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Quantifying Efficacy of Workplace Reinforcers: An Application of Behavioral Economic Demand to Evaluate Hypothetical Work Performance

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Behavioral economics is an approach to understanding decision making and behavior using principles of behavioral science and economics (Hursh, 1980). An area of investigation in behavioral economics includes evaluating demand for a commodity (such as drug and nondrug reinforcers), given changes in price, using hypothetical purchase tasks, which are a reliable and efficient assessment method. Given recent calls for organizational behavior management to examine work performance from a behavioral economic perspective (e.g., Wine, Gilroy, & Hantula, 2012), the present studies sought to extend the demand and hypothetical purchase task literature to work tasks and workplace reinforcers. Undergraduate participants completed 2 hypothetical work tasks—a variation of the hypothetical purchase task. Respondents indicated the likelihood they would complete an increasing work requirement for a fixed amount of money at 2 delays to payment (1 hr vs. 4 weeks). Exponential demand curve analyses provided excellent fits to the data and revealed (a) that individuals with and without experience completing the work behavior responded similarly, and (b) that there was higher demand for the 1-hr delay condition. These results suggest the hypothetical work task is a promising method for assessing demand for workplace reinforcers.

Keywords: performance management, demand, behavioral economics, hypothetical work task

Organizational behavior management (OBM) is a subdiscipline of applied behavior analysis that focuses on behavioral and environmental changes in the workplace to improve employee performance (Wilder, Austin, & Casella, 2009). An empirically supported practice within this discipline is the provision of high-quality employee training. Unfortunately, high-quality training may be insufficient to maintain high levels of employee performance over time (Reid & Parsons, 2002). Although employees may learn how to perform a task through training, they may not do so consistently because consequences for desired behavior are absent or consequences for undesired behavior are present (Austin, 2000). One potential solution—the delivery of incentives—has consistently resulted in performance improvements in analogue and applied research (see Bucklin & Dickinson, 2001, for a review). *Incentives* are preferred items or activities (i.e., reinforcers) designed to foster desired behavior or enhance productivity, and include monetary (e.g., Luiselli et al., 2009) and nonmonetary items (e.g., meals; Reid & Whitman, 1983). Incentive systems can be costly because they require resources—including money and personnel time—to manage the system. Thus, it is in the organization's best interests to ensure employees not only desire available incentives but also are motivated to work to obtain them.

Research demonstrates managers may not always accurately predict employees' preferences for incentives (e.g., Wilder, Harris, Casella, Wine, & Postma, 2011). To address this issue, managers may conduct preference assessments by asking employees to identify or rank prospective reinforcers (Waldvogel & Dixon,

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2008). Although preference assessments are an improvement over manager selection, they are not without their limitations—namely, the reinforcers identified are sometimes inconsistent across methods (Waldvogel & Dixon, 2008). Moreover, preference assessments do not capture the work requirement needed to obtain a reinforcer (e.g., Roane, Lerman, & Vorndran, 2001). Because reinforcer effectiveness depends on the work required to receive it, OBM may benefit from examining employee performance from a behavioral economic perspective (Jarmolowicz, Reed, DiGennaro Reed, & Bickel, 2015; Wine et al., 2012). Researchers have used a behavioral economic approach to identify reinforcers for individuals with disabilities with much success (e.g., Roane et al., 2001). A similar methodology may permit an analysis of the value of workplace reinforcers, potentially increasing the effectiveness and feasibility of incentive systems in organizations.

