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# The Stability Heuristic for Weight Judgments

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## Abstract

The ubiquity of the intrinsic shape of a product, package, or logo makes understanding the effect of shape on consumer judgments an important theoretical and managerial question. Drawing upon the premise that people believe heavier objects are more stable, and past research on lay theories, we examine the novel hypothesis that consumers use shape stability to judge weight. Eight studies provide convergent evidence that more stable shapes are perceived as heavier, which leads to higher calorie and volume perceptions. However, this effect is mitigated when volume judgments are made before weight judgment (replicating the elongation effect), when participants get access to more diagnostic information (i.e., haptic input), or when the "heavier = more stable" lay belief is challenged. These results add to the literature on spatial judgments by examining the effects of shape stability on consumers' judgments of weight, volume, and calorie content.


*Keywords:* shape stability; weight judgments; volume judgments; lay theory; cross-modal influence; sensory perception; accessibility diagnosticity model

"*An object at rest stays at rest … unless acted upon by an unbalanced force*."

Newton's First Law of Motion (Inertia)

The consumer behavior literature has investigated the effect of visual cues on a variety of consumer judgments including size (Sevilla and Kahn 2014), volume (Raghubir and Krishna 1999), and weight (Deng and Kahn 2009). Reviewing the extant literature on visual information processing, and suggesting a conceptual framework to guide future research, Greenleaf and Raghubir (2008) proposed that there are four primary visual information properties: geometric, statistical, temporal, and other that can affect consumer judgments. Under geometric properties, they defined four dimensions: complexity, curvature, congruence, and completeness. The sub-dimensions of congruence that they identified were symmetry, planned distortion, stability, and centrality. We contribute to the literature on sensory perceptions, specifically, weight judgments, by examining the effect of product shape on weight perceptions, via perceptions of stability.

Prior research has documented that consumers' weight judgments are malleable and affected by cues such as size (Charpentier 1891), material (Wolfe 1898), color (Pinkerton and Humphrey 1974), background sounds (Lowe and Haws 2017), display location (Deng and Kahn 2009), movement speed (Jia, Kim, and Ge 2020), and product shadow (Sharma and Romero 2020).

Weight judgments affect other sensory judgments such as volume (Lin 2013), and color darkness (Walker, Scallon, and Francis 2017). Weight judgments can also affect other conceptual judgments through metaphorical links, such as calorie assessment (Romero and

Biswas 2016), and issue importance (Jostmann, Lakens, and Schubert 2009).

We examine how weight judgments are a function of perceived stability of a product. Stability is an important shape characteristic but has received limited attention, specifically in the domain of logos (Rahinel and Nelson 2016). Shape stability is a visual input which has the potential to integrate findings using other shape properties such as elongation (Koo and Suk 2016; Raghubir and Krishna 1999; Wansink and van Ittersum 2003), completeness (Hagtvedt 2011; Sengupta and Gorn 2002; Sevilla and Kahn 2014), and symmetry (Bajaj and Bond 2018; Creusen, Veryzer, and Schoormans 2010; Luffarelli, Stamatogiannakis, and Yang 2019).

We propose a *stability heuristic* in weight judgments, whereby consumers judge objects as heavier the more stable they look, holding objective weight constant. We propose that this occurs due to the presence of the lay theory that heavy objects are more stable: heavy → stable, being invoked using the reverse causality: stable → heavy. The fact that consumers use (and misuse) lay theories to make judgments is well established in the literature (Folkes and Matta 2004; Hagtvedt and Brasel 2017; Haws et al. 2017; Raghunathan, Naylor, and Hoyer 2006; Thomas and Morwitz 2009). As such, the contribution of this paper is to demonstrate the existence of a new heuristic based on a lay theory, and demonstrate its consequences. Results from eight studies provide convergent support for the stability → heavy heuristic, show its marketing-related downstream effect on calories perception and WTP, and shed light on its underlying process by identifying boundary conditions.

