Scarcity captures attention and induces neglect: Eyetracking and behavioral evidence

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Abstract

Resource scarcity poses challenging demands on the human cognitive system. Budgeting with limited resources induces an attentional focus on the problem at hand. This focus enhances processing of relevant information, but it also comes with a cost. Specifically, scarcity may cause a failure to notice beneficial information that helps alleviate the condition of scarcity. In three experiments, participants were randomly assigned with a small budget ("the poor") or a large budget ("the rich") to order a meal from a restaurant menu. The poor participants looked longer at the prices of the items and recalled the prices more accurately, compared to the rich participants. Importantly, the poor neglected a useful discount that would save them money. This neglect may arise as a result of attentional narrowing, and help explain a range of counter-productive behaviors of low-income individuals. The current findings have important implications for public policy and services for low-income individuals.

Keywords: Poverty; visual attention; memory; encoding; decision making;

Scarcity is the condition of having insufficient resources to cope with demands, and is an urgent and pervasive problem in the world: Roughly 1.2 billion people live in extreme poverty with less than $1.25 a day, 1.3 billion people live without electricity, and more than 780 million lack access to clean water. This condition presents significant challenges to the human cognitive system. For example, having limited financial resources requires the meticulous calculation of any expenses. Similarly, having limited time requires stringent management of schedules.

The cognitive consequences of scarcity are recently revealed by a number of studies (Mullainathan & Shafir, 2013). For example, scarcity causes myopic behavior which results in the neglect of future events (Shah, Mullainathan, & Shafir, 2012). Specifically, people under scarcity tend to prioritize the task at present and over-borrow resources from the future. Financial scarcity directly impairs cognitive function, reducing fluid intelligence and the ability to exert cognitive control (Mani, Mullainathan, Shafir, & Zhao, 2013). These cognitive and behavioral consequences are particularly problematic because these impairments can lead to suboptimal decision making and behaviors (e.g., poor time management or financial planning skills) that further perpetuate the condition of scarcity.

Currently, it is still unclear what cognitive mechanisms underlie the impairments caused by scarcity. A possible explanation of these impairments is that scarcity presents urgent demands that hijack attentional resources, causing a strong focus on the present task. Such focus can induce a neglect of other potentially important information.

Support for this explanation comes from the previous theoretical and empirical work on the limits of the cognitive system. Specifically, the cognitive system has a finite capacity, and people can only receive and process a limited amount of information at a time (Baddeley, 1992; Luck & Vogel, 1997; Miller, 1956; Pashler, Johnston, & Ruthruff, 2001). Given this limited capacity, engaging in one process consumes cognitive resources needed for another, thus causing interference. For example, studies on inattentional blindness (Simons & Chabris, 1999; Neisser, 1979) show that performing a demanding task (e.g., counting how often the basketball is passed around) results in an inability to notice a salient event (e.g., a man dressed as a gorilla passing by). Basic visual features of unattended stimuli may not even be perceived (Rock & Gutman, 1981). In addition to perception, this interference can cause serious behavioral consequences such as impaired driving (Strayer, Drews, & Johnston, 2003). The limited cognitive resources given competing demands can thus result in attentional trade-offs between focus and neglect.

Here, we propose that scarcity forces attentional trade-offs. Specifically, people operating under scarcity may prioritize urgent tasks at hand, leaving other information unattended. This process can be counter-productive because the attentional neglect can cause the failure to notice useful and beneficial information in the environment that alleviates the condition of scarcity. To investigate the attentional trade-offs under scarcity and the resulting memory performance of task-relevant information, we conducted three experiments in the current study.

Experiment 1

The goal of this experiment was to examine the effects of scarcity on visual attention. We predict that scarcity draws attention to the task-relevant information, but at the same time, also causes the neglect of other useful information in the environment.

