A PARTITIONING EXPLANATION OF THE DENOMINATION EFFECT

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ABSTRACT OF THE DISSERTATION

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Five studies examined the mechanisms by which large denomination bills reduce consumer willingness to make discretionary purchases. The first study demonstrated the denomination effect, in which large denomination bills can act as spending deterrents. Study 2 examined consumer perception of large denominations as an effective tool for monitoring spending and reducing discretionary consumption. Study 3 compared fungibility, processing fluency, and partitioning explanations for the effect, finding the strongest support for a partitioning based explanation. Study 4 provided additional evidence for the partitioning explanation, demonstrating that large denomination bills are as effective as envelopes in deterring spending. Study 5 demonstrated the effect in a real-world spending situation.

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Introduction

As of January, 2013 American consumers had more than $850 billion dollars in revolving debt (Federal Reserve). This kind of debt includes the most expensive kinds of loans, such as credit card debt, which can have interest rates in excess of 20% annually. Reducing consumer debt requires individuals to forgo discretionary purchases in favor of paying down the debt. To avoid increasing short-term debt loads, consumers must forgo discretionary purchases now in favor of saving for larger purchases they plan to make later, such as new appliances, cars, and vacations, if they are to avoid purchasing those items with expensive short-term credit.

Understanding the psychology of discretionary purchases is critical for interventions aimed at decreasing consumer discretionary spending. Intervening before consumers make the first purchase in a shopping situation may be the most crucial. Dhar, Huber, and Khan (2007) identified the shopping momentum effect, in which a consumer who makes a first purchase is significantly more likely to make an additional purchase. Additionally, those who are striving to stick to a budget may be especially negatively affected by that first impulsive purchase. Dieters who deviate even a small amount from their diet often exhibit the "what the hell" effect, and, having already deviated a small amount, go on to binge on the forbidden foods (Herman & Mack, 1975; Polivy, 1976; Polivy & Herman, 1985). An intervention that decreases the probability that a shopper trying to save or pay down debt would make a first discretionary purchase therefore may be the most effective at curbing unwanted spending.

In the current paper, I examine the mechanism underlying the denomination effect: the phenomenon that consumers tend to spend less when an equivalent amount of money is in the form of a large bill rather than smaller denominations (Mishra, Mishra, & Nayankuppam, 2006; Raghubir & Srivastava, 2009). Previous research has demonstrated that, for example, consumers purchase less at a gas station convenience store when given a $5 bill than when given five $1 bills (Raghubir & Srivastava, 2009) and that students rate their willingness to purchase items such as a T-shirt and watch as lower when they are given a $100 bill than when they are given five $20 bills (Mishra et al., 2006).

Previous researchers have suggested two possible explanations for the denomination effect: processing fluency and fungibility. In the current paper I compare the predictions of those two accounts with those from a third potential account: a partitioning mechanism. The processing fluency account is based on the notion that large bills are processed more easily than small bills. This ease of processing elicits more positive affect, creating a preference for the single large bill (Mishra et al., 2006). Consequently, consumers are reluctant to give up the large bill by spending it. This explanation does have some appeal. Affect enters into consumer decision making at many points (see Raghubir 2006 for a short review), and the affect inspired by the cost of processing could be yet another area in which consumers are driven by affect rather than by reason. Ease of processing has been shown to influence affect, with easier-to-process stimuli leading to increased positive affect (Winkielman & Cacioppo 2001, Reber, Winkielman & Schwarz 1998), and consumers rely on ease of processing when estimating the difficulty of an upcoming task (Song & Schwarz 2008). Consumers estimate that familiar denominations ($1 bills) have more purchasing power than unfamiliar denominations of the same objective value ($1 Susan B. Anthony coins) (Alter & Oppenheimer 2008). Even stock movements have been shown to be affected by processing fluency, with stocks that had names that were easily pronounceable (thus easier to process) outperforming stocks with more difficult names (Alter & Oppenheimer 2006).

The second explanation the literature has proposed for the denomination effect focuses on perceptions of fungibility, with large bills perceived as less fungible than smaller bills (Raghubir & Srivastava, 2009). The technical definition of fungibility requires one good to be perfectly substitutable for another of the same type. While in theory money is perfectly fungible, in the real world this is not so (Zelizer, V. A. 1994). For items to be perfectly fungible, consumers must be perfectly indifferent between any two items of the class that hold the same value. However for many situations in which this is normatively true, consumers do not regard the items as fully fungible (McGraw, Tetlcok, & Kristel 2003). Theoretically, a consumer should be indifferent between a $100 bill and $100 of value presented as any other denominations, such as 100 $1 bills. Consumers in the real world do not regard these two ways of comprising $100 of value to be perfectly equivalent, as the two do not allow the same transactions. For example, if one were to desire to buy a hotdog from a street vendor, it is very unlikely this transaction could be successfully completed with a $100 bill. However, if the holder had instead 100 $1 bills, the transaction could be easily completed and the hotdog acquired. Because different denominations of currency lead to differences in tractable exchanges in the real world, they are not perfectly fungible. This perception of large bills as less fungible presumably leads consumers to believe they are less easily spent, and are therefore attractive as devices to regulate spending.

