set of nine laptops was used in the experiment. Processing speed and memory size were presented first on the list. The order of these two features was manipulated as a way of making them more or less salient.

Procedure. As in the first study, the first phase of the experiment served as a manipulation of cognitive load. Upon arrival, participants were asked to solve mental arithmetic multiplication problems. Solving this type of problems has been shown to be demanding on working memory (Seitz and Schumann-Hengsteler 2000), unless the solution can be retrieved from rote memory (Dehaene 1997). Participants in the high prior load condition had to solve 5 problems of the type “55 times 23”. Participants in the low prior load condition had to solve 5 problems of the type “7 times 11”, the solution of which people typically know by heart. The test was conducted on PC.

In the next phase, all the 36 possible pairs of the 9 laptops were sequentially shown on a computer screen, in a randomized order for each participant. Each time, two laptop pictures were shown next to one another. Below each picture, the attribute quality levels of the depicted laptop were given for each of the five features. For each pair, participants had to rate the similarity on a scale from 0 to 10. We manipulated the salience of the attributes by changing the position of the first two attributes (for a similar manipulation, see Kardes, et al. 1993). For half of the participants, processing speed was in first position and hard drive memory capacity in second position for all 36 pairwise comparisons. For the other half of the participants, this order was

reversed. Because the order was manipulated for the first two attributes, our analyses focused on the dimensions reflecting these two attributes.

Results and discussion

The similarity ratings were analyzed using INDSCAL (ordinal level) on the similarity matrix. In a three-dimensional solution (badness of fit: 0.17) an ambiguous dimension was obtained that represented a blend of the first two product attributes. This precluded the test of our main hypothesis. We therefore selected a four-dimensional solution (badness of fit: 0.13) in which the first dimensions represented the first two product attributes. The first dimension matched the hard drive memory capacity, which was the first attribute in one condition and the second attribute in the other condition. The second dimension matched the processing speed, which was the second attribute in one condition and the first attribute in the other condition. The third dimension matched software package installed (Works® or Office®, fourth attribute on the attribute list), and the fourth dimension matched the screen size (14.1" or 15.4"; fifth attribute on the attribute list). The INDSCAL algorithm yielded four weights per participant: one for each of the four dimensions.

Note that the dimension weights of the first two dimensions are relevant for our purposes. Only the position of first and second attribute (processing speed or hard disk memory capacity) was manipulated. The first attribute in the attribute list was thereby assumed to be more salient than the second attribute in the attribute list (see Kardes et al. 1993). So, to test the hypothesis that prior load increases the role of the salient dimension in product similarity ratings, we conducted a 2 (Salience: first attribute vs. second attribute) by 2 (prior load: low vs. high) ANOVA on the dimension weights of the first two dimensions.

The expected two-way interaction between Prior load and Salience was significant: $F(1, 127) = 4.35, p < .04$ (see figure 1). When the participants had gone through a phase of high cognitive load, the first attribute received more weight in the similarity ratings. The average weight for the first attribute was significantly higher for participants in the high prior load condition ($M = 1.109, SE = 0.010$) than for participants in the low prior load condition ($M = 1.077, SE = 0.011, t(127) = 2.18, p < 0.04$). Consistently, the average weight for the second attribute was lower for participants in the high prior load condition ($M = 1.079, SE = 0.010$) than for

participants in the low prior load condition ($M = 1.087$, $SE = 0.010$), albeit not significantly so ($t = 0.58$). We also looked at the interaction between Prior load and Salience from the other angle. For the participants in the high prior load condition, the first attribute received significantly more weight than the second attribute, $F(1, 68) = 4.41$, $p < .04$. This difference was not significant for the participants in the low prior load condition ($F = 1.43$, NS).

FIGURE 1. DIMENSION WEIGHT USED IN THE SIMILARITY RATINGS AS A FUNCTION OF SALIENCE AND PRIOR LOAD

Our results indicate that people who have just gone through a highly demanding phase elaborate less on product information than people leaving a situation of normal cognitive load. People leaving a situation of high load give relatively more weight to the most salient product feature (i.e. the first attribute on the attribute list) in evaluating product similarity than people that just have gone through a normally demanding situation. After high load, people also give more weight to the most salient product feature than to the less salient product features (attributes that are mentioned further down the attribute list). This finding is consistent with the general view that prior cognitive load decreases subsequent elaboration.