Participants

One hundred and ninety undergraduate students (152 female, 35 male, 3 unspecified; mean age = 20.39 years, *SD* = 3.92 years) were recruited from the Human Subject Pool at the Department of Psychology at the University of British Columbia (UBC), and participated in the experiment for course credit. Participants in all experiments reported normal or corrected-to-normal vision and provided informed consent. All experiments reported here were approved by the UBC Behavioral Research Ethics Board.

Stimuli and Procedure

Participants were presented with a restaurant menu which contained 24 food items. For each item, the price and the calories were listed in two columns on the menu (Fig.1). The menu subtended 12.4° of visual angle in width and 16.2° in height. A discount clause was shown on the bottom of the menu ("You may ask for an 18% student discount.").

Participants were randomly assigned with a small budget ($20; the poor condition) or a large budget ($100; the rich condition). Thus, the experiment used a between-subjects design.

Participants were asked to view the items on the menu and think about what they would like to order, as if they were ordering a meal from a restaurant. They were given unlimited time to place the order, and were told not to exceed the assigned budget, but they were not required to spend the entire budget.

The eye gaze of each participant was monitored throughout the experiment using an SMI RED-250 Mobile Eyetracking System (60hz). To examine which part of the menu was prioritized, the menu was divided into four areas of interest: the left column of the food items, the middle column of the price information, the right column of the calories information, and the discount clause.

To measure visual attention, we calculated the dwell time and the number of fixations in each area of interest. Since there was no time limit in the experiment, we used the proportional dwell time (the dwell time spent in each area divided by the total dwell time on the menu) and the proportional fixations (the number of fixations in each area divided by the total number of fixations on the menu) as two measures of visual attention. The heat maps of the average duration of dwell time between the poor and the rich conditions were shown in Figures 1 and 2.

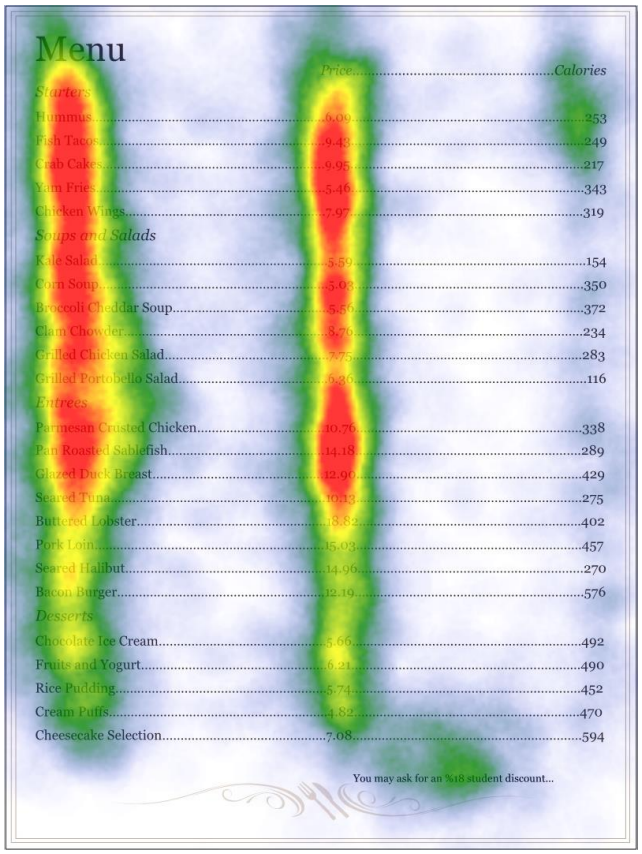

Figure 1. Experiment 1. A heat map of the menu showing the distribution of the average dwell time for the participants in the poor condition (who ordered a meal with $20). Warmer colors represent longer average dwell time.