I propose that the denomination effect is not driven by processing fluency of fungibility, but instead is driven by partitioning. Partitioning manipulations can significantly improve self-control and reduce consumption of certain goods. Cheema and Soman (2008) found that partitioning packages of cookies with colored dividers significantly slowed consumption. Geier, Wansink, and Rozin (2012) similarly found that participants ate fewer potato chips when every 7th chip in the tube was dyed red, acting as a partition. Cheema and Soman (2008) placed tickets for gambles into 1, 4, or 10 separate sealed envelopes, finding that partitioning the tickets reduced overall gambling, with participants in the 10 partition condition gambling least of all. In rural India where wages are still commonly paid in cash separating wages into multiple envelopes has been found to increase savings behavior (Soman & Cheema, 2011). Partitioning manipulations likely have their effect by triggering deliberative decision processes. For example, rather than mindlessly eating the next potato chip, when participants reach the partition they deliberatively consider whether they should consider eating more, giving them an opportunity to assess whether they really want to consume additional chips.

I propose that large denomination bills act like a partition, much like an envelope or a divider in a food package, by triggering deliberation about whether to spend. Whereas one might make a small discretionary purchase almost without thinking if one has small denomination bills, one will think more deliberatively about the purchase if it requires breaking a large bill. To the extent that deliberation causes consumers to decide against making discretionary purchases, large bills will reduce the likelihood of such purchases.

Explaining the denomination effect in terms of partitioning links the denomination effect to two other related phenomena: increased spending with credit cards, and mental accounting effects. Consumers have regularly been found to spend more readily when using credit cards or gift certificates compared to spending cash (Hirschman 1979; Prelec & Simester 2001; Raghubir & Srivastava 2008, 2009.), and even the presence of credit card cues can increase spending (Feinberg 1986). Credit cards differ from cash in a number of ways; however, one important aspect is that when credit cards or gift cards are used for spending, the same physical item is retained by the consumer, even if some (or all) of the value has been lost. When cash is spent, however, its physical form changes or is lost, in that the change a consumer receives is physically different from the bill that she paid with. Thus, spending cash breaks a partition in a way that using a credit card or gift card does not.

The partitioning account of the denomination effect also suggests a link between the denomination effect and mental accounting phenomena (Thaler 1985). Consumers often divide available funds into different mental accounts, each earmarked for a particular purpose (Heath & Soll 1996). Mental accounts are often used for budgeting purposes (Heath 1995) and may be especially relevant to consumer decisions about purchasing luxury goods (see Kivetz 1999 for a short review). Mental accounts work by creating partitions that hold amounts of money in a consumer's mind. These partitions separate money to be used for different expenses, say entertainment or groceries. In some cases, the denomination of a bill itself may denote a particular account (e.g., "This $100 bill is for my anniversary dinner"). Overspending a particular mental account is like breaking a partition to reach additional money. The deliberative thought triggered by breaking a partition may reduce willingness to overspend an account. Although partitioning and mental accounts have some similarities, there are also some differences. Mental accounts do not require physical partitions, such as envelopes, and bills can act as partitions without having mental accounts assigned to them. For example, Raghubir and Srivastava (2009) found that students spent more after receiving four quarters than a one-dollar bill even though such small monetary values were unlikely to be linked to a mental account.

In the current studies I test these three explanations and provide evidence for the notion that partitioning drives consumers to reduce discretionary spending when holding larger denomination bills. Study 1 demonstrates the denomination effect in a hypothetical scenario. Study 2 investigates consumers' beliefs about the effects of the denominations held on spending and saving behaviors. Study 3 compares large denomination bills, envelopes, and gift cards to compare the predictions of the fungibility, processing fluency, and partitioning accounts, providing evidence that large bills are viewed as monetary partitions. Study 4 investigates whether the effects of large bills and envelopes are differentiable or whether they employ the same mechanism, to provide additional evidence for the partitioning explanation. Study 5 compares large denomination bills and envelopes in a real-world setting with actual spending behavior.

Study 1

This first study replicates previous demonstrations of the denomination effect using a hypothetical purchase situation—that is, it demonstrates that consumer preference for leaving large bills intact can lead to decreased discretionary spending.

Methods

Participants (N=119) were recruited at a university bus stop and completed a brief pencil and paper questionnaire for a piece of candy. Subjects were randomly assigned to one of two conditions (forced-break or optional-break).

All participants read a story about going to the pharmacy to purchase an $18 prescription. A picture showed the bills participants hypothetically had in their wallet. Participants in the forced-break condition had $117: one $100 bill, one $10 bill, one $5 bill, and two $1 bills. Those in the optional-break condition had $119, consisting of the same bills with two additional $1 bills. Participants were instructed to circle the bills they would use to pay for their $18 prescription. In the forced-break condition, participants needed to pay with the $100 bill whereas those in the optional-break condition could pay with smaller bills and keep the $100 bill intact if they so chose.

The scenario then introduced an optional discretionary purchase of a DVD, and participants were asked to rate how likely they were to buy the DVD on an 11-point scale from 0% (definitely will not) to 100% (definitely will).

Results and Discussion

Consistent with previous research on the denomination effect (Mishra et al., 2006; Raghubir & Srivastava, 2009) subjects were significantly less likely to purchase the discretionary item in the optional-break condition (M= 25.5, SE = 2.77) than in the forced-break condition (M=41.3, SE = 4.11), $t(118)=3.19$, $p=0.002$, (Figure 1) presumably because in the latter case participants already needed to break the $100 bill to pay for the prescription. That is, participants were significantly less likely to purchase the discretionary DVD when doing so would force them to break a large denomination bill that would otherwise remain intact. Previous studies of the denomination effect have used equal endowments across the large bill and small bill conditions. Here, however, participants in the optional-break condition were actually $2 richer than their counterparts who were forced to break the bill. The effect was so strong participants in the optional-break condition were still significantly less likely to purchase the DVD, even with a larger endowment. Participants clearly showed a preference for keeping the $100 bill intact when possible, with only four (of 59) participants choosing to break the $100 bill to pay for the basic prescription when it was not necessary to do so.