Behavioral economics is an approach to understanding decision making and behavior by integrating principles from behavioral science and microeconomics (Hursh, 1980, 2014). An area of investigation in behavioral economics evaluates demand for a commodity (such as drug and nondrug reinforcers), given changes in price. Research in this area shows that consumption of a commodity or reinforcer declines as the price increases, which is known as the *law of demand* (Samuelson & Nordhaus, 1985). This robust relation has been obtained with a variety of commodities (e.g., cigarettes, opioids, food, and water) and populations (e.g., nicotine-dependent adults, substance users, children, monkeys; Reed, Kaplan, & Becirevic, 2015). Behavioral economic demand curve analyses quantify the relation between reinforcer price (e.g., money, time, effort) and consumption (e.g., reinforcers obtained or consumed). The rate at which reinforcer consumption decreases relative to increases in price is termed *elasticity of demand*. Demand is *elastic* when a one-unit increase in price results in greater than a one-unit decrease in consumption, whereas *inelastic* demand remains relatively constant across price increases (i.e., a one-unit increase in price results in less than a one-unit decrease in consumption). Hursh and Silberberg's (2008) exponential model of demand quantifies the rate of change in elasticity across the entire range of prices, termed *alpha* (α). Smaller α values indicate relative inelasticity, that is, the organism will respond commensurately to larger increases in price. Relatedly, the inverse of alpha is *essential value* (*EV*), a more intuitive metric in which larger values indicate that the organism will meet increasing price requirements to more closely defend baseline levels of reinforcer consumption.

Experiential preparations for assessing demand commonly used with nonhuman animal populations are often not feasible with humans because of time and/or monetary constraints (Jacobs & Bickel, 1999). As a result, demand assays with humans often adopt hypothetical purchase tasks (HPTs; e.g., Murphy & MacKillop, 2006). HPTs are self-report measures that assess an individual's estimated purchasing and consumption of a commodity during a specified time across a range of increasing prices to generate a demand curve for a commodity (Murphy, MacKillop, Skidmore, & Pederson, 2009). In a typical HPT, experimenters present participants with a vignette describing the commodity of interest and the circumstances under which purchasing and consumption are being assessed. Participants subsequently provide an estimated level of consumption across a range of prices (beginning with a zero or a near-zero price).

For example, Jacobs and Bickel (1999) presented opioid-dependent participants with a HPT containing a vignette indicating that (a) there were no legal consequences for using heroin, (b) they were not in treatment, (c) they had no access to other drugs, and (d) any purchases had to be used by them alone within a 24-hr period. Participants reported the number of cigarettes or bags of heroin they would hypothetically purchase at 15 prices ranging from $0.01 to $1,120. As expected, given heroin's abuse liability, demand for heroin was greater than demand for cigarettes, lending further confidence to the validity of the hypothetical nature of the data.

Similar results with HPTs have been obtained with other drug (e.g., Murphy & MacKillop, 2006) and nondrug (e.g., Reed, Kaplan, Roma, & Hursh, 2014) reinforcers. For example, Roma, Hursh, and Hudja (2015) evaluated the *likelihood of purchase*, in which participants reported how likely they would be to purchase a single commodity on a scale of 0 to 100. This method is particularly useful for commodities that are rarely purchased or consumed in multiples (e.g., a vacation package). Additionally, researchers are beginning to evaluate the correspondence between responding in a demand assay for hypothetical versus real outcomes with much success (e.g., Amlung, Acker, Stojek, Murphy, & MacKillop, 2012; Amlung & MacKillop, 2015). The results of these and other HPT studies provide support for the validity of HPTs as a means to assess demand quickly and cost effectively in a variety of contexts (Reed et al., 2015).

Measures generated by demand curves may have utility in organizational settings. Differences in consumption and expenditure on a simulated work task might capture important variability in the value of monetary and nonmonetary reinforcers. The data from demand analyses may help inform a number of areas relevant to the development of organizational reinforcement systems, including (a) identification of effective reinforcers, (b) selection of appropriate work requirements to earn the reinforcers, (c) cost–benefit analyses to assess financial feasibility, and (d) frequency of reinforcer delivery. Thus, a behavioral economic approach to OBM can lead to a greater understanding of behavior and motivation (i.e., the persistence of work behavior at increasing work requirements) in the workplace. Despite recent calls for OBM to examine work performance from a behavioral economic perspective (e.g., Jarmolowicz et al., 2015; Wine et al., 2012), generality of behavioral economic methodology and demand curve analyses to the organizational setting remains relatively unexamined. The purpose of the present pilot studies was to extend the behavioral economic literature by demonstrating its applicability to the (a) identification of workplace reinforcers, (b) behaviors of relevance to organizations, and (c) pay schedules commonly adopted by organizations. Specifically, we evaluated the utility of a novel *hypothetical work task* (HWT), a variation of the HPT, and demand for a monetary reinforcer for completing a work task, given various delays to payment.

