In press (August, 2011), Psychonomic Bulletin & Review

Action and motivation: Measuring perception or strategies?

Frank H. Durgin, Dinah DeWald, Stephanie Lechich,
Zhi Li, and Zachary Ontiveros
Department of Psychology, Swarthmore College

It has been suggested that when judging the distance to a desirable object, motivated distortions of perceived distance occur, and that these distortions can be measured by actions, such as throwing a beanbag. The results of two new experiments suggest that reported variations in beanbag performance may instead depend on instructional effects, such as ones that emphasize proximity rather than accuracy. When the goal was to be the closest to the target, under-throwing was observed whether the target was intrinsically valuable or not. When the goal was to hit the target, however, throwing performance was unbiased.

Do valuable objects appear nearer? In a series of clever studies, Balcetis and Dunning (2010) argued that desirable objects were perceived to be physically nearer than unvalued counterparts. For instance, after eating salty food, estimates given for the distance to a bottle of water were less than after drinking water. Whereas many of these kinds of results might be interpreted in terms of judgmental biases in response to experimental demand characteristics[1] (see Durgin, Baird, Greenberg, Russell, Shaughnessy & Waymouth, 2009; Woods, Philbeck & Danoff, 2009), one of the findings reported by Balcetis and Dunning seemed to directly contradict such an account: When a valuable gift card was the target of a beanbag toss, Balcetis and Dunning (Experiment 3a) found that participants threw short of the target, as if the gift card seemed nearer than it was. In the control condition, where the gift card was known to the participant to have no value, tosses were relatively accurate. Balcetis and Dunning proposed that under-throwing was due to the perceptual contraction of visual distance in the presence of a valued object rather than the result of experimental demand characteristics. After all, participants in this experiment were probably more motivated to throw accurately than to please the experimenter.

The present investigation sought to determine whether participants under-throw beanbags when trying to win a valuable gift card because the value of the gift card makes it appear physically nearer. On the face of it, inaccurate action with respect to the location of desired objects does not seem a particularly adaptive perceptual strategy. We therefore sought to reproduce the under-throw effect while controlling for three alternative explanations.

Hypothesis 1. Choking under pressure. In the original experiment (Balcetis and Dunning, 2010), the control condition was a gift card worth $0. Motivational demands of the task might tend to place more performance pressure on the toss in the valuable card condition. A similar phenomenon occurs in basketball, where "Buzzer-beater" pressure shots are often airballs (i.e., short). To control for pressure

[1] An experimental demand characteristic is present when participants can intuit the experimenter's hypothesis. For example, should eating salty food make a bottle of water seem nearer or farther? It might actually appear nearer, but it is hard to know based on an experiment in which no control for experimental demand is used. Conversely, participants who set themselves farther from chocolate than from fake dog poo may be trying to compensate for an expected bias ("I'd rather be closer to the chocolate, so I'll err in the other direction so as to get it right.") We have found that participants are often surprisingly articulate about their thoughts and beliefs about experimental procedures.

Frank H. Durgin, Swarthmore College, Department of Psychology, 500 College Ave., Swarthmore, PA 19081. Email: fdurgin1@swarthmore.edu; phone: +01 610 328 8678

we allowed some participants a single "practice" shot that did not count, prior to the real shot, and then measured the practice throw. If perceived distance determines throwing distance and is determined by target value, then practice shots should also be under-thrown.

Hypothesis 2. Anticipating bounce. In their paper, Balcetis and Dunning (2010) described their beanbag as rubber-coated and emphasized it stuck to the floor upon landing. However, their participants may have nonetheless anticipated a bounce or roll at the termination of the throw and therefore aimed short in order to end up closer to the target. To control for this we instructed half our participants in Study 1 that the closest throw would win (as per Balcetis and Dunning), but the other half were told that hitting the card directly was required to win the gift card. We reasoned that attempts to hit the target directly would control for strategic under-throw. We note that prior studies of perception using throwing measures use an instruction equivalent to "hit" (e.g., Eby & Loomis, 1987; Thomson, 1983; Woods et al., 2009).