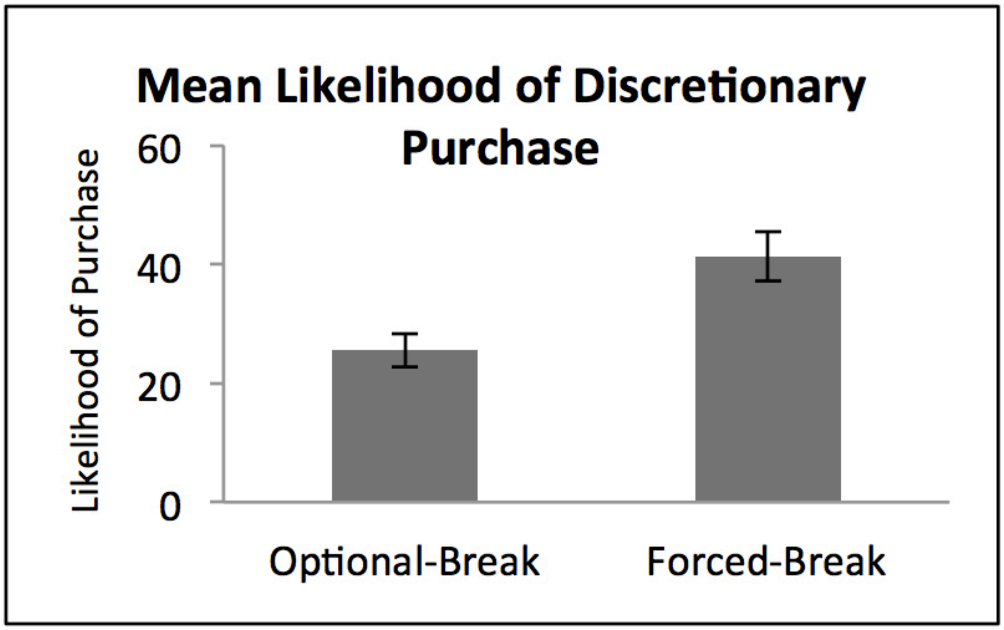

Figure 1: Mean reported likelihood of purchasing the discretionary item in Study 1.

Study 2

Dividing cash or tickets for monetary gambles into envelopes has been shown to reduce spending and increases savings (Cheema & Soman 2008). In those studies, however, the divisions were artificial, created by the experimenters, not the consumers themselves. U.S. consumers today often receive direct deposit or checks that are deposited into bank accounts, and do not receive their wages in cash. This likely has left very few consumers who physically divide their pay into envelopes or jars as budget-minded consumers were often encouraged to do in the past. However, other simple actions may have a similar effect on savings. Because most pay is deposited directly into the bank, and many regular bills such as a mortgage, groceries or utilities are paid online, with a debit or credit card, or by check, much of the cash that is withdrawn is likely to be spent on discretionary purchases. This makes cash withdrawals a prime opportunity for small changes that can increase saving through decreased discretionary spending. The current study investigates consumer beliefs about the effectiveness of choosing large denomination currency when withdrawing cash as a method for spending control.

Methods

In exchange for a small piece of candy, 60 participants at a university bus stop completed a paper-and-pencil study with a hypothetical scenario describing two women, Sally and Jane, who were each getting money out of an ATM. The scenario explained that both were saving for a down payment on a used car, and both withdrew $400 for use over the next two weeks. The women differed only in the denominations of bills they withdrew. Sally withdrew three $100 bills and five $20s, while Jane withdrew twenty $20 bills. Subjects were then asked to rate which woman was more likely to (1) successfully save money, (2) buy extra items she does not really not need and (3) have an easier time monitoring her spending, each using a 7 point rating scale from "Definitely Jane" to "Definitely Sally."

Results & Discussion

The results indicate that consumers believe that currency denomination can impact spending and savings choices. Single sample t-tests revealed that Sally (three $100s) was rated as significantly more likely to successfully save money, $t(59)=3.53$ $p=.001$, and to have a significantly easier time monitoring her spending, $t(59)=3.21$, $p=.002$. Jane (all $20s) was rated as significantly more likely to buy extra items she did not really need, $t(59)=-4.12$, $p<.001$ (Figure 2). These results suggest that consumers are aware of the effectiveness of large bills as barriers to spending, and may be experienced with the denomination effect in their own interactions with their cash holdings. The rating of Sally as more easily able to monitor her spending suggests that consumes may also believe fewer, larger, bills make it easier to track the current amount of money held, which may help consumers make better spending decisions once they are deliberating on the purchase under consideration.