General Method

We recruited participants from an introductory behavioral science course. They received extra credit for participation. Participants completed the study online via Qualtrics Research Suite (see http://www.qualtrics.com). An announcement containing a link to the study was posted on a Blackboard site for the undergraduate course from which students were recruited. After selecting the study link, the online survey presented participants with an information statement and a dichotomous question asking them to indicate agreement to participate.

Participants read a vignette individualized to each study and answered three multiple-choice questions designed to verify participants attended to the relevant information in the vignette. After correctly answering the attending questions, participants completed a HWT containing 13 work requirements. The work task involved passing out flyers on a college campus—a job in which the majority of participants would have at least some familiarity because of the prevalence of students distributing flyers on campus. For each work requirement, participants were asked, “How likely are you to pass out **XX** flyers?” with the value of “**XX**” being each of the following work requirements (presented in order): 1, 50, 100, 150, 200, 250, 375, 500, 600, 800, 1,000, 1,300, and 1,500. Participants entered a numerical value ranging from 0 to 100 to indicate the likelihood they would complete the given work requirement. If participants failed to enter a response or entered an invalid response (e.g., 1,000), the program displayed an error message. Following the HWT, a brief survey asked participants to provide demographic information, including age, gender, and their experience holding a position distributing flyers.

Data Analysis

We excluded individuals who displayed unsystematic responses from all analyses (e.g., a 1% likelihood of distributing 50 flyers and a 30% likelihood of distributing 100 flyers), as this violates the law of demand and may suggest inattention to the task (Stein, Koffarnus, Snider, Quisenberry, & Bickel, 2015). Data for three participants in Study 1 and two participants in Study 2 met this criterion. Participants’ data were also excluded from analyses at the individual level (but retained in the aggregate data) if their responses derived negative (and thereby implausible) demand indices (Study 1, $n = 7$; Study 2 long delay, $n = 3$; Study 2 short delay, $n = 8$). Negative indices occurred when participant responses decreased abruptly from a value of 100 to 0 between any two prices; the exponential demand equation is unable to calculate interpretable demand parameters under such circumstances. Finally, responses on the HWT were divided by 100 to transform the values into proportions (i.e., 0–1).

Demand curves and associated metrics were generated by fitting the following equation (Hursh & Silberberg, 2008) to participant responses:

$$\log Q = \log Q_0 + k(e^{-\alpha \cdot (Q_0 \cdot C)} - 1) \quad (1)$$

where Q is equal to consumption (i.e., a participant's stated likelihood of distributing a given number of flyers), Q_0 equals baseline consumption or maximum demand (i.e., the level of consumption when the requirement is zero or near zero, in this case, one flyer), k is the scaling constant equal to the number of log units of consumption, and C equals cost, or the number of flyers required to earn the monetary compensation. Finally, α is a fitted parameter quantifying the rate of change in elasticity, or how consumption (i.e., the likelihood of distributing flyers) changes as a function of price (i.e., work requirement) across the entire range of prices. Larger α values indicate steeper demand curves and less demand. In the present studies, k was set to a value of 2 because responses could only range between 0 and 1, which is equivalent to two log units. The Exponential Model of Demand GraphPad Prism Template (www.ibrinc.org) was used with GraphPad Prism version 6.05 for Windows (GraphPad Software, La Jolla, CA; www.graphpad.com) to fit the demand equation to the data.