Hypothesis 3: Value of prize, not target matters. Balcetis and Dunning concluded that the gift card appeared closer because it was valuable, but they did not test whether it was the value of the prize or the value of the target that mattered. To distinguish whether the value of the target mattered, we replicated their original study using a valueless piece of blue tape as the target of the toss, but differently-valued gift cards ($0 or $25) as the prizes.

Experiment 1: Controls for pressure and anticipated bounce.

The participants were 38 Swarthmore College undergraduates (20 male) offered the chance to compete for a $25 gift card while in the lab. (Balcetis and Dunning tested 40 participants.)

Design. The experiment was conducted in a carpeted hallway. Our bean bag was coated with velcro and would not normally move after initial contact with the carpet. A $25 Visa gift card, at 4 m distance, was the target of all tosses. Each participant was assigned at random to one of four conditions crossing two manipulated variables: Pressure and Strategy.

To manipulate Pressure, we either allowed a practice throw or not. Although only the first throw mattered for our experiment, for about half the participants, the first throw was described in advance as a practice toss (Practice) whereas for the others they were told they would only have one try (One-Toss), as a way of manipulating immediate pressure. To manipulate Strategy, about half the participants in each condition were told that the toss that landed closest to the gift card would win it (Closest). The other half of the participants were told that if they hit the gift card directly they would win it (Hit).

Procedure. Participants already at the lab for other experiments were invited to participate in the toss game to win a prize. They were told they would have a chance to win a $25 gift card and the rules were explained according to the condition assigned prior to their arrival in the lab. Those in the practice condition threw twice, but only the first toss was used as data.

Results

The data were recorded and analyzed in terms of the "under-" or "over-shoot" (in cm) relative to the main direction of the target. A 2 (Pressure: Practice vs. One Toss) X 2 (Instruction: Hit vs. Closest) X 2 (Sex) ANOVA was conducted on the resulting toss measures. This overall ANOVA showed that there was a main effect of Instruction, $F(1, 30) = 8.47$, $p = .0068$. There was also an effect of Sex that differed as a function of Pressure, $F(1, 30) = 4.94$, $p = .0340$. Because of the interaction, the data for the One-Toss and Practice conditions were analyzed separately.

In the One Toss condition, the data were consistent with the idea that throwing strategies were different depending on the characterization of the task. Participants threw reliably less far when told that the prize would go to whoever came "closest" to the target than

when instructed they must hit the target, $F(1, 17) = 10.2$, $p = .0053$. Participant seeking to end up closest to the target underthrew, t(9) = 4.81, p = .0010, whereas those seeking to hit the target were not reliably biased, t(10) = 1.46, p = .1741. Note that when the practice toss data are included, tosses in the "hit" condition remain statistically unbiased, t(17) = 0.77, p = .4495, and those in the "closest" condition remain reliably short, t(19) = 4.88, p = .0001. These results are consistent with a strategic difference in the approach depending on the instruction. These data are shown in Figure 1.

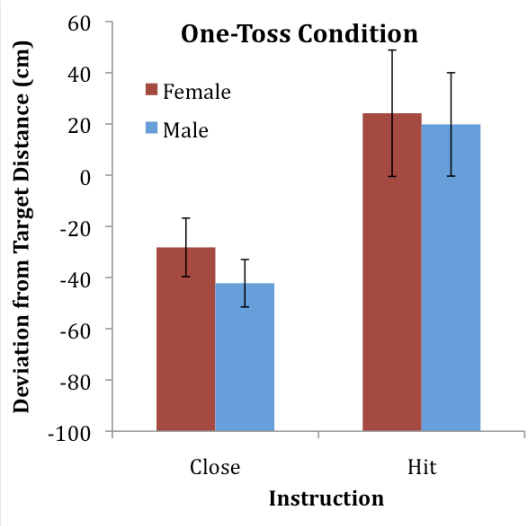


Figure 1. Results of Experiment 1. When the first toss counted, participants instructed to try to "hit" the gift card were not reliably biased. Those trying to get the bean bag "closest" to the target under-threw reliably (replicating Balcetis & Dunning, 2010).