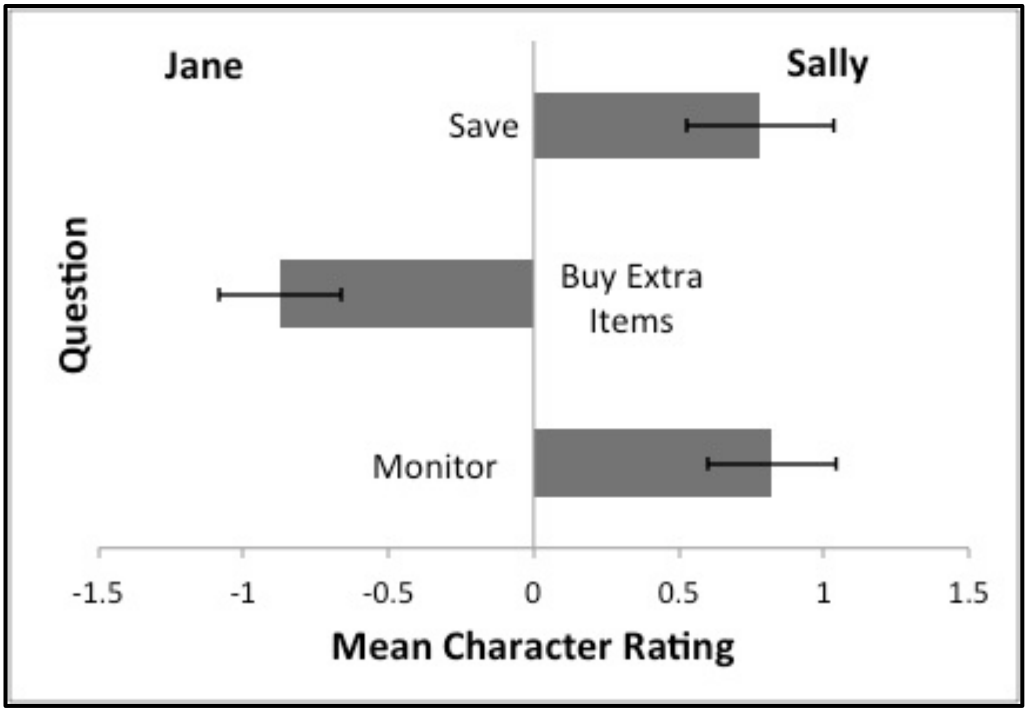

Figure 2: Mean predicted character and likelihood for the three items in Study 2.

Error bars depict standard error of the mean.

Study 3

In Studies 1 and 2 I have demonstrated that the denomination effect persists in hypothetical scenarios even when participants able to hold a large bill are also holding more money overall than participants forced to hold smaller bills, and that consumers seem aware of the effect and its potential to increase savings through reduced discretionary spending. As any of the previously proposed mechanisms underlying the denomination effect could account for the results of Experiments 1 and 2, the question of primary interest is the mechanism driving the effect. The literature suggests two mechanisms: fungibility (Raghubir & Srivastava, 2009) and processing fluency (Mishra et al., 2006). In Experiment 3 I test an alternative hypothesis: that large denomination bills act as a partition, creating a decision point similar to opening a new envelope of lottery tickets or eating past the red potato chip. Because $20 bills are broken frequently in daily transactions, consumers are likely not sensitive to these bills as partitions. I predict that $100 bills, in contrast, do act as partitions. In Study 3 I compared the effect of different ways of holding $300: 3 $100 dollar bills, 3 envelopes of five $20 bills each, and 3 one-hundred dollar American Express gift cards, all relative to 15 loose $20 bills.

If processing fluency is the mechanism driving the denomination effect, the gift cards and hundred dollar bills are expected to be rated as equally likely to lead to savings. Both have their value clearly marked, and both require a single multiplication action to find the full value of the holdings ($100 * 3), and therefore should be equally easy to process. The 3 envelopes of five $20 bills should be much less likely to lead to saving than either the hundred dollar bills or the gift cards, as the $20s require significantly more mathematical effort ([$20 * 5] * 3) to arrive at the total value of the holdings. There should be little difference between holding 15 $20 bills in envelopes and holding 115 $20 bills loose, as they both require the same amount of processing. According to the processing fluency account, the increased difficulty processing the $20 bills compared to the $100s should lead to negative affect, and a desire to rid oneself of the bills, leading to greater spending when holding the $20s (See Figure 3a for directional predictions).

If fungibility is the mechanism driving the denomination effect, the three $100 gift cards would be the most likely to lead to saving. Gift cards are the least fungible of the possible holdings, as they cannot be used at stores that do not take credit cards, and many stores that do take credit cards do not accept American Express. Next, the $100 bills would be expected to be slightly more likely to lead to spending, as all stores accept cash, and cash can be used for many other non-retail transactions such as paying a babysitter. However, there are still many places (such as gas stations and coffee shops) who often do not accept $100 bills. Therefore, the $20s are the most fungible, and as such should be the most likely to lead to spending. The envelopes enclosing the bills do not decrease the fungibility of the bills inside, and therefore according to the fungibility account should have no effect on the likelihood of spending, and the $20s in envelopes should be rated equally as likely to lead to spending as the loose $20s (see Figure 3b for directional predictions).

If, however, the underlying mechanism is the deliberation triggered by partitioning, a different pattern of results is predicted. Envelopes, of course, serve as explicit partitions and thus should curb spending. When money in an envelope is to be spent, one must physically rip open the envelope, a very physical manifestation of the destruction of the partition. Similarly, when a large bill is broken, the partition is clearly physically destroyed, with the large bill no longer present and small bills and loose change taking its place. Therefore, I expect the partitions created by the three envelopes of five $20 bills each and the $100 bill to both lead to more saving compared to loose $20 bills. In contrast, the American Express gift cards should lead to more spending than loose $20 bills, because it is not necessary to destroy any partition when spending with a gift card. When a consumer pays using a gift card, he or she retains the same physical object, unchanged, after the transaction, even if the card is no longer of any monetary value. I hypothesize this lack of physical destruction of the partition will lead to increased spending relative to large bills and envelopes (see Figure 3c for directional predictions).