Additional demand indices were derived from Equation 1, including (a) *EV*, (b) P_{max}, and (c) O_{max}. A freely available Microsoft Excel-based tool (Kaplan & Reed, 2014) was used for calculating *EV* $[1/(100^*\alpha^*k^{1.5})]$, P_{max} $[1/(Q_0{}^*\alpha^*k^{1.5})^*(0.083^*k+0.65)]$, and O_{max} (percent likelihood x response requirement at P_{max}). *EV* reflects the reinforcing value of the commodity (i.e., the $10.00 compensation). P_{max} provides a quantitative description of the point at which the demand curve transitions from inelastic to elastic. From an organizational perspective, this is the point at which the work requirement becomes too high, and the likelihood the individual will complete the work decreases steeply. O_{max} quantifies the maximum response output (amount of work) at P_{max}.

Study 1

Study 1 sought to provide proof of concept for the applicability of demand curve analyses to work behavior and the use of the HWT. Much of the previous HPT research has evaluated commodities with which participants have experience purchasing; thus, we do not know the extent to which an individual's purchasing history or behavioral repertoire influences responding. To this end, we compared demand indices of participants with and without formal work experience performing the job described by the vignette.

Participants

Fifty-six undergraduate students aged 18 to 47 years (M = 20.68) participated in the study. The sample was primarily female (n = 45; 80%).

Vignette

Before completing the HWT, participants read the following vignette:

- You have been hired to pass out flyers to college students walking to class.
- You can earn $10.
- The flyers must be distributed in 1 hour.
- Due to payroll processing time, you will receive $10 *at the end of the hour*.

In the following questions you will be asked to indicate how likely you are to pass out the number of flyers. Use a value between 0 and 100 to indicate the likelihood that you will pass out the flyers.

0 = you will *not* pass out the flyers.

100 = you will *definitely* pass out the flyers.

Please answer all the items honestly, thoughtfully, and to the best of your understanding as if you were actually in the situation.

Results and Discussion

We separated participants into two groups: participants who reported work experience distributing flyers (i.e., experienced; n = 9) and participants who never held a job distributing flyers (i.e., naïve; n = 47). Mean consumption (i.e., likelihood of flyers distributed) values were calculated for both groups for use in fitting Equation 1. The left panel of Figure 1 depicts the average likelihood of distributing flyers as a function of the number of flyers required to earn the monetary compensation. Both groups demonstrated a general and systematic decrease in the distribution likelihood as the requirement increased (in conformance with the law of demand). At the aggregate level, Q_0 (1.0), α (7.8 × 10^{-4}), *EV* (4.5), $P_{\max}$ (369.87), and $O_{\max}$ (116.63) were equivalent for both groups. Given the identical values obtained at the aggregate level, we examined demand indices at the individual level (right panel of Figure 1). In general, similar values for Q_0, α, *EV*, $P_{\max}$, and O_{max} were obtained for both groups.

Overall, the present demand curves resembled demand curves found in previous research, and Equation 1 provided an excellent fit to the aggregate data (R^2s > .94). These results suggest behavioral economics may serve as a viable method for assessing employee motivation for workplace reinforcers. These results also demonstrate that individuals with work experience distributing flyers respond comparably to participants who reported never having held a job distributing flyers, providing some support for the validity of the HWT. Although these findings provide some proof of concept, any conclusions comparing the experienced and naïve groups must be tempered because of the small number of participants in the experienced group and the effects experience may have, based on unique learning histories.

Study 2

Study 2 evaluated the effects of timing of reinforcer delivery in the workplace (i.e., delay to payment) on behavioral economic measures of demand. We hypothesized delay to reinforcement would modulate the sensitivity of reported reinforcer consumption to price.

Participants

Fifty-five undergraduate students aged 18 to 55 years (M = 21.11) participated in the study. A large majority of the sample was female (n = 40; 73%).

Vignette

Participants responded to two HWTs in which the vignette indicated they would receive payment after delays of 1 hr (i.e., short delay; identical to Study 1) and 4 weeks (i.e., long delay). Participants completed the long delay before the short delay, separated by a distractor task.