This has managerial consequences. While it has been almost twenty years since the publication of Raghubir and Krishna (1999), short and wide containers are not uncommon in the market (see Appendix A). For example, relative to the containers of other yogurt brands such as Yoplait and Dannon, the packages used by Fage and Noosa are shorter and wider. Similarly, Mr. Brown's canned coffee is shorter and wider than Starbucks, with other differences in categories ranging from shampoos and lotions to energy drinks and ice cream. Could there be an advantage, under some conditions, for managers to choose less elongated containers? We attempt to identify one such condition as part of a broader inquiry into the question of how shape affects weight judgments. Given that yogurt is available as either "regular" or "light" could more or less stable package shapes lead to improved market performance?

Additionally, consistent with our main thesis, a number of well-known fast food brands including Burger King, Pizza Hut, Domino's, and KFC that are associated with higher calorie foods have made their logos visually less stable (Appendix A). Would other brands be better served by doing the same?

This paper hopes to shed light on these questions. We contribute firstly to the literature on weight judgments by introducing visual stability as a new antecedent, adding to prior factors that have been identified including size (Charpentier 1891), material (Wolfe 1898), location (Deng and Kahn 2009), color (Pinkerton and Humphrey 1974), and background sound (Lowe and Haws 2017). Secondly, we contribute to the shape literature by examining a property that has not received much attention, stability, adding to other shape characteristics, such as angularity (Jiang et al. 2016; Zhang et al. 2006; Zhu and Argo 2013), completeness (Hagtvedt 2011; Sengupta and Gorn 2002; Sevilla and Kahn 2014), and symmetry (Bajaj and Bond 2018; Creusen, Veryzer, and Schoormans 2010; Luffarelli, Stamatogiannakis, and Yang 2019). Thirdly, we identify conditions when the stability heuristic versus the elongation heuristic (Raghubir and Krishna 1999; Wansink and van Ittersum 2003; Yang and Raghubir 2005) will predominate. We reverse the robust elongation effect by showing that taller containers are perceived to have lower volume when weight judgments precede volume judgments; but when volume judgments precede weight judgments, the elongation effect replicates. Managerial implications for when managers should use more or less elongated packaging are discussed.

## *CONCEPTUAL DEVELOPMENT*

### *The "Heavy → Stable" Lay Theory*

Stability is defined as an object's ability to remain in its original position without moving. Stability is determined by the position of the center of gravity which is a function of the size of the base area, and the weight of the object, among others (Cholewiak, Fleming, and Singh 2015; Grimshaw et al. 2004; Whiting 2018). Higher stability is characterized by a lower center of gravity, and higher mass. A heavier object is more stable than a lighter one as it has greater inertia as per Newton's first law of motion. We conducted a pilot study to empirically validate the "heavier is more stable" belief. We asked 112 MTurkers (60 females; $M_{age}$ = 34.06) to indicate the extent to which they agree or disagree (1 = strongly disagree; 7 =

strongly agree) with two statements adapted from Rahinel and Nelson (2016): "Heavier objects are more stable" and "It is hard to tip over heavy objects" ($r$ = .54). Participants' agreement is significantly higher than the midpoint ($M$ = 5.55, $SD$ = 1.22; $t(111)$ = 13.49, $p$ < .001, $d$ = 1.27), with 83.04% (N = 93) reporting agreement greater than the mid-point of 4. Results suggest that the majority of consumers, indeed, hold the "heavy = stable" lay theory.

***The "Stable → Heavy" Heuristic***

One of the first papers that showed that if individuals believe "A → B", they also tend to believe the reverse (B → A), although logically such an inference should not be made is the "*accessibility-as-information*" heuristic (ease of recall → greater frequency; Schwarz et al. 1991), which is based on the reversal of the "*availability*" heuristic (greater frequency of items in memory → greater ease of recall; Tversky and Kahneman 1973).

Applying this theory to numerical cognition, Thomas and Morwitz (2009) showed that as consumers hold a naive theory that larger numerical differences are easier to calculate than smaller differences, they use computational ease or difficulty to estimate the magnitude of numerical difference. Accordingly, differences that are easier to calculate (e.g., 5.00 - 4.00) are judged larger than those that are difficult (e.g., 4.97 - 3.96).