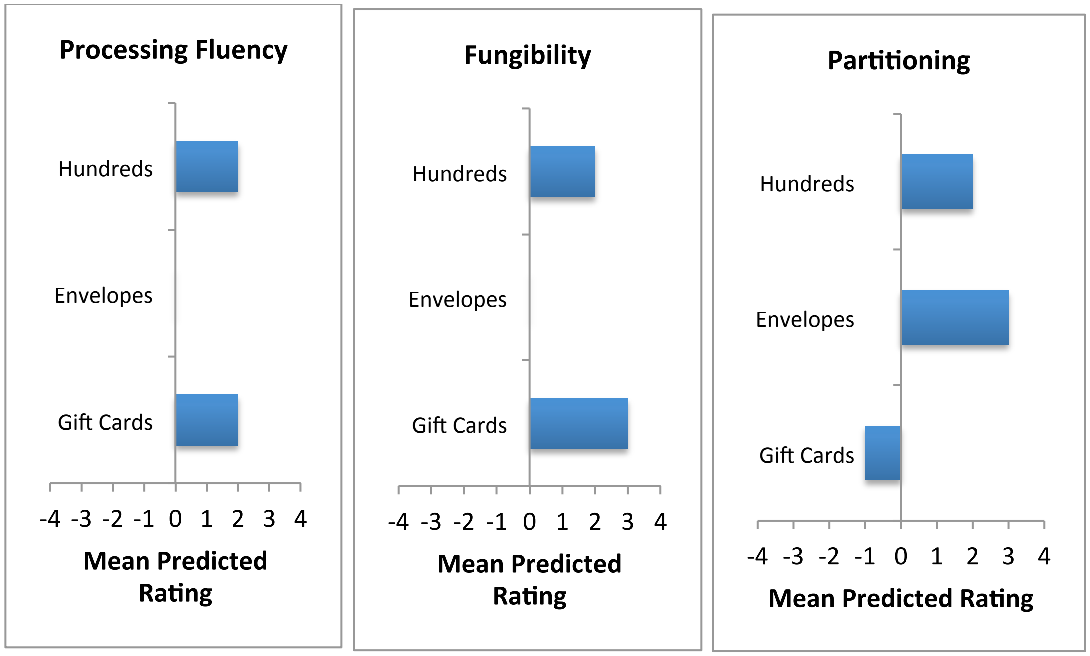

Figure 3: Predicted ratings from Study 3. Combined predictions range from -4 (more likely to spend than with loose $20 bills) to 4 (more likely to save than with loose $20 bills). (a) Processing fluency predictions. (b) Fungibility predictions (c) Partitioning predictions.

Methods

Undergraduates (N=268) were recruited at university bus stops and given a piece of candy in exchange for filling out a brief pencil-and-paper questionnaire. The design was similar to that used in Study 2. A hypothetical scenario was presented in which two women, Sally and Jane, went into a bank to withdraw $300 for the next two weeks. In each condition Jane withdrew the $300 as 15 twenty dollar bills. In condition 1 Sally received her money as three $100 bills. In condition 2 Sally received her money as three envelopes each containing five $20 bills, and in condition 3 Sally received three $100 American Express gift cards. Participants answered the same questions and used the same scale as in Study 2.

Results and Discussion

Eighteen subjects were removed from the analysis because they reported having taken part in a similar pilot study, leaving 250 in the analysis. To increase the ease of comparison across the three conditions, I created a single omnibus saving scale by combining the three ratings (after reverse-coding the item about buying things one doesn't really need), Cronbach's $\alpha = 0.82$. A one-way ANOVA on this measure revealed significant differences among the three conditions, $F(2,247)= 10.42$, $\eta^2 = .08$, $p<.0001$. Pairwise comparisons showed that the envelope condition yielded higher ratings than the hundred dollar bill condition $F(1,247)=6.18$, $p=0.01$. Breaking a partition created by an envelope requires actual physical destruction or tearing of the envelope. It is possible that this physical destructive act is felt more keenly by consumers, leading to even less willingness to break such a partition than one created by a large bill, as doing so would leave the large bill intact if not in the consumer's possession. In addition, the hundred dollar bill condition yielded higher ratings than the gift card condition, $F(1,247)=3.92$, $p=0.049$ (see Figure 4). Furthermore, mean ratings for the hundred dollar bill condition were significantly higher than the scale midpoint, $t(79)=2.05$, $p<.04$, as were ratings for the envelope condition, $t(86)=6.71$, $p<.0001$, while those in the gift card condition were not, $t(85)$-0.51, $p=0.61$. These results support our hypothesis that partitioning, and not fungibility or processing fluency, is the mechanism driving the reduced discretionary spending associated with the denomination effect.

Figure 4: Mean combined measure of saving for the three conditions (each compared to $20 bills) in Study 3.