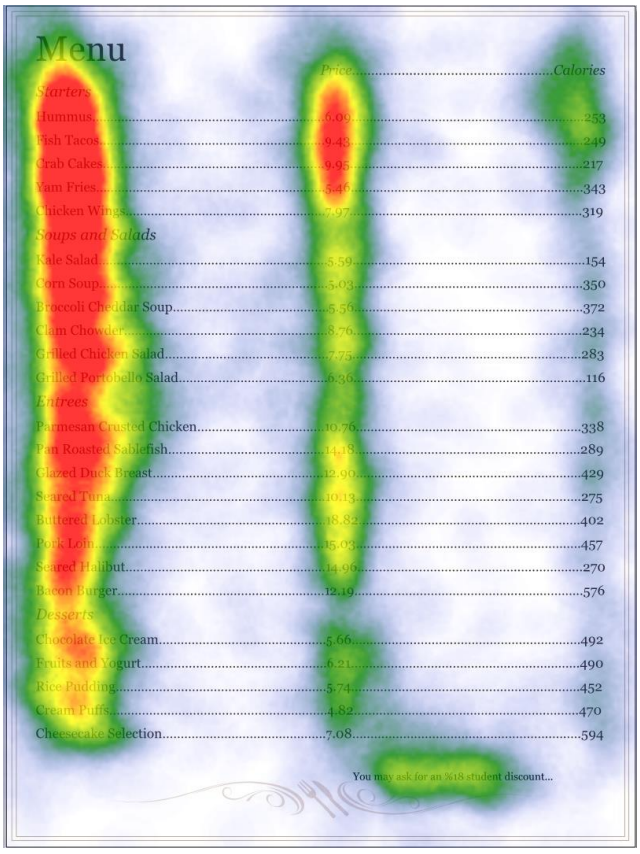

Figure 2. Experiment 1. A heat map of the menu showing the distribution of the average dwell time for the participants in the rich condition (who ordered a meal with $100). Warmer colors represent longer average dwell time.

Results and Discussion

First, we observed that participants in the rich condition took more time to order (M = 89 seconds) than the participants in the poor condition (M = 76 seconds) [$t(188) = 2.24$, $p = .03$, $d = .33$]. This provided motivations for using the proportional dwell time and fixations in the following analyses between the two conditions. Moreover, participants with more than 3 standard deviations away from the mean in each measure were excluded (between 1 and 4 participants in total, depending on the measure).

For the food items (Fig.3), participants in the poor condition spent less dwell time (M = 35.11%) than those in the rich condition (M = 51.98%) [$t(185) = 3.91$, $p < .001$, $d = .57$]. The poor also made few fixations (M = 36.66%) on the food items than the rich (M = 48.50%) [$t(187) = 3.08$, $p = .002$, $d = .45$]. This suggests that the poor participants spent less time considering which food items they would like to order than the rich participants did.

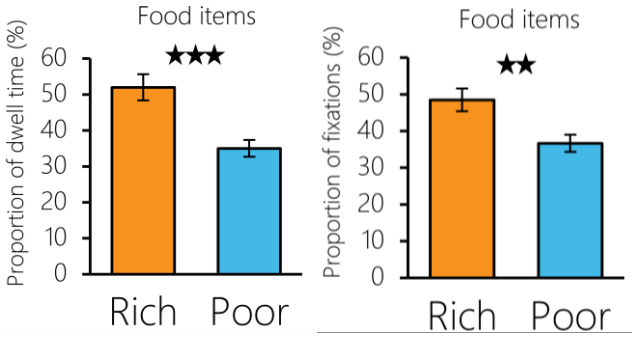

Figure 3. The proportional dwell time and fixations on food items between participants in the poor and the rich conditions (error bars reflect ±1 SEM; **p<.01, ***p<.001).

For prices (Fig.4), participants in the poor condition spent more dwell time (M = 21.08%) than those in the rich condition (M = 15.23%) [$t(185) = 2.16$, $p = .03$, $d = .32$]. Similarly, participants in the poor condition made more fixations on prices (M = 23.07%) than those in the rich condition (M = 15.81%) [$t(185) = 2.91$, $p < .01$, $d = .43$]. This suggests that the poor attended more to prices than the rich participants.