In the marketing context of judgments of health, consumers' daily observations and experience produce "healthy = expensive," "unhealthy snacks are sold in glossy packages," and "unhealthy = tasty" beliefs. These beliefs lead consumers to judge more expensive foods as healthier (Haws et al. 2017), foods in glossy packaging as less healthy (Ye, Morrin, and Kampfer 2020), and tastier foods as unhealthier (Raghunathan et al. 2006).

In the domain of sensory judgments, based on consumer's lay beliefs that larger objects are more attention-catching, consumers judge attention-grabbing objects – such as containers in highly saturated colors (Hagtvedt and Brasel 2017) or those of novel shapes (Folkes and Matta 2004) – to be larger or more voluminous.

In the domain of visual information, based on consumer's lay belief that higher prices products are placed on top shelves, consumers judge items on higher shelves to be of higher price and quality (Valenzuela and Raghubir 2015), and the belief that popular items are placed in the middle of a shelf (Valenzuela, Raghubir, and Mitakakis 2013), to infer that items in the middle of the shelf are more popular (Valenzuela and Raghubir 2009).

The closest examination to our current research question is that of Deng and Kahn (2009) who found that products placed at the bottom-right (vs. top-left) of a package led to the package being perceived as heavier. Their reasoning was based on the learned association of the center of gravity and weight. Recasting their findings using the lens of stability, packaging that primed greater stability (product on bottom-right), were qualitatively judged as heavier. This demonstrated the literal consequence of visual cues, based on lay theories (or learned associations), on perceptions of weight.

A conceptual effect of visual cues and lay theories on related metaphorical judgments associated with weight, was shown by Koo and Suk (2016) who found that participants judged food contained in more elongated packages as having fewer calories than food in wider packages. Their explanation was based on the inference drawn from the schema that "elongated → slim."

In line with their findings, we predict that taller objects will be perceived to be lighter than their wider counterparts. However, we propose an alternate route for this effect: the lower stability of the elongated package, not the association with slimness. Physical weight judgments could translate into caloric judgments both literally, as well as metaphorically (e.g., higher-calorie foods are referred to as heavier, Romero and Biswas 2016).

In summary, these findings suggest that:

H1: More stable products are judged as heavier than less stable ones, *ceteris paribus*.

To our knowledge, this stability heuristic has not been demonstrated. It represents a bias, as the inverse relationship between stability and weight is not necessarily true (e.g., the Leaning Tower of Pisa is heavy but unstable, while a hat is very light yet stable).

***Boundary Conditions for the "Stable → Heavy" Heuristic***

The use of information to make a judgment is a function of its accessibility and diagnosticity, and an inverse function of the accessibility and diagnosticity of alternate inputs to make a judgment (Feldman and Lynch 1988; Menon, Raghubir, and Schwarz 1997). Accordingly, we propose four factors that affect the accessibility and diagnosticity of the "stable → heavy" heuristic: visual information cues, haptic cues, discrediting lay beliefs, and changing the relevance of the lay belief for the decision to be made. These are discussed next as moderating conditions.

*Accessibility of Visual Cues and the Elongation Bias*: Relative to a more elongated container, a less elongated one is more stable because it has a lower center of gravity and a larger supporting base. This implies that less elongated containers will be perceived to be heavier, and more voluminous. However, the well-documented elongation bias has shown that consumers tend to perceive a more elongated container as more voluminous than a less elongated one, even though the objective volume is held constant (Raghubir and Krishna 1999). Thus H1, that argues a less (vs. more) elongated container should be judged as heavier (e.g., more voluminous), is inconsistent with the elongation bias.

To resolve this seeming contradiction, we turn to the accessibility of information used to make a judgment, which is a function of the judgment task. Extant literature suggests that when individuals can infer multiple meanings from the same piece of information, their selection of a naïve theory is determined by "*the judgment task itself, which presumably recruits a relevant theory that can serve as an applicable inference rule*" (Schwarz 2004).