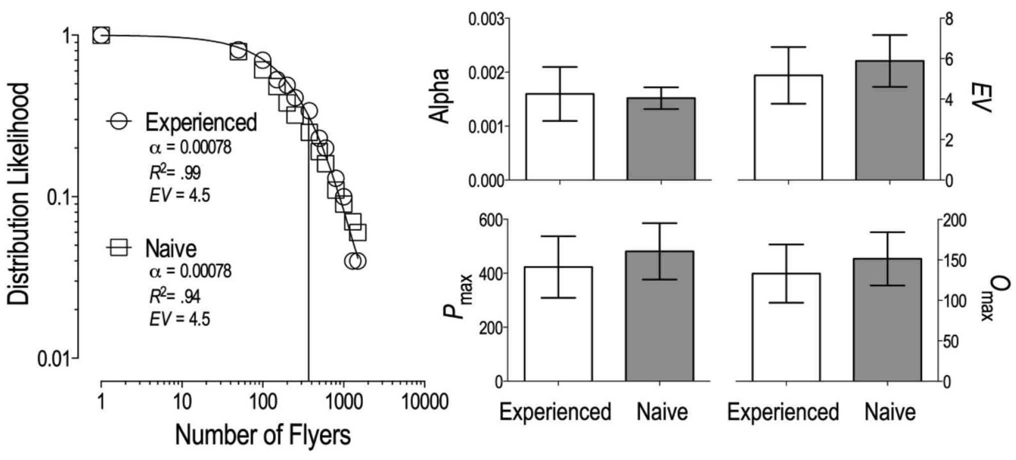

Figure 1. Exponential demand for monetary reinforcement for the experienced and naïve groups in Study 1 is depicted in the left panel. The vertical line corresponds to $P_{\max}$. Study 1 individual demand indices categorized by work history are depicted in the right panel. Error bars indicate *SEM*.

Statistical Analyses

None of the demand metrics evaluated were normally distributed, as indicated by the D'Agostino and Pearson omnibus normality test, and thus a Wilcoxon's matched-pairs signed rank test was used to evaluate within-subject differences in demand between the two conditions (Motulsky & Christopoulos, 2004). A sum-of-squares *F* test, commonly used in demand analyses (e.g., Cassidy & Dallery, 2012; Gentile, Librizzi, & Martinetti, 2012; Hursh & Roma, 2013; Madden & Kalman, 2010; Reed et al., 2014; Roma et al., 2015), compared differences in demand elasticity (i.e., α) between groups. All statistical tests were conducted using GraphPad Prism 6.05 for Windows.

Results and Discussion

Mean consumption values were calculated for both the short and long delay conditions for use in Equation 1 model fitting. The left panel of Figure 2 depicts the distribution likelihood as a function of the work requirement. Although a general and systematic decrease in likelihood of distribution as the requirement increased was observed for both delays to payment, a sum-of-squares *F* test revealed statistically significant differences in α between the two conditions, $F(1, 24) = 146$, $p < .0001$. For the short delay, $\alpha = 8.2 \times 10^{-4}$ ($R^2 = 0.99$), and for the long delay, $\alpha = 1.2 \times 10^{-3}$ ($R^2 = 0.99$), indicating higher demand in the short delay condition. *EV* was also higher in the short delay condition (4.31) compared with the long delay condition (2.95). At the aggregate level, P_{max} values were 379.35 and 261.32 flyers for the short and long delay conditions, respectively. Aggregate O_{max} values were 110.94 (short delay) and 75.71 (long delay) flyers, indicating a 46% increase in the number of flyers distributed in the short delay.

There were no significant differences in Q_0 ($W = -3$, $p = .81$) at the individual level. However, significant differences between the two delays were found for α ($W = 629$, $p < .0001$), *EV* ($W = -615$, $p < .0001$), P_{max} ($W = -615$, $p < .0001$), and O_{max} ($W = -615$, $p < .0001$), with higher demand in the short delay condition. These data are depicted in the right panel of Figure 2. This finding is promising because it replicates a body of literature showing that strength of reinforcement is modulated by the delay of reinforcement, a robust relation that has been demonstrated with numerous reinforcers in a variety of contexts (e.g., Hursh & Fantino, 1973), including demand analyses of drug reinforcement (Hursh, 2014).