STUDY 3

In the two preceding studies, we found that situations characterized by a high cognitive load temporarily reduced consumer's subsequent level of elaboration. As a result, consumers based their decision relatively more on salient information. In this study we seek to generalize the finding in two ways. First, we want to replicate the effect, while substituting accessibility for salience. We found that following load, consumers become more vulnerable to externally provided *salient* product information. We contend that this process is driven by reduced information integration capacities following load. If this process holds, highly *accessible* information should also become more influential following load. In this study, we manipulate accessibility by means of an arousal manipulation.

The second way in which this study seeks to generalize the preceding results is by increasing the consequential nature of the choice behavior. Product choice in study 1 had no consequences for the participants in any way. The product-pair similarity ratings in study 2 also did not have important consequences for the participants. In inconsequential choice situations, ignoring a substantial part of the available information poses less risk to consumers and, hence, they may more easily switch to a less elaborative processing mode. In consequential choice situations, however, the shift to a less elaborative processing mode potentially entails more harm. Therefore, consumers might resist the shift to a less elaborative processing mode in situations that entail real consequences. A replication of the after-effect that we documented in studies 1 and 2 with real consumption behavior seems warranted.

We used a taste test setting, and we measured consumed quantity. Like in a real life consumer setting, in a taste test a diverse set of internal and external cues may be accessible simultaneously, such as the food's attractive taste, consumer's food restriction goals, product color, the ambient odor in the lab, etc. Arousal has been shown to focus attention to the most task-relevant cue (Easterbrook 1959). For instance, Pham (1996) showed that arousal increased consumers' use of diagnostic information. Similarly, arousal helps to ignore irrelevant information. Chajut and Algom (2003) recently showed that the Stroop effect vanished under high stress conditions: People were better able to focus on the one relevant dimension and ignore the irrelevant, yet highly dominant dimension surprisingly well.

We now apply this reasoning to a taste test. In a state of low arousal, consumers may pay attention to a variety of factors, such as product color, and food restriction goals. In a state of high arousal, however, consumers' focus narrows down to the most task-relevant situational cue, the taste itself. From our preceding studies, we know that prior load results in less elaborate information integration and increased vulnerability to easily available information. Therefore, we predict that consumption of affectively attractive foods such as M&Ms will increase after prior load, at least when the affectively attractive aspect (i.e. taste) is highly accessible.

In the present study, we manipulated prior load by a preceding task in which participants had to study under time pressure. To induce a state of arousal, we used music and varied its tempo (Gorn, Pham, and Sin 2001). In sum, in study 3 we attempted to replicate our finding that prior cognitive load subsequently increases the impact of easily available (here accessible) information on consumer decisions (namely consumption quantity). We varied the accessibility of the target cue (i.e. taste in a taste test) by means of an arousal manipulation. We expected that prior cognitive load should increase consumption more in the high arousal condition than in the low arousal condition.

Method

Participants. Fifty-eight women participated in exchange for a participation fee of €7. Two did not taste any M&Ms and were discarded from analyses. Two ate extreme amounts (more than 2.5 standard deviations from the mean) and were also discarded from analyses. So the results obtained reflect the data of 54 participants.

Design. The target taste test was imbedded in a series of allegedly unrelated studies. One of the studies was a music evaluation test in which arousal was manipulated (high vs. low). In the following study we manipulated cognitive load. All participants had to study a matrix of country names, flags, and country dial codes. For half of the participants, the matrix was easy. For the other half, it was challenging. Both assignments occurred randomly. Then the taste test started. The M&Ms eaten were weighed.

Procedure. Participants came to the lab in groups of 4 to 8 participants. They participated in a series of studies. The first three studies were actually the three phases of this study.

Manipulation of arousal. The first study was a music evaluation test. All participants had to listen to a repetitive five tone tune. In the low arousal condition one tone took one second. In the high arousal condition, one tone took 1/3 of a second. Similar manipulation stimuli have been used in previous research (Gorn, Pham, and Sin 2001). After having listened for some minutes, participants filled out an evaluation sheet. We used a semantic differential scale to measure arousal (five items, $\alpha = 0.87$) and pleasure (three items, $\alpha = 0.80$). The up-tempo music led to higher arousal, $F(1, 56) = 90.73, p < .001$, than the slow music but not to higher pleasure, $F(1, 56) = 1.78, NS$, suggesting that our manipulation was successful and specific.