Consider metacognitive experience as an example. A person who finds it easy (difficult) to recall many examples of an event infers that (a) there are (aren't) many when asked about *frequency* (Menon and Raghubir 2003; Raghubir and Menon 1998; Schwarz et al. 1991); (b) the relevant events happened very recently (vs. a long time ago) when asked about *event dating* (Raghubir and Menon 2005; Schwarz 2003); and/ or (c) his or her memory for this information is good (vs. poor) when asked about *memory quality* (Weingarten and Hutchinson 2018; Winkielman, Schwarz, and Belli 1998).

Therefore, as the same shape characteristic of elongation might be linked to the perception of volume via the elongation bias (a positive effect), as well as the lay theory of the stability heuristic (a negative effect), we propose that the judgment task, itself, will lead individuals to use the theory that is the most accessible.

In other words, we suggest that the elongation heuristic is more likely to be activated when participants are asked to estimate volume, while the stability heuristic is more likely to come into play when the focal judgment is about weight. Given weight and volume are closely related, we further reason that once a volume or weight judgment is made, people do not go back to activate a different heuristic, but use information in the context to make their judgment – in this case, their response to the first question (Bröder and Schiffer 2006; Feldman and Lynch 1988; Levav, Reinholtz, and Lin 2012; Xu and Wyer 2007).

This reasoning has been supported by previous literature. Lin (2013), for example, shows that participants tend to use weight as a cue to estimate volume. We, therefore, propose question order as a boundary condition for both the stability heuristic and the elongation bias. Specifically, when weight judgments are made first, the stability heuristic (H1), should replicate while the elongation bias should reverse. On the other hand, when volume judgments precede weight judgments, the elongation bias should replicate, and the stability heuristic should reverse. Thus,

H2: Question order moderates H1, such that:

a. when weight judgments precede volume judgments, H1 replicates

b. when volume judgments precede weight judgments, H1 is reversed, and the elongation effect is replicated.

*Diagnosticity of Haptic Cues*: As haptic information is more diagnostic than visual information in weight judgments (Krishna 2006), and the use of information to make a judgment is a direct function of its accessibility and diagnosticity and an inverse function of the accessibility and diagnosticity of alternate sources of information (Feldman and Lynch 1988), we predict:

H3: H1 is attenuated when consumers have access to haptic information.

*Diagnosticity of Lay Belief*: Our prediction is built on the premise that consumers hold a "heavy → stable" lay belief. While this assumption was confirmed by the pretest, previous literature suggests that the individuals' lay beliefs can be contextually changed (e.g., "higher priced brands on top shelves," Valenzuela and Raghubir 2009). Such contextually forged lay beliefs can affect judgment and behaviors. For example, consumers who are primed with a lay theory that obesity is caused by a lack of exercise (a poor diet) consume more (less) (McFerran and Mukhopadhyay 2013). This implies that when participants are primed with evidence against the "heavy → stable" lay belief, H1 should be attenuated. More formally,

H4: H1 will be attenuated when the "heavy → stable" lay theory is weaker (vs. stronger).

*Changing the Relevance of the Lay Belief for the Decision to be Made*: Given the prediction that consumers hold a "stable → heavy" lay belief, the decision context can also lead to different choices being made as a function of whether consumers are shopping for a "heavy" or a "light" product. As Appendix A shows, there is wide variation in shapes in the yogurt market, and yogurts are either "regular" or "light." There would be convergent evidence for the presence of the "stable → heavy" belief if consumers would be more likely to choose a more (vs. less) stable product shape for a "regular" product as compared to a lower-calories "light" product. Formally, H5: The downstream consequence of H1 is moderated by the relevance of the lay belief for the decision to be made, that is, less stable (vs. more stable) products will be preferred when the context of "light" is activated.

## *OVERVIEW OF STUDIES*

We conducted eight studies to test our hypotheses. The first three studies 1A-1C provide evidence for our core effect – the stability heuristic (H1), using three product categories: tortilla chips, chocolate, and yogurt. Using an incentive-compatible paradigm, study 2 demonstrates the downstream effect on consumers' willingness to pay. Study 3 examines the relative accessibility of volume information versus stability information by using question order as a moderator (H2) to reconcile the stability heuristic with the elongation bias (Raghubir and Krishna 1999). The next two studies examine the predictions of diagnosticity of cues. They show that the effect is attenuated when participants have access to more diagnostic haptic information (H3; study 4), and when the diagnosticity of the lay belief is called into question (H4; study 5). Finally, study 6 examines the effect of the relevance of the lay belief: product choice between two brands of yogurt that differ in terms of their stability, when the context of "light" is (or is not) activated (H5).