For those in the Practice condition, where nothing was stake in the first toss, a rather different pattern emerged. A 2-way ANOVA (Sex X Instruction) on the practice trials, showed no reliable effect of Instruction, F(1, 13) < 1. However, women under-threw (-42 cm) more than men (+4 cm), F(1, 13) = 6.85, p = .0213. Given that there was no effect of Sex in the conditions where the throw counted, we regard this result as a possible consequence of a sex-related difference in motivation (Stevenson & Allen, 1964) or strategy when the outcome of the toss did not matter.

Overall, it seems likely that motivated participants who are instructed that "the closest toss wins" may anticipate that the initial landing position of the beanbag would not be the final position. Consistent with this interpretation, a few of our participants spontaneously asked whether it was the initial or final position of the beanbag that mattered. They were then told (accurately) that our beanbag did not normally bounce. Prior experience with less frictional bean bags may have encouraged a strategic choice to throw short in some participants. In prior perception experiments using throwing tasks it was the initial landing position that was explicitly designated as the outcome of the throw (Eby & Loomis, 1987; Rieser, Pick, Ashmead & Garing, 1995; Sahm, Creem-Regehr, Thompson & Willemsen, 2005; Thomson, 1983; Woods et al., 2009). Evidently this is an important feature with regard to how participants are instructed. In such experiments, throwing performance is normally found to be unbiased at distances of 5 m or less (Eby & Loomis, 1987; Thomson, 1983).

Experiment 2: Control for value of target

If under-throw is the result of a strategic behavior, rather than a perceptual shift, then the same pattern of under-throw should emerge if the target itself has no value, but the prize for hitting the target does (so as to motivate strategic throwing). To test this we conducted an additional version of the experiment, concurrent with the first. In this experiment we contrasted performance when the prize was a $25 gift card with performance when the gift card was said to contain $0. The target of the throw was not the card, however, but a valueless piece of blue tape.

Method

The participants were 29 undergraduates (19 male) from the same pool as those in Experiment 1 and recruited concurrently.

Design. The same location and bean bag were used. The conduct of the experiment was similar to Experiment 1, except that only the "Closest" instruction was given and a piece of blue tape approximately the size of the gift card was the target on the floor. The prize for the closest toss was a gift card, which was said to be valued at either $25 or $0.

Procedure. To minimize the awkwardness of offering a valueless prize, the experimenter first described the competition as an optional one to win a gift card. If a person agreed to participate, they were informed of the rules and led to the throwing line. They were then told either (High Value) that the gift card prize was worth $25 or (Low Value) that the card was worth $0, but was rechargeable. (Note that a Visa Gift Card worth $25 costs $29, so being "rechargeable" means the prize is not entirely valueless.) They were never shown the card, but threw the beanbag toward a piece of blue tape 4 m away instead. A single toss was allowed and its distance measured relative to the target distance.