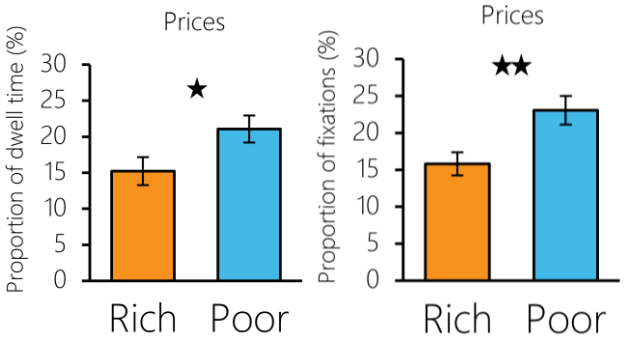

Figure 4. The proportional dwell time and fixations on prices between participants in the poor and the rich conditions (error bars reflect ±1 SEM; *p<.05, **p<.01).

This result could be driven by the possibility that scarcity enhanced attention to all numerical information. Thus, we examined attention to the calorie information (Fig.5). Participants in the poor condition spent less dwell time on calories (M = 2.92%) than those in the rich condition (M = 4.35%) [$t(185) = 2.65$, $p < .01$, $d = .39$]. The poor (M = 3.51%) also made fewer fixations on calories than the rich did (M = 5.09%) [$t(184) = 2.39$, $p = .02$, $d = .35$]. These results indicate that financial scarcity draws attention only to prices and induces a neglect of food items and calories.

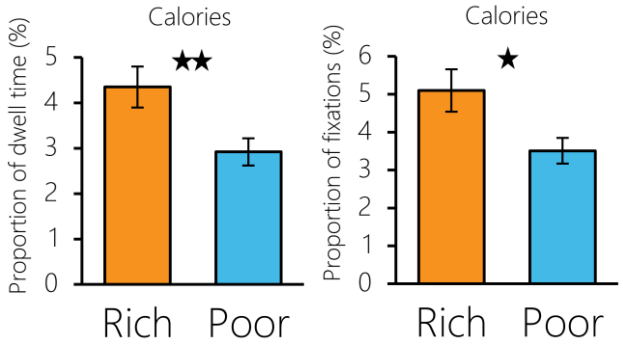

Figure 5. The proportional dwell time and fixations on calories between participants in the poor and the rich conditions (error bars reflect ±1 SEM; *p<.05, **p<.01).

Importantly, for the discount clause (Fig.6), participants in the poor condition spent less dwell time (M = 0.83%) than those in the rich condition (M = 1.83%) [$t(184) = 3.51$, $p < .001$, $d = .52$]. The poor also made fewer fixations on the discount clause (M = 0.85%) than the rich (M = 1.82%) [$t(184) = 3.51$, $p < .001$, $d = .52$]. This suggests that the poor neglected the discount more than the rich participants. However, there was no difference in the number of poor (47%) and rich (55%) participants who looked at the discount [$X^2 = 1.35$, $p = .25$]. This suggests that the poor and the rich are equally likely to look at the discount, but the poor spent less time looking at the discount.

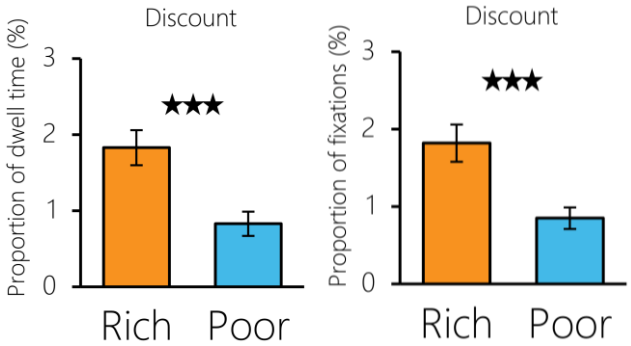

Figure 6. The proportional dwell time and fixations on the discount clause between participants in the poor and the rich conditions (error bars reflect ±1 SEM; ***p<.001).