Across studies, we operationalized stability in multiple ways including product orientation (studies 1A-1C), base size (studies 2 and 4), elongation (study 3), and center of gravity (studies 5 and 6) to demonstrate the robustness of the core construct of stability. A pretest for all studies ensured that the stimuli did not vary on other dimensions (e.g., perceived slimness, attention, height/ width salience, attractiveness, liking, novelty, and mood, see Web Appendix A).

Unless noted, all studies manipulate stability between-subjects where participants are assigned at random to the more stable and the less stable condition(s). Initial analyses are ANOVAs and are followed by contrast tests, and mediation analyses, when appropriate, using the PROCESS macro (Hayes 2013, with 5000 bootstrapping samples). A summary of the stimuli and main results is presented in Web Appendix B.

## *STUDY 1A: TORTILLA CHIPS*

Study 1A tests whether participants judge more stable objects as heavier than less stable ones, holding objective weight constant.

### *Method*

*Participants.* We recruited 90 participants (45 females, $M_{age}$ = 34.11, SD = 9.39) from Amazon's MTurk. Participants were told that the research was about consumers' perception of tortilla chips.

*Procedure.* All participants were presented with a picture featuring a tortilla chip. Following Rahinel and Nelson (2016), we manipulated stability by varying the orientation of the chip (Web Appendix B): upright (more stable condition) or right-leaning (less stable condition). After viewing the picture, all participants rated perceived weight using three 7-

point scales anchored at 1 (unsubstantial/ weightless/ feathery) and 7 (substantial/ weighty/ hefty; Deng and Kahn 2009), that were averaged to form a weight-perception index ($\alpha$ = .88).

***Results***

Participants perceived the tortilla chip to be heavier when it was upright ($M$ = 3.90, $SD$ = 1.28) versus right-leaning ($M$ = 3.35, $SD$ = 1.16; $F(1, 88)$ = 4.59, $p$ = .035, $d$ = .45), providing initial support for H1, the stability heuristic.

## *STUDY 1B: CHOCOLATE*

Study 1B attempts to rule out the possibility that previous results are attributable to idiosyncratic factors associated with the less stable stimulus by using two less stable conditions. It also aims to extend previous research by examining how shape stability affects calorie estimates. Drawing on previous studies showing that individuals associate the concept of heaviness with high caloric amount (Deng and Kahn 2009; Manippa, Giuliani, and Brancucci 2020; Romero and Biswas 2016), we examine if more (vs. less) stable shapes increase calorie estimates.

***Method***

*Participants.* In exchange for course credit, 240 undergrads (113 females, $M_{age}$ = 22.22, SD = 4.29) completed this study.

*Stimuli selection*. We used Hershey's Kisses chocolate as the stimulus. In the *more stable* condition, the chocolate was upright-oriented. In the *downward less stable* condition, it was downward-oriented. In the *left-leaning less stable* condition, it was rotated to being left-leaning (Web Appendix B; pretest results see Web Appendix A).

*Procedure.* Participants first saw a picture of Hershey's kisses. After viewing it, they rated how calorific the chocolate was (1 = very low; 7 = very high) as well as its perceived weight using the same three-item scale employed in studies 1A ($\alpha$ = .71).

***Results***

*Weight perception.* A one-way ANOVA on weight perception yielded a significant main effect of orientation ($F(2, 237) = 4.88$, $p = .008$, $d = .41$). Replicating study 1A, participants in the upright condition judged the chocolate to be heavier ($M = 3.03$, $SD = 1.33$) than the average of those in the downward less stable condition ($M = 2.63$, $SD = 1.13$) and the left-leaning less stable condition ($M = 2.43$, $SD = 1.19$; $t(237) = 2.95$, $p = .003$, $d = .41$), with the latter two conditions not significantly different ($t(237) = 1.07$, $p = .29$).