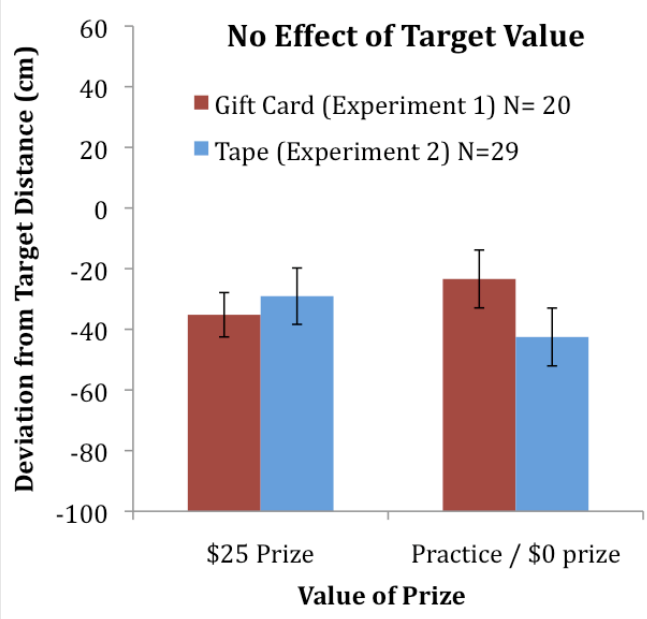


Figure 2. Results of Experiment 2 when the target was a piece of blue tape on the floor did not differ from the results of Experiment 1 when the gift card was the target (all bars represent "closest" instructions). Both conditions show under-throw.

Results

Participants under-threw to the target in both conditions, $t(28) = 5.40$, $p < .0001$, but there was no reliable difference between the two Value conditions, $t(28) = 1.01$, $p = .3221$. The mean undershoot (-36 cm) was essentially identical to the under-shoot found in Experiment 1 (-29 cm) when the instruction was the same. In other words using the "closest" instruction, we observed undershoot whether the gift card was itself the target of the toss or merely the prize of a contest to be the closest to the target. The results of Experiment 1 ("closest" instruction) are plotted along with those of Experiment 2 in Figure 2.

As we have noted, prior throwing experiments have shown that throwing is unbiased for targets at this distance (e.g., Eby & Loomis, 1987). But in those experiments the initial landing location of the projectile was explicitly indicated as what counted. The fact that the present results demonstrate underthrow is consistent with our interpretation that the underthrow is a strategic reaction to a different task description. As indicated by spontaneous queries of a few participants, some participants likely interpreted "closest" as referencing the final resting location rather than the initial landing location of the bean bag.

General Discussion

It is not straightforward to interpret actions as measures of perception. Based on a pattern of throwing too short, Balcetis and Dunning (2010) concluded that participants in their beanbag experiment perceptually underestimated the distance to targets that were valuable. They contrasted a normal competition condition (try to win a $25 gift card) with an anomalous motivation condition (try to win a worthless prize) and concluded that the under-throwing in the normal condition was due to a perceptual change induced by the value of the target. In two studies we have provided evidence that when the goal

of throwing is to end up "closest" to the target, under-throwing seems to occur (1) whether or not the target itself is a desired object, and (2) possibly as a result of the goal of allowing for secondary movement of the beanbag after initial contact with the floor. When the instruction was specifically to "hit" a $25 visa gift card with a beanbag, throws were not short. We emphasize again that in standard throwing tasks participants are instructed that it is the initial point of contact that is to represent the thrown distance – consistent with our "hit" instruction. In such tasks, throws are typically found to be unbiased.

The present pattern of results does not support the motivated perception idea, but is consistent with motivated strategies. It might be objected that we have not explained the other findings reported by Balcetis and Dunning (2010). However, most of their other experiments did not control for experimental demand. That is, because many of their manipulations seem relatively transparent, it remains possible that most of their results could be explained by uncontrolled demand characteristics (Durgin et al, 2009; Durgin, Hajnal, Li, Tonge & Stigliani, 2010a, 2010b). For example, Durgin et al. (2009) found that when participants were asked why they thought they had been required to wear a heavy backpack while making slope judgments of walkable surfaces, they nearly all assumed the backpack was intended to affect their estimates, and about half reported complying with the demand. The estimates of the compliant subset were reliably affected. If, on the other hand, a deception was used to successfully conceal the experimental intent of the backpack so as to remove this experimental demand, the weight of the backpack did not influence judgments of surface orientation (see also Durgin, Ruff & Russell, in press).

The interpretation of action measures can be problematic. For example, a common haptic adjustment task for measuring perceived slant (palm board) has sometimes been taken as an unbiased measure of perceived surface orientation (e.g., Gibson, 1950; Norman, Crabtree, Bartholomew & Ferrell, 2009). However, Durgin et al. (2010b; see also Li & Durgin, 2011) have shown that a palm board at waist level is highly inaccurate when tested for full-cue surfaces that are within reach of the hand -- surfaces for which normal reaching actions are precise and accurate. Although the use of bean bag tosses has precedent in the distance perception literature, the inclusion of an ambiguous instruction "closest" seems to substantially alter strategic throwing behavior, rendering the measure problematic as a measure of perception.