Study 4

Study 3 provides evidence against the fungibility and processing fluency accounts of the denomination effect, and for the partitioning account. Study 4 provides additional evidence for the partitioning account by examining whether the effect of envelopes and large bills are differentiable when consumers are making hypothetical purchase decisions, rather than predicting long-term behavior of another consumer (as participants did in Study 3). Specifically, Experiment 4 tested whether envelopes and large denomination bills promoted saving via the same partition mechanism or whether the two manipulations achieved the same effect via different mechanisms. If envelopes and large bills act via different mechanisms, then the combination of the two would be expected to yield a stronger effect than either alone (a simple additive effect). In contrast, if they act via the same mechanism, then the combination of the two would be expected to yield an effect no larger than either factor alone (a sub-additive interaction).

Methods

Participants (N=239) completed a paper-and-pencil study at a university bus stop in exchange for a small piece of candy. Each participant was given a hypothetical scenario to read in which they were told they were walking home from school on a cold day and passed a café, where they considered stopping in to get a hot drink to take home with them. Each participant was assigned to one of four conditions in a 2 ($100 bill or five $20s) x 2 (loose or in an envelope) design, and were told that inside their wallet they had no debit or credit cards, but only the condition-appropriate bills or envelope. That is, in each of the four conditions, participants were told, respectively, that they had a loose \$100 bill, a \$100 bill in an envelope, five loose \$20 bills, or five \$20 bills in an envelope.

Participants were then asked to rate how likely they were to stop in the café and purchase a hot drink, using a response scale from 0% (definitely will not) to 100% (definitely will) in increments of 10%.[1]

Results and Discussion

A 2 x 2 ANOVA revealed a main effect of bill type, $F(1, 235) = 9.46$, $p=.002$, and a significant interaction between bill type and presence of an envelope, $F(1,235) = 17.00$, $p<.001$. Planned contrasts showed a significant difference between \$20 bills ($M=65.0$) and a \$100 bill ($M=32.3$) when both were loose, $t(120) = 5.14$, $p<.001$, but no significant difference when they were in envelopes ($M= 40.5$ and $M=45.3$, respectively), $t(119) = 0.73$, $p = .46$. There was also a significant difference between the \$20 bills loose ($M=65.0$) and in an envelope ($M=40.5$), $t(120)=3.97$, $p<.001$. Finally, there was a marginal difference in the opposite direction between the single \$100 bill loose ($M=32.3$) and in an envelope ($M=45.3$), $t(119)=1.94$, $p=.055$, with the greater likelihood of purchasing the coffee occurring when the \$100 bill was in the envelope (See Figure 5).

[1] The prompts for this study reinforced the experimental conditions. The specific wordings were as follows: "How likely are you to break the \$100 bill to purchase a hot drink from the café?" (loose \$100 bill), "How likely are you to tear open the envelope and break the \$100 bill to purchase a hot drink from the café?" (\$100 bill in envelope), "How likely are you to break one of the \$20 bills to purchase a hot drink from the café?" (loose \$20 bill), and "How likely are you to tear open the envelope and break one of the \$20 bills to purchase a hot drink from the café?" (\$20 bills in envelope).

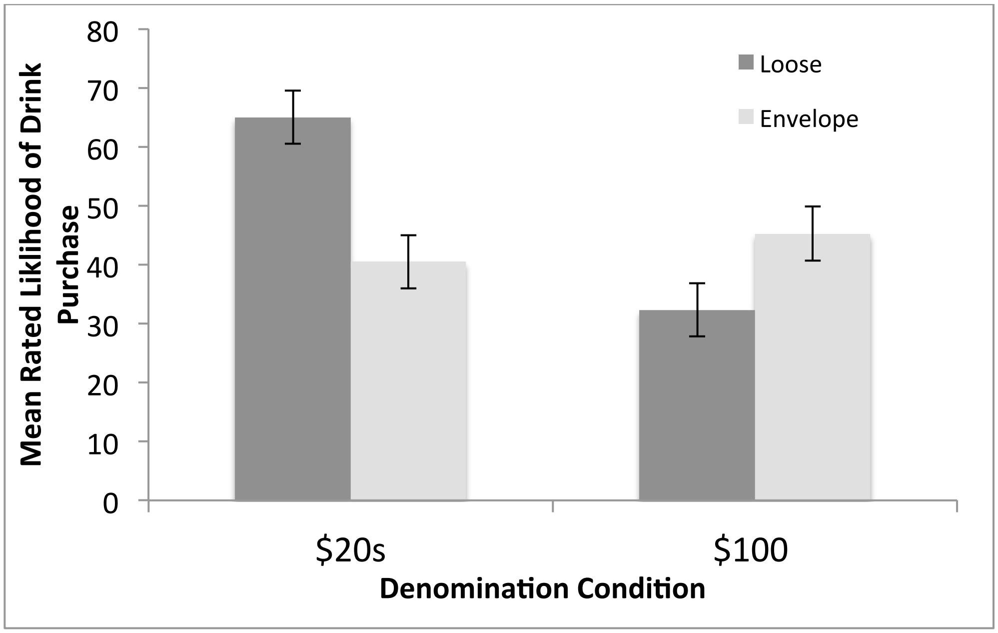

Figure 5: Mean rated likelihood of drink purchase in Study 4.

These results show the predicted subadditive interaction pattern and provide support for the partitioning account of the denomination effect. The findings suggest that large bills act as partitions of value, similarly to envelopes when bills are sealed inside. There was no significant difference between the $20 bills sealed in an envelope and the loose $100 bill, suggesting that these methods of partitioning $100 of cash are interchangeable. The interaction pattern indicates that there is a ceiling to the effectiveness of partitioning on reducing likelihood of discretionary spending, such that sealing a large bill inside an envelope is no more effective than either a loose large bill or an envelope containing small bills. This pattern suggests that envelopes and large bills curb spending via the same partitioning mechanism. Surprisingly, participants rated their likelihood of making a purchase directionally higher for the $100 bill in the envelope than loose.