*Calorie estimate.* A similar one-way ANOVA on calorie perceptions revealed a significant main effect of orientation ($F(2, 237) = 3.66$, $p = .027$, $d = .35$). In line with our reasoning, participants in the upright condition judged the chocolate to have more calories ($M = 4.05$, $SD = 1.72$) than the average of those in the downward condition ($M = 3.44$, $SD = 1.79$) and the left-leaning condition ($M = 3.41$, $SD = 1.52$; $t(237) = 2.70$, $p = .007$, $d = .37$). There was no significant difference between the latter two conditions ($t(237) < 1$, $p > .80$).

*Mediation analysis.* To assess the mediating role of weight perception on calorie estimates, we conducted a mediation analysis (model 4). When both the independent variable (shape; 1 = less stable; collapsed the two less-stable conditions into one group; 2 = more stable) and the mediator (weight perception) were included in the model to predict calorie perceptions, the effect of weight perception was significant ($t(237) = 2.04$, $p = .043$, $d = .26$) whereas the direct effect of shape reduced in significance ($t(237) = 2.30$, $p$ value change from .004 to .023). Bootstrapping results indicate that the indirect effect is significant (B = .09; SE = .06; 95% CI = [.0082, .2474]).

## *STUDY 1C: YOGURT STUDY*

Study 1C was designed to examine robustness to product category, stability manipulation, to examine alternative explanations, and directly test the mediating role of stability perceptions on weight perceptions.

### *Method*

*Participants.* Ninety MTurkers (42 females, $M_{age} = 35.22$, SD = 10.65) participated in exchange for a small monetary reward.

*Procedure.* Participants were shown a picture of yogurt. We operationalized stability by varying the position of the center of gravity and the size of the base area. Specifically, participants in the more stable condition saw a picture of a regular Yoplait yogurt container while those in the less stable condition saw a reversed container that has a relatively higher center of gravity and smaller base area (Web Appendix B).

After viewing the picture, all participants reported their weight perception of the yogurt on the same three-item scale used in studies 1A and 1B ($\alpha = .66$), and rated the perceived stability of the yogurt using two items: "The yogurt appears to be very stable," "The yogurt is likely to fall over (reverse coded)" (1 = strongly disagree; 7 = strongly agree; $r = .55$). We also asked participants to indicate familiarity (How familiar are you with this yogurt package; 1 = not familiar at all, 7 = very familiar), perceptions of novelty (How novel is this yogurt package; 1 = not novel at all, 7 = very novel), and attention (The yogurt package captures my attention/ This yogurt package is attention getting; $r = .95$; 1= not at all, 7 = definitely; Hagtvedt and Brasel 2017).

***Results and Discussion***

*Stability perception.* A one-way ANOVA on perceived stability showed a significant main effect ($F(1, 76.311) = 6.51$, $p = .013$, $d = .54$),[1] with the regular Yoplait container rated as more stable ($M = 5.96$, $SD = .95$) than the reversed version ($M = 5.32$, $SD = 1.37$).

*Weight perception and mediation.* The yogurt judged to be more stable was perceived to be heavier ($M = 4.16$, $SD = .90$) than the one judged to be less stable ($M = 3.70$, $SD = 1.03$; $F(1, 88) = 5.14$, $p = .026$, $d = .48$). A mediation analysis (model 4), showed that the effect of container shape on weight perceptions was via stability judgments (indirect effect: B = .10; SE = .07; [.0092, .2824]).

*Eliminating alternative explanations*. A series of ANOVAs on perceived familiarity ($F < 1$, $p = .85$), novelty ($F(1, 88) = 1.31$, $p = .26$), and attention ($F < 1$, $p = .94$) did not reveal significant differences. Mediation tests (Model 4) showed no significant indirect effects for perceived familiarity (95% CI: [-0.0553, 0.1055]), novelty (95% CI: [-0.0268,

[1] In this and later studies, we used a Brown-Forsythe test because of the violation of equality of variance (Brown and Forsythe 1974).