Manipulation of prior load. The next phase of the study (presented to participants as a new study) consisted of a memory task. Participants had to learn a matrix of flags, countries, and international phone dialing codes by heart in a limited time. In the low prior load condition, the four countries were three neighboring countries of the participants' country and the USA. In the high prior load condition, they had to study 8 country combinations and the countries were less known in this population (e.g. Slovenia, Mauritius, etc.) Based on a pretest ($n=74$) with the same high and low prior load condition, we selected 165 seconds as the time limit for the high prior load condition and 90 seconds as the time limit for the low prior load condition.

Measurement of consumption amount. The next 'study' was a taste test of an allegedly new type of M&Ms. Each participant received a bowl with 400g of M&Ms and an evaluation sheet with ten items (such as, "is of high quality", "has an intense flavor", etc.). They were free to eat as many M&Ms as they wanted. In a pretest in the same population ($n = 32$), M&Ms were generally evaluated positively. On a 100-point scale, the average liking of M&Ms was $M = 68.7$ ($SD = 30.3$), the median rating was $Md = 75$, and 81.3% rated M&Ms above the midpoint of the scale. Apparently, for the vast majority of our participants M&Ms tasted good.

Results and Discussion

We conducted an ANOVA with quantity consumed (in grams) during the taste test as a dependent variable, and with arousal (high versus low) and prior cognitive load (high versus low) as independent between subject variables. The covariate ‘time elapsed since the last meal’ was negatively related to quantity consumed, $F(1, 49) = 3.90, p = .054$. The results revealed an interaction between arousal and prior load: $F(1, 49) = 5.78, p = .02$. Consistent with our prediction, participants in a state of high arousal consumed a larger quantity of M&Ms in the high prior load condition ($M = 14.8, SD = 11.8, n = 13$) than in the low prior load condition ($M = 8.0, SD = 7.5, n = 17$), $F(1, 49) = 3.74, p = .059$. In a state of low arousal, in contrast, participants’ consumption quantity in the high prior load condition ($M = 5.4, SD = 3.8, n = 14$) did not differ significantly from that in the low prior load condition ($M = 10.3, SD = 9.7, n = 11$), $F(1, 49) = 2.22, NS$.

The test would also be supportive for our view if in the high prior load condition, arousal would increase consumption by virtue of its attention focusing capacity. Consistently, arousal increased consumption in the high prior load condition ($F(1,49) = 8.75, p < .005$), but not in the low prior load condition ($F(1,49) < 1, NS$). The main effects of arousal ($F(1, 49) = 2.79, NS$) and cognitive load ($F(1,49) < 1, NS$) were not significant.

The data showed that prior cognitive load leads to a subsequent increase in consumption in a taste test situation, but only if the instigating cue (i.e. taste) is highly accessible. Cue accessibility was increased by means of an arousal manipulation. When arousal was high, people focused on the task-relevant cue (namely the taste, Chajut and Algom 2003). For those among them that just had gone through a situation of high cognitive load, the high accessibility of the taste had a disproportionate impact on consumption behavior (cf. study 1), which made them consume more. When arousal was low, the taste cue had to compete with also accessible but more task-irrelevant features, which reduced the impact of prior load.

GENERAL DISCUSSION

Concurrent load is one of the most popular manipulations in consumer research but little is known about what happens when cognitive load is removed. This question deserves attention because there are good reasons to believe that consumers avoid deciding during episodes of high cognitive load (Anderson 2003) and prefer to defer

their choice (Dhar 1996). This paper is a first attempt to fill that gap in our knowledge. Our data consistently suggest that the after-effects of cognitive load are similar to the concurrent load effects. Cognitive load increases consumer's vulnerability to easily available information. We showed the after-effect in a brand choice situation (study 1), provided evidence for the underlying process in terms of reduced information integration (study 2) and showed corresponding behavioral effects in a consumption situation (study 3).