Study 5

In Studies 1-4 participants read and made judgments about hypothetical scenarios. Study 5 was conducted to replicate these findings in a real-world situation in which participants spent actual money.

Methods

This study was conducted at the annual street fair in a small New Jersey town. Two booths were set up next to each other and staffed by the experimenter and research assistants. At the first booth, individuals passing by were offered a chance to take an (unrelated) survey in exchange for a payment of $2.00. At the second booth, a ping-pong ball toss game was set up where individuals at the street fair could pay $0.25 for a chance to toss a ping pong ball at colored cups and win a prize. The booths were next to each other, but were set up to appear as different as possible to disguise the relationship between the two.

Individuals who completed the unrelated survey were paid $2.00 in one of three ways: as 8 quarters in a small, open cup; as 8 quarters in a sealed, clear envelope; or as a $2 bill. In the envelope condition the envelope used was clear, and the quarters were stuck onto a sheet of cardboard so that participants could easily see that their entire payment was present. In order to reduce the likelihood of participants noticing the differences in payment methods, the same payment method was used to pay 15 participants in a row before the payment method was switched. Once each participant was paid, the researcher observed whether they moved to the game booth and chose to spend any money. Any money spent at the game booth was recorded, whether it was money that had just been paid to the participants or money they had brought with them. The quarters were marked with small red or black marks on the side to act as a check on the accuracy of the observer.

In total 154 (n1=60, n2=45, n3=49) individuals completed the unrelated survey, and were paid $2.00, and were included in the study. A small number of individuals took the survey but refused payment, and are not included in the sample of 154 analyzed here.

Results and Discussion

A one-way ANOVA revealed a marginally significant difference in amount spent across the three payment conditions, $F(2,151) = 2.95$, $p=.056$, with participants paid using a $2 bill spending less (M=$.07) than those paid with quarters in an envelope (M=$0.11), who spent less than those paid with quarters in a cup (M=$0.27) (see Figure 6). Planned contrasts reveal a significant difference between the $2 bill and cup conditions, $t(109) = 2.34$, $p=.021$, and a marginally significant difference between the envelope and cup conditions, $t(94) = 1.76$, $p = .081$. There was no significant difference between the $2 bill and envelope conditions, $t(105) = 0.45$, $p = .66$[2].

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[2] While the data were skewed, with most participants spending nothing. The number of participants who spent anything was 3 of 60 (5%), 7 of 45 (16%), and 10 of 49 (20%) in the $2 bill, envelope, and loose quarters conditions, respectively. Non-parametric tests

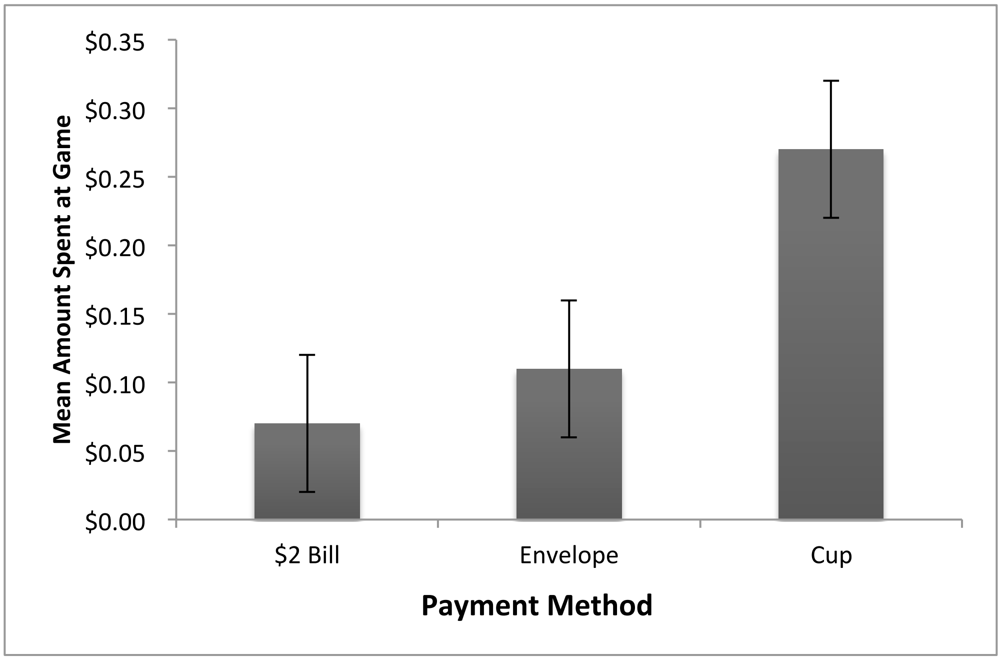

Figure 6: Mean amount spent on carnival game in Study 5.

These results again provide evidence for the deliberation triggered by partitioning as the mechanism driving the denomination effect. Participants paid using a $2 bill did not spend significantly differently than those paid with eight quarters in an envelope. In contrast, participants paid with loose quarters spent more than either of the other two groups. This replicates the findings of Study 4, suggesting that when consumers are making spending decisions for themselves, large bills act as partitions of value in a way that is interchangeable with sealed envelopes.

revealed the same marginal effect, $X^2(2) = 6.04$, p=.049, and Kruskal-Wallis H(2)=5.94, p=.051.