0.2088]), or attention (95% CI: [-0.1550, 0.1344]). Finally, the effect of stability on weight perception remains significant when including these factors as covariates in an ANCOVA ($F(1, 85) = 5.70$, $p = .019$, $d = .52$).

***Discussion***

Collectively, studies 1A-1C support the core proposition (H1) that greater shape stability results in greater weight perceptions. These findings are triangulated through using three product categories, three different operationalizations of shape stability, two different weight measures, and a direct measure of mediation via stability perceptions.

## ***STUDY 2: WILLINGNESS TO PAY***

Study 2's goal is to examine the downstream consequence of the effect of shape stability on weight judgment using an incentive-compatible paradigm. We solicited participants' willingness to pay (WTP) using a modified BDM mechanism to assess their unbiased and true WTP (Becker, Degroot, and Marschak 1964; Wertenbroch and Skiera 2002). We predict that, since product heaviness often means a larger quantity, participants' WTP should be higher when the shape is more (vs. less) stable. In addition, we also predict that it is weight perception that mediates the effect of shape stability on WTP.

***Method***

*Participants.* One hundred and four consumers (61 females, $M_{age} = 30.98$, ranging from 17 to 64 years, SD = 8.49) recruited from a professional market research agency participated in this online study in exchange for a small monetary reward.

*Procedure.* Participants were shown a picture of a trapezoidal box of chocolate. To mimic a real purchase scenario, the picture featured a person holding the product in their hands and the height of the box (12 cm) was marked. Participants in the more stable condition saw a picture of a box of larger base while those in the less stable condition saw a reversed box that has a smaller base (Web Appendix B).

After viewing the picture, all participants in the main study were asked to estimate product weight (in grams) with reference information that an egg is about 50-60 grams. Next, we solicited participants' WTP using an incentive-compatible BDM lottery. Specifically, participants were told that as a reward for their participation, ten participants would receive a 100 RMB reward (≈ $15; $1≈RMB 7.04) on a lottery basis and the money could be used to purchase the chocolate. Following Fuchs, Schreier, and Van Osselaer (2015), we asked participants to indicate the maximum price they were willing to pay for the chocolate, using a sliding scale (0 RMB - 100 RMB). Participants were told that the selling price of the chocolate would be randomly determined by drawing a price from a box (X). If their stated maximum WTP (Y) was lower than the randomly drawn price (Y < X), they could not buy the chocolate; whereas if their WTP was higher than the randomly drawn price (Y > X), they could receive the chocolate and the left-over money: 100 RMB - X). This paradigm has been demonstrated to truthfully reveal participants' maximum WTP (Fisher, Newman, and Dhar 2018; Wertenbroch and Skiera 2002).

***Results and Discussion***

*Weight perception.* Because weight estimates were collected using an open-ended format, following prior work (Koo and Suk 2016; Krishna 2006), we excluded three responses that deviated from the mean by +3 SDs from the main analysis (Descriptive analysis of the outliers in this and the following studies are shown in Web Appendix C). A one-way ANOVA revealed a significant effect of shape stability ($F(1, 70.734) = 4.59$, $p = .036$, $d = .44$), such that the more stable chocolate ($M = 240.00$ grams, $SD = 177.69$) was perceived to be heavier than the less stable one ($M = 173.61$ grams, $SD = 117.49$).

*WTP.* In parallel, another one-way ANOVA on WTP yielded a significant main effect ($F(1, 99) = 4.25$, $p = .042$, $d = .41$), showing that participants indicate a higher WTP for the more stable chocolate ($M = 59.09$ RMB, $SD = 22.85$) than the less stable one ($M = 49.84$ RMB, $SD = 21.98$). Mediation results (model 4), indicate that the effect of shape on WTP is entirely via weight perceptions (B = 2.90; SE = 1.73; 95% CI = [.3286, 7.1030]).

*Discussion.* Employing an incentive-compatible setting, study 2 replicates and extends study 1 results, by showing the downstream consequence of stability on participants' WTP. Weight perceptions mediate the effect of shape stability on WTP.