A sum-of-squares *F* test was used to compare demand between Study 1 and the short delay condition in Study 2 to evaluate whether a sequence effect may have contributed to the dif-

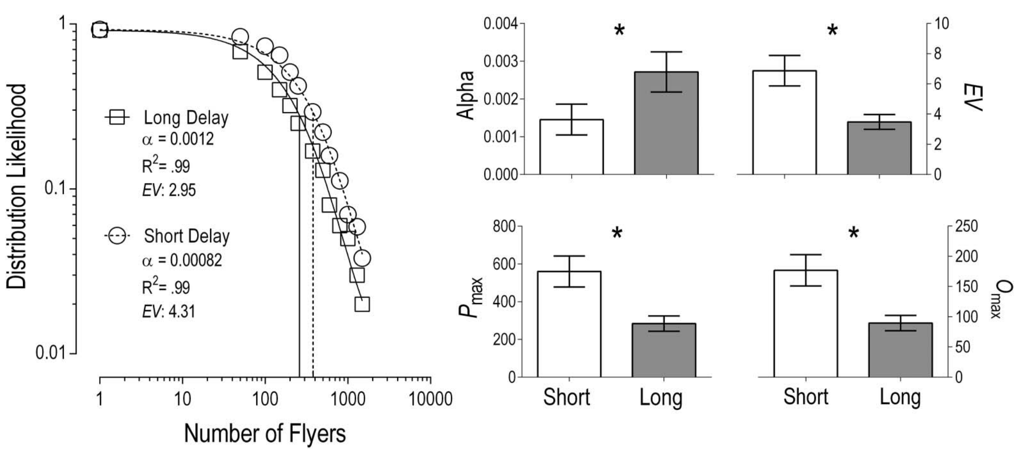

Figure 2. Exponential demand for monetary reinforcement for the short delay (1 hr) and long delay (4 weeks) conditions in Study 2 is depicted in the left panel. The vertical lines correspond to P_{max}. Study 2 individual demand indices are depicted in the right panel. Error bars indicate *SEM*. Statistically significant differences are denoted by * $p < .0001$.

ferences in demand between the short and long delay conditions. Differences between these identical conditions, except for the prior exposure to the long delay condition and distractor task in Study 2, would suggest the possibility of a sequence effect or confound. No significant differences were found, $F(1, 24) = 1.6$, $p = .22$.

General Discussion

The purpose of the present studies was to assess the applicability of behavioral economic demand analyses to OBM and evaluate a novel method for identifying effective workplace reinforcers. Across both studies, responding was sensitive to increases in price (i.e., work requirement), conformed to the prototypical downward sloping curves found in previous demand research (e.g., Murphy & MacKillop, 2006), and was well accounted for by the exponential model of demand (Equation 1; Hursh & Silberberg, 2008). The HWT demonstrated utility even when participants lacked direct experience emitting the behavior under study (distributing flyers). Differences between the short and long delay conditions provide construct validity by demonstrating demand assessed via the HWT is sensitive to, and varies in the predicted direction with, hypothetical contextual variables (Hursh, 2014). Taken together, findings from Studies 1 and 2 provide additional evidence of the generality of the exponential demand equation, and suggest a behavioral economic framework may be useful for determining the extent to which workplace reinforcers maintain levels of work performance among potential employees regardless of their experience with the task.