General Discussion

The current studies demonstrate that large bills inhibit impulsive spending (Study 1), and that decision makers are aware of this inhibition effect (Study 2). This effect does not appear to be driven by fungibility or processing fluency, as has been previously suggested, but by partitioning (Study 3). Large bills act as partitions of value in a way that is interchangeable with envelopes when consumers are making spending decisions, both in a hypothetical scenario (Study 4) and a real world setting (Study 5).

If carrying large denomination bills helps to decrease impulsive spending, it might be a successful means of reducing discretionary spending to promote short term savings behavior. Saving for short term purchases requires repeated acts of self control as the saved money accrues, and tempting items must repeatedly go unpurchased. If carrying large denomination currency acts as a method of monetary portion control, then individuals who are attempting to limit their spending might benefit by requesting large bills when withdrawing cash, especially if they know that cash might be used for discretionary purchases. The use of large bills could be an easy-to-implement method of improving self-control. Indeed, three-quarters of all US currency is in the form of hundred-dollar bills, much of it held by people outside the US as a form of savings (NPR, 2013).

Raghubir and Srivastava (2009) suggest that the denomination effect is a result of large bills being perceived by consumers as less fungible than smaller bills, and that consumers who wish to exert self control capitalize on this effect and strategically choose large denominations. Our results support the idea that consumers use the denomination effect as a self regulation strategy, but our data do not support fungibility as the underlying mechanism. Gift cards are less fungible than cash, as they are only accepted at limited locations (in the case of Study 3, only those locations that take American Express credit cards) and cannot be exchanged for cash. If a perceived lack of fungibility were the underlying cause of the denomination effect, then the gift cards in Study 3 would be expected to be perceived as more likely to reduce spending than cash in small bills; however this was not the case. Instead, gift cards were perceived as no more effective in controlling spending than small denomination currency, suggesting that another mechanism is at work. Additionally, in Studies 4 and 5, sealed envelopes of smaller bills were found to be equally as effective at decreasing spending as larger denomination bills. There is clearly a difference in fungibility between these two, so this similarity in decreasing spending suggests that fungibility is not the underlying cause.

Mishra et al. (2006) propose a processing fluency account, with large bills being processed more easily, leading to more positive affect for larger denominations. They found that a manipulation to increase fluency and one to increase familiarity both increased positive affect in the small bills condition, but not in the large bill condition (where affect was already high), and consequently these manipulations eliminated the denomination effect. If it is fluency itself that drives the denomination effect, however, hundred-dollar gift cards and hundred-dollar bills would presumably be equally easy to process compared to smaller bills, with envelopes containing five $20 bills each requiring more processing than the larger bills. Thus, if processing fluency were at the root of the denomination effect, the expectation would be to find similar results in Study 3 for the gift cards and large denomination bills, both of which should lead to decreased propensity to spend compared to envelopes or loose $20 bills. The results of Study 3 did not support this fluency prediction. Additionally, in Studies 4 and 5, envelopes of small denominations and large denominations were equally good at reducing spending, although presumably quite different in ease of processing, again undermining the processing fluency account.

Studies 4 and 5 do, however, provide additional evidence for the partitioning account. Large bills were just as likely as envelopes to decrease discretionary spending. This suggests that there is a ceiling to the effectiveness of partitioning, and that either holding a large bill or putting small bills in an envelope can decrease spending, but that there is no additional benefit to be gained by putting large bills in envelopes. This pattern suggests that large bills decrease spending via the same mechanism employed by envelope partitions.

The current results replicate previous demonstrations of the denomination effect and suggest that this effect is due to partitioning rather than previously hypothesized mechanisms. Thus, large bills represent a partition that decision makers are reluctant to cross. The partition likely acts as a choice point, triggering deliberative thought about whether one should break the partition and make a purchase. Once this partition is breached, discretionary spending is increased.

An understanding of the mechanism underlying the denomination effect sheds light on the ways in which the denomination effect can be harnessed to encourage savings behavior and promote other forms of self regulation. For example, a smoker trying to cut back might benefit from cigarettes sold in packs of 5, rather than 20, because that provides more partitions that cue deliberative decisions. Dieters may benefit from a sandwich being cut into four pieces instead of left whole.

However, some partitioning interventions designed to improve consumer behavior may have surprising effects. Scott et al. (2008) found that partitioning the same number of calories into small packages containing smaller food (e.g. mini M&Ms in small packs vs. regular M&Ms in regular packs) led eaters who were dieting, but not those who were not, to actually consume more calories. Thus, partitions do not always reduce consumption. One possible explanation is that dieters are more likely to finish a pack of M&Ms once they are opened, or are more willing to break partitions when they are able to justify it as a small deviation that they believe is unlikely to lead to over-eating. Dieters may also be more likely to overestimate their self-control in the face of available chocolate candies than non-dieters. More research must be done to investigate the boundaries of the effectiveness of partitioning. For example, large bills and partitions may have differing effects for those on a budget compared to consumers who are not trying to abide by a specific budget.

The current studies provide strong evidence for the deliberative thought triggered by partitioning as the mechanism driving the denomination effect. Large bill denominations and other partitions can be employed as self-control devices. Understanding the mechanism underlying such a powerful and low-cost way of reducing consumers' unwanted discretionary spending can be an important step towards creating more effective methods to help consumers reach their long-term financial goals.

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