As another measure of attention to the discount, after placing the order the participants were asked if they had noticed other information on the menu besides the price and

calorie information. While measures of visual attention showed that the poor looked less at the discount than the rich did, there was no reliable difference between the number of poor participants (38%) and rich participants (35%) who explicitly reported noticing the discount during debriefing of the experiment [X^2 = .09, p = .76]. However, less than 5 participants spontaneously requested the discount during their order. Thus, the attentional neglect of the discount was largely implicit.

We also analyzed the absolute proportional dwell time and fixation count for all analyses, which yielded nearly identical results. These absolute measures were not bounded, and therefore were not subject to trade-offs within a limit. This means that although the poor dwelled longer on price information, they did not necessarily dwell less on the discount.

An alternative explanation for the finding that the poor attended less to the discount was that scarcity might result in more efficient processing of task-relevant information. This would suggest that the poor did not need to look at the discount as much as the rich, because they were faster in seeing the discount. Since both the prices and the discount were task-relevant, this explanation would predict that the poor would be efficient in processing both price information and the discount. However, we found that the poor looked more at the prices but less at the discount than the rich did, which could not be explained by the efficiency account.

The discount on the menu could in theory help the poor participants save money and stay within their budget. Despite this usefulness, the poor participants still neglected the discount and focused more on the prices of the food items. This finding is ironic and could help explain why the low-income individuals engage in neglectful behaviors that are counter-productive.

Experiment 2

Experiment 1 demonstrated that financial scarcity prioritizes the processing of price information, at the cost of other useful information. Given the attentional prioritization of prices, we predict that memory encoding of prices will also be enhanced. This prediction is supported by the recent work that suggests that visual working memory can be construed as visual attention preserved internally over time (Chun, 2011; Chun, Golomb, & Turk-Browne, 2011). Feature-based theories of attention also predict selective facilitation in visual processing for task-relevant features (Hayden & Gallant, 2008; Jehee, Brady, & Tong, 2011).

Thus, in Experiment 2 we examined the effects of scarcity on memory encoding, as a result of attentional prioritization. We predict that financial scarcity facilitates memory encoding specifically for price information, and not for other types of information.

Participants

A new group of 60 undergraduate students (43 female, 17 male; mean age = 19.95 years, *SD* = 2.30 years) from UBC participated in the experiment for course credit.

Stimuli and Procedure

To increase the demand for memory encoding, we increased the number of items on the menu. Participants were presented with a menu which now contained 50 food items. Similar to Experiment 1, the menu included the price and calories for each food item.

As in Experiment 1, participants were asked to place a meal order from the menu as if they were ordering from a restaurant. As before, participants were randomly assigned with a small budget ($20; the poor condition) or a large budget ($100; the rich condition). The experiment again used a between-subjects design.

After participants placed their order, they were given a surprise memory test. Participants were asked to recall as many items from the menu as possible. For each item recalled, they were also asked to recall the price and the calorie information of the item as accurately as possible.

Results and Discussion

To measure memory encoding, we calculated the average absolute error between the recalled prices (and calories) and the objective prices (and calories) for each participant (Fig.7). Participants in the poor condition (*Mean error* = $1.32) were reliably more accurate in the price recall than those in the rich condition (*Mean error* = $2.17) [$t(58) = 2.35$, $p = .02$, $d = .61$]. However, there was no reliable difference in the calorie recall between the poor and the rich participants [$t(57) = .80$, $p = .42$, $d = .21$].