These results have several applied and practical implications that may guide future research. From a functional standpoint, the HWT is a novel preference assessment for use with employees that improves upon the methods currently available to organizations by incorporating the work requirement needed to obtain the reinforcer. The addition of work requirements addresses a limitation of traditional preference assessments, wherein putative reinforcers are identified at low work requirements, which is not indicative of conditions employees actually experience. Furthermore, the HWT has the potential to be a flexible instrument for assessing relevant aspects of a variety of reinforcement or incentive systems. The work task (distributing flyers), reinforcer (\$10.00), and contextual variables (delay to payment associated with various pay schedules) are some of the many variations that can be evaluated. For example, if monetary incentives are unavailable, such as in nonprofit or service-delivery settings, in which funds may be limited, organizations could use the HWT to compare the effectiveness of various nonmonetary incentives (e.g., a desired parking spot vs. selection of preferred duties). Thus, the HWT has promise as a tool that can be customized to meet the needs of various organizational settings.

Organizations must consider the feasibility and sustainability of any reinforcement system, particularly when costs are associated with its implementation. The HWT could be used to aid in cost–benefit analyses of incentive systems or organizational policy changes (e.g., assess whether monetary savings resulting from increased productivity when employees receive weekly compared with biweekly paychecks outweigh the costs associated with increased payroll processing [similar to the manipulation in Study 2]). Finally, as mentioned previously, the effectiveness of incentive systems may also depend on the work requirement selected. A work requirement that is too high may not evoke the desired behavior, but a work requirement that is too low may not be sustainable for the organization financially. Because P_{max} quantifies the point at which the curve shifts from inelastic to elastic (i.e., the likelihood of engaging in the work task decreases steeply), this value could be used to guide the selection of an appropriate work requirement for an incentive system. Although more research is needed, these examples serve to highlight some of the many potential applications offered by this novel method.

These studies have a number of limitations that should be addressed in future research. First, the relatively simple work task and undergraduate participant sample are not representative of most workplaces. It is unclear whether we would obtain the same results with more complex work tasks. Thus, we recommend that future research evaluate other versions of the HWT that represent typical work settings and more complex tasks. Although included in group-level analyses, we excluded a large number of participants from individual analyses because of implausible demand indices. Such implausible patterns may have occurred because the instructions only provided exemplars of the two extremes (100% and 0% likelihood). Because compensation for participation was not contingent on providing accurate or quality responses, participants may have quickly completed the task. Real employees may not emit this pattern if their responses influence the development of an incentive program or are tied to reinforcer delivery. To address this issue, organizations could prompt employees to provide intermediate responses (i.e., a likelihood value between 100 and 0) or adjust the HWT to include additional prices between the prices at which employee responding shifts from 100% to 0% likelihood.

Without counterbalancing the conditions in Study 2, we do not know if order effects influenced our findings despite verifying similar response patterns in Study 1 and the short delay condition. Finally, the hypothetical nature of this methodology may not accurately predict responding in the workplace. Recent research has demonstrated the congruence of responding for hypothetical and actual outcomes with drug reinforcers (Amlung et al., 2012; Amlung & MacKillop, 2015). An important and necessary next step in the validation of the HWT is to assess predictive validity and ensure responding on the HWT approximates responding in a real-world context and identifies functional reinforcers. Moreover, evaluating the validity of the HWT for more complex or abstract work tasks should be a direction for future research. Researchers will also need to explore the effectiveness of an incentive program designed on the results of group-level versus individual demand analyses. These collective findings would be a valuable contribution to both the behavioral economic and OBM literatures. In particular, the HWT may be advantageous in organizations in which testing incentive applications is dangerous, unethical, or impractical without prior understanding of the influence on performance (e.g., health care or service-delivery professionals).

Despite these limitations, our findings support the utility of behavioral economic concepts and methodology by extending their applicability to organizational behavior. Moreover, these studies provide a translational framework for extending behavioral economic principles derived from laboratories to an understanding of behavior observed in organizations. To our knowledge, the current studies constitute one of the first attempts to meet the call from researchers who have recommended such investigations translating behavioral economic concepts to the domain of organizational behavior (Jarmolowicz et al., 2015; Wine et al., 2012). Although our findings are preliminary and warrant additional research, particularly prior to application in real organizations, they are promising and suggest behavioral economic approaches have relevance to and may benefit work-related issues.

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