Balcetis and Dunning (2010) defined the goal of throwing in terms of proximity to the target ("closest"), but did not tell participants whether it was the final location of the beanbag that mattered or the initial position. Instead they tried to make these two outcomes the same by using a rubber-coated bean bag. But their participants may not have realized that the beanbag was as frictional as it was. In our experiments a number of people asked whether it was the initial location or the final location that mattered, but most people did not ask. Those who play bean bag games in college are often accustomed to rules that refer to the ultimate location of the beanbag, not the initial landing point[2]. It thus appears quite likely that the underthrowing that Balcetis and Dunning observed was the result of a strategic choice to throw short based on prior experience with less frictional bags that move after landing.

[2] A search using the Google search engine on July 31, 2011, for "college bean bag toss game" showed that a single popular game was indicated among 99 of the first 100 "hits". This game allows for secondary bean bag motion after landing and is scored according to where the bean bags end up, not according to where they initially land.

Our study has shown that throwing to a valued target is fairly accurate when the instruction is to hit the valued target. Because this is more similar to standard instructions in the literature (where throwing performance has been shown to be well calibrated at this distance) this tends to undermine the claim that desirability reduces perceived distance. In contrast, when the instruction encouraged proximity, underthrowing was observed in our study even when the target (and the prize) had very little value. We hasten to point out that we have not explained why Balcetis' and Dunning's participants threw more accurately when they believed the prize was valueless. It is possible that they threw more naturally (i.e., aimed directly at the target) and less strategically when the contest made no sense to them because they understood the prize to be truly worthless (a used-up gift card).

Two reviewers of our paper have made conflicting negative points about our study. One questioned our results on the grounds that most prior studies of bean bag tosses have shown little overall bias whereas we demonstrated underthrowing across most conditions. The second reviewer argued that the absolute error in our studies was not useful evidence because only relative distance could be interpreted. We think that the first reviewer is correct to note that absolute underthrowing is unusual. Several studies of throwing have shown excellent performance at distances of 4 or 5 m. We have suggested that the task instructions we derived from the Balcetis and Dunning study ("closest") depart in important ways from most prior studies of bean bag tossing. Thus, we attribute the underthrowing we observed across most conditions to a reasonable strategic behavior based on experience with bean bags (they don't usually stop on impact) in combination with the "closest" instruction.

In contrast, the argument of the second reviewer (that only relative distance matters) was intended to undermine our finding in Experiment 2 that throwing was also short for a valueless target. However, even if only relative predictions were at stake, a direct comparison between Experiment 2 and Experiment 1 is possible because the very same bean bag and target distance was used in both experiments. In Experiment 1, when the instruction was to hit a valuable target, participants were quite accurate overall. This is consistent with the prior literature on bean bag tossing, but is inconsistent with the claim that desirability makes things look closer. Thus, our study does not merely provide an alternative account of the underthrowing that Balcetis and Dunning attributed to the value of the target. It also provides evidence inconsistent with their explanation of their finding.

Balcetis and Dunning (2010), themselves, made an absolute prediction: "We predicted that participants would underthrow the beanbag when they looked at the desirable object, because they would perceive that object as closer." (p. 150). Because our experiments provide direct evidence that throws to valued objects do not fall short when the intention of the participant is to hit the target, this contradicts their value hypothesis.

Because the stable perception of space is functionally important for the successful control of action, theories that suggest that space perception is so arbitrarily altered (e.g., by perceived value) seem literally dysfunctional. We have suggested (but not proven) that other experiments from Balcetis and Dunning's (2010) paper may also be interpretable by alternative accounts. We suspect that a more nuanced examination of participant beliefs about the goals of such experiments might be very revealing, but we have limited our current investigation to their throwing experiment.