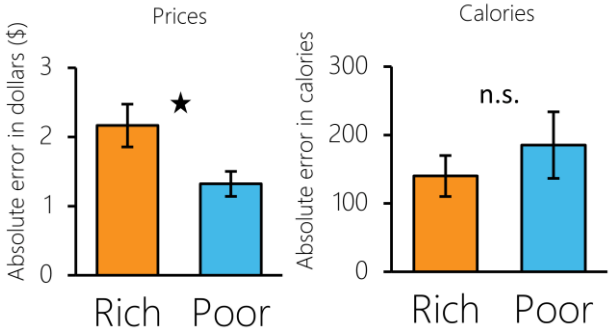

Figure 7. The absolute error in the price recall and the calorie recall between participants in the price poor and the price rich conditions (error bars reflect ±1 SEM; *p<.01).

This enhanced performance in price recall in the poor cannot be explained by the fact that the poor participants ordered fewer items (M = 2.13) than the rich (M = 3.67) [$t(58) = 3.74$, $p < .001$, $d = .98$]. First, there was no reliable difference in the number of recalled times between the poor and the rich [$t(58) = 1.31$, $p = .20$, $d = .34$]. Second, there was no difference in the time taken to place the order between the poor and the rich participants [$t(58) = 1.44$, $p = .16$, $d = .37$]. Third, even if ordering fewer items might improve memory recall, this benefit would be seen in both price and calorie recall, but we found that the poor were more accurate only in price recall, not in calorie recall.

Thus, these findings suggest that financial scarcity improves memory encoding for task-relevant information (i.e., prices), but not for task-irrelevant information (i.e., calories). Scarcity selectively facilitates memory encoding.

Experiment 3

To generalize the findings in Experiment 2 to a different domain, we examined how calorie scarcity affects memory encoding. We predict that calorie scarcity facilitates memory encoding specifically for calorie information, and not for other types of information.

Participants

A new group of 60 undergraduate students (49 female, 11 male; mean age = 20.03 years, *SD* = 2.11 years) from UBC participated in the experiment for course credit.

Stimuli and Procedure

The stimuli and the procedure were identical to those in Experiment 2, except for a critical difference. Participants were randomly assigned with a small calorie budget (500 calories; the poor condition) or a large calorie budget (2000 calories; the rich condition). As before, participants were then asked to place a meal order from the menu as if they were ordering from a restaurant. After the order, participants were given a surprise memory test, where they recalled items from the menu with the price and calorie information.

Results and Discussion

To measure memory encoding, we calculated the average absolute error between the recalled calories (and prices) and the objective calories (and prices) for each participant (Fig.8). Participants in the poor condition (*Mean error* = 48.05 calories) were reliably more accurate in the calorie recall than those in the rich condition (*Mean error* = 71.61) [$t(58) = 2.27$, $p = .03$, $d = .58$]. This suggests that the calorie poor showed better memory encoding of calorie information than the calorie rich.

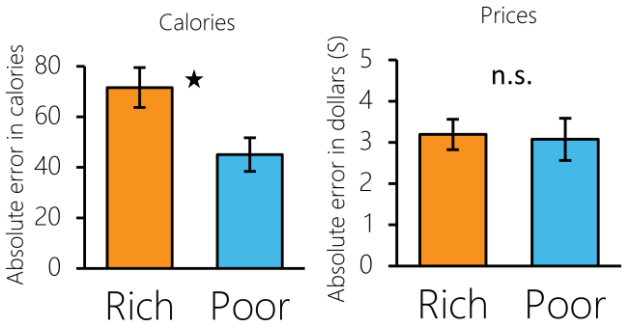

Figure 8. The absolute error in the calorie recall and the price recall between participants in the calorie poor and the calorie rich conditions (error bars reflect ±1 SEM; *p<.01).

A critical test of our prediction was whether this memory facilitation is specific to task-relevant information (i.e., calories). We found that there was no reliable difference in the price recall between the two conditions [$t(58) = 0.19$, $p = .85$, $d = .04$]. Thus, memory encoding was selectively enhanced for the calorie information in the calorie poor participants.