In terms of underlying process, our data appear consistent with the predictions derived from the self-control strength model (Baumeister 2002). Declaring our findings consistent with the ego depletion literature implies two assumptions. First, we have to assume that the tasks that we used as manipulations of cognitive load (i.e. information search under time pressure, study 1; mental arithmetic, study 2; and studying under time pressure, study 3) rely on the scarce self-control resource. Second, we have to assume that the act of information integration that is needed to go beyond the information that is relatively available (i.e. the poster display in study 1, the attribute on the first position in study 2, and the taste in study 3) also relies on the same scarce self-control resource.

For the first assumption ("the cognitive load tasks rely on the scarce self-control resource"), we find support in Schmeichel et al (2003). Under time pressure (study 1 and study 3), one has to continue increasing one's normal cognitive operation speed. Because this implies a modification of one's own behavior, it fully complies with Baumeister's definition of depleting tasks. Engaging in mental arithmetic (study 2) puts a high tax on working memory (Seitz and Schumann-Hengsteler 2000), which is in itself depleting (Schmeichel et al 2003). The second assumption ("information integration tasks rely on the scarce self-control resource") is plausible because of the working memory component in that task.

Alternative explanations

Three alternative explanations deserve consideration. First, like all depletion effects, our depletion effects are reminiscent of fatigue effects. Although mere fatigue might be an alternative explanation for the findings of studies 1 and 2, it does not apply to study 3 because fatigue and arousal are negatively related (Lorist and Tops 2003). If a state of depletion were identical to a state of fatigue, consumption should

have increased in the low arousal condition (where both fatigue effects coincide) rather than in the high arousal condition. Second, one could object that the stress of studying was higher in the depletion condition because of the test that followed. However, in study 2, both conditions were subjected to a test, and the effect still occurred. Third, one might object that arousal differences underlie depletion. Some studies documenting depletion effects measured arousal (e.g. Schmeichel et al. 2003) but none found effects of depletion manipulations on arousal or of arousal on self-control, which makes arousal an unlikely explanatory variable. Further, the results of study 3 are not consistent with an arousal explanation. If arousal were behind the depletion effects, we should have obtained high consumption in all cells that were either arousing or depleting.

Note that the entire pattern of results is also inconsistent with an experimental demand explanation. In study 1, participants might have guessed that we were investigating the effect of the product display on their brand choices. However, the impact of the poster increased only in the high prior cognitive load condition and not in the other conditions, which at first sight seems to rule out a straightforward experimental demand explanation. Still, the view that prior cognitive load increases the impact of easily available information on decision making is consistent with the interpretation that consumers' vulnerability to experimental demand would increase in a state of depletion. That would be the case if the manipulation is conspicuous, such as in study 1. Studies 2 and 3 are not consistent with this more sophisticated version of an experimental demand explanation. In study 2, the salience manipulation (position of the attributes) as well as the dependent measure (similarity ratings) was more subtle. In study 3, the strict separation of the three phases in which we induced arousal, manipulated prior cognitive load, and measured quantity consumed rules out an explanation in terms of experimental demand.

Theoretical and practical implications

On a practical level, the data suggest that mental load situations do not only have concurrent detrimental effects but also consistent after-effects. Consumers will make relatively more use of easily available information when they have just gone through a cognitively demanding episode. In stores and other retail environments, information availability might be related to saliency of the product displays, the package, and the

product attributes such as price, or an inviting picture. Study 3 suggests that information availability might also be manipulated in a more subtle way by means of varying task definitions and the level of arousal (Babin and Darden 1995). For instance, if the goal is saving money, then arousal should increase the focus on price, and a state of depletion could in turn increase the impulse to buy cheap products because the product appears as a good deal. But if the goal is finding high quality products, arousal might increase the focus on the brand name's reputation, which a state of depletion could turn into buying the high quality product rather than the cheap product.

On a theoretical level, the important role of information availability in our studies (that are consistent with the self-control strength model) suggests that the ego depletion model might be tightly connected to information processing. For instance, many studies show that exerting self-control reduces subsequent persistence on difficult physical (e.g. stamina) or psychological (e.g. solving unsolvable puzzles) tasks. Perhaps depleted people have difficulties going beyond the increasingly accessible pain experience in case of physical persistence or the increasingly accessible frustration experience in case of psychological persistence. Future research is needed that explores how crucial fluctuation in information processing capacity is for the ego depletion phenomenon, both in general and in a consumer context.

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