Elsewhere (Durgin et al., 2009) we have discussed the cognitive illusion described by magicians as "closing all the doors",

which depends on seeming to demonstrate the same trick (i.e., finding) repeatedly while (giving the illusion of) quashing all non-magical (i.e., alternative) explanations serially. This is a form of confirmation bias to which scientists are known to be susceptible. Our goal in the present contribution has been to take one of the most striking demonstrations from the Balcetis and Dunning paper and examine it more closely. Our limited conclusion is simply this: Their bean bag tossing experiment should be excluded from counting as independent evidence in favor of their value hypothesis. When people try to *hit* a valuable gift card with a bean bag, their throws tend to be unbiased.

Acknowledgments

This research was supported by Award R15EY021026-01 from the National Eye Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Eye Institute or the National Institutes of Health.

References

Balcetis, E., & Dunning, D. (2010). Wishful seeing: More desired objects are seen as closer. *Psychological Science, 21*, 147-152.

Durgin, F. H., Baird, J. A., Greenburg, M., Russell, R., Shaughnessy, K., & Waymouth, S. (2009). Who is being deceived? The experimental demands of wearing a backpack. *Psychonomic Bulletin & Review, 16*, 964-969.

Durgin, F. H. Hajnal, A., Li, Z., Tonge, N., & Stigliani, A. (2010a). An imputed dissociation might be an artifact: Further evidence for the generalizability of the observations of Durgin et al. 2010. *Acta Psychologica* (online). http://dx.doi.org/10.1016/j.actpsy.2010.09.002

Durgin, F. H. Hajnal, A., Li, Z., Tonge, N., & Stigliani, A. (2010b). Palm boards are not action measures: An alternative to the two-systems theory of geographical slant perception. *Acta Psychologica, 134*, 182-197. http://dx.doi.org/10.1016/j.actpsy.2010.01.009

Durgin, F. H., Ruff, A. J., & Russell, R. (in press). Constant enough: On the kinds of perceptual constancy worth having. In G. Hatfield and S. Allred (eds.), *Visual Experience*. Oxford University Press.

Eby, D. W., & Loomis, J. M. (1987). A study of visually directed throwing in the presence of multiple distance cues. *Perception & Psychophysics, 41*, 308–312.

Gibson, J. J. (1950). The perception of visual surfaces. *The American Journal of Psychology, 63*, 367-384.

Li, Z., & Durgin, F. H. (2011). Design, data and theory regarding a digital hand inclinometer: A portable device for studying slant perception. *Behavior Research Methods*. DOI: 10.3758/s13428-010-0047-7.

Norman, J. F., Crabtree, C. E., Bartholomew, A. N., & Ferrell, E. L. (2009). Aging and the perception of slant from optical texture, motion parallax, and binocular disparity. *Attention, Perception & Psychophysics, 71*, 116-130.

Rieser, J. J., Pick Jr., H. L., Ashmead, D., & Garing, A. (1995). Calibration of human locomotion and models of perceptual-motor organization. *Journal of Experimental Psychology: Human Perception and Performance, 21*, 480-497.

Sahm, C. S., Creem-Regehr, S. H., Thompson, W. B., & Willemsen, P. (2005). Throwing versus walking as indicators of distance perception in similar real and virtual environments. *ACM: Transactions on Applied Perception, 2*, 35-45.

Stevenson, H. W. & Allen, S. (1964). Adult performance as a function of sex of experimenter and sex of subject. *Journal of Abnormal and Social Psychology*, *68*, 214-216.

Thomson, J. A. (1983). Is continuous visual monitoring necessary in visually guided locomotion? *Journal of Experimental Psychology: Human Perception and Performance, 9*, 427–443.

Woods, A. J., Philbeck, J. W., & Danoff, J. V. (2009). The various perceptions of distance: An alternative view of how effort affects distance judgments. *Journal of Experimental Psychology: Human Perception and Performance, 35*, 1104-1117.