Interestingly, we did not observe worse memory encoding for the neglected task-irrelevant information. That is, the calorie recall was the same for the price poor and the price rich in Experiment 2, and the price recall was the same for the calorie poor and the calorie rich in Experiment 3. Even though Experiment 1 suggested that task-irrelevant information was neglected, here we did not see neglect influenced memory encoding of task-irrelevant information.

General Discussion

The goal of the current study was to examine how scarcity forces attentional trade-offs and influences memory encoding driven by such trade-offs. When operating under a limited financial budget, the poor focused more on the price information, compared to the rich (Experiment 1). This focus came with the neglect of other information in the environment, even if the information could be useful or beneficial to the poor (e.g., the discount). The attentional prioritization of prices also resulted in enhanced memory encoding of price information among the poor participants (Experiment 2). Likewise, the attentional prioritization of calories led to better memory encoding of calorie information among the calorie poor (Experiment 3).

The current findings provide a new perspective on how scarcity shapes the way people perceive and experience the external environment. While the perceptual experiences can be largely characterized by information overload, scarcity selectively orients people's attention to specific aspects of the environment. When operating with financial constraints, people automatically prioritize price-relevant information. Such prioritization facilitates memory encoding of these information, but crucially it comes with a cost, which is the neglect of the beneficial discount on the menu. An alternative explanation is that the poor spent less time looking at the discount because it was highly accessible to them due to high relevance. However, this explanation fails to account for the prioritization of the price information which is also highly relevant to the poor.

The findings also suggest that the rich with abundant resources have the luxury to attend broadly to the environment, compared to those under scarcity. The rich participants in Experiment 1 attended more to the food items, the calorie information of the food, and the discount, than the poor did. This means that the rich are able to consider which food they want to eat, rather than which food they can afford. In addition, they can also consider health-related (calorie) information of the food. Overall, the rich can attend to and process more types of information in the environment to make an informed choice.

The current study also reveals a painful irony of scarcity. People with limited resources were too focused on prices, such that they paid less attention to the beneficial discount that could save money and alleviate the financial burden. This

irony can help explain why low-income individuals sometimes engage in neglectful behaviors that are counter-productive (e.g., missing an appointment for a health checkup, or failure to sign up for benefit programs).

It is worth noting that the current experiments involved an artificial simulation of scarcity in the lab. In fact, just by randomly assigning people to receive a hypothetical small or large budget, we observed a strong effect of scarcity on attention and memory. Moreover, the participants in our experiments were not provided with real money, were not rewarded for frugality, and knowingly were not to receive any food from the menu. In the absence of possible consequences of their decisions, the poor participants still focused on task-relevant information and neglected help to alleviate the condition of scarcity. This raises the possibility that, outside the lab when people operate with scarce resources and can face real consequences of their actions, the effects of scarcity on attention and cognition observed in this study may be amplified.

The current findings can help inform public policy and services targeting low-income populations. Among the OECD countries, enrollment in social assistance and public benefit programs is estimated to range between 40% and 80% (Hernanz, Malherbet, & Pellizzari 2004). Our current study provides a new explanation for the low participation rate. That is, the poor who are eligible for these programs fail to participate because of the attentional trade-offs under scarcity. Low-income individuals may need to focus on their financial challenges and deadlines under scarcity, and either are not aware of these benefit programs and services, or neglect the enrollment procedures. This attentional account is not the only factor that can explain the low participation rate, as there are many other social barriers and stigmas related to enrollment in assistance programs.

Given the attentional constraints under scarcity, we propose that social assistance and public benefit programs should be designed to avoid the attentional neglect in the poor under scarcity. It may be helpful to streamline assistance applications and services to make them more salient, more accessible, and easier to process for the poor. The amount of effort and attention required from the poor should be minimized to increase or maintain participation. Benefit programs and social services can also be made more salient by using prompts and reminders. This could be done through any messaging medium such as text-message or email, and could be effective in catching the attention of those living under scarcity. Based on our current findings, future research can design behavioral interventions to avoid attentional neglect in the poor.

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