The next three studies examine the underlying mechanism using the accessibility and diagnosticity of the visual cue of stability, and the accessibility and diagnosticity of alternate sources of information to make the same judgment.

## ***STUDY 3: THE ACCESSIBILITY OF STABILITY VERSUS VOLUME JUDGMENTS: RECONCILING THE STABILITY HEURISTIC AND THE ELONGATION BIAS***

Study 3 serves two purposes. First, we use a different operationalization of stability by manipulating the elongation of a package. Second, we aim to manipulate the accessibility of stability cues through question order, with the goal of identifying boundary conditions for the stability heuristic. A spill-over effect of this goal is to assess if we can reconcile the seeming inconsistency between the predictions of the stability heuristic and the elongation bias (Raghubir and Krishna 1999) by showing when the stability effect will obtain and when it will reverse into an elongation effect (H2).

***Method***

*Participants and design.* In return for a small monetary payment, 101 participants (35 females, $M_{\text{age}} = 34.22$, SD = 11.11) recruited from MTurk were assigned at random to conditions in a 2 (bottle shape: less elongated vs. more elongated) × 2 (question order: weight first vs. volume first) mixed factorial design. Bottle shape was a within-subjects factor, while question order was a between-subjects factor.

*Procedure.* Participants first viewed a picture of two bottles of orange juice adapted from Koo and Suk (2016). One of the bottles is less elongated while another is more elongated, but they have the same volume and the same weight (Web Appendix B). The order of presentation of the two bottles was counterbalanced. In the *weight first* condition, participants first estimated the weight of the two bottles respectively in grams with the reference information that a Coke can is about 366 grams (Krishna 2006). After the weight judgments, they estimated the volume of the two bottles, one by one, in fluid ounces (fl. oz.), with reference information that the volume of a Coke can is 12 fl. oz. In the *volume first* condition, the order of the measures was reversed. As both weight and volume estimates were elicited using open-ended ratio-scale measures, six outliers outside the range (Mean ±3 SD) were excluded from the analysis.

***Results and Discussion***

*Estimations.* We separately submitted participants' weight and volume estimates to a 2 × 2 repeated measures ANOVA including bottle shape as a within-subjects factor and question order as a between-subjects factor. These analyses revealed significant interaction effects for both weight estimates ($F(1, 93) = 9.86$, $p = .002$, $d = .65$; Figure 1a) as well as for volume estimates ($F(1, 93) = 11.53$, $p = .001$, $d = .70$; Figure 1b).

Contrast analyses showed that in the *weight first* condition, the stability effect replicated: the less elongated bottle ($M = 363.16$ grams, $SD = 132.35$) was judged as heavier than the more elongated bottle ($M = 348.33$ grams, $SD = 115.21$; $F(1, 93) = 5.33$, $p = .023$, $d = .48$). In this condition, the elongation bias reversed, such that the less elongated bottle ($M = 15.43$ fl. oz., $SD = 6.62$) was perceived to be more voluminous than the more elongated one ($M = 14.63$ fl. oz., $SD = 5.22$; $F(1, 93) = 4.94$, $p = .029$, $d = .46$).

The opposite pattern of results is evident in the *volume first* condition. The elongation bias replicated, such that participants estimated the more elongated bottle ($M = 13.82$ fl. oz., $SD = 5.44$) to be more voluminous than the less elongated one ($M = 12.82$ fl. oz., $SD = 5.35$; $F(1, 93) = 6.60$, $p = .012$, $d = .53$). Further, as predicted, the stability heuristic reversed: the more elongated bottle ($M = 359.32$ grams, $SD = 126.27$) was perceived as heavier than the less elongated one (*M* = 344.50 grams, *SD* = 137.86; $F(1, 93) = 4.59$, $p = .035$, $d = .44$).

[Insert Figure 1 about here]

*Discussion.* Study 3 replicated the stability heuristic when weight perceptions were elicited first, and the elongation bias when volume perceptions were elicited first. The carry-over effects of the first judgment made on the second judgment led to reversals of the stability heuristic in the volume-first condition and the reversal of the elongation bias in the weight-first condition. These findings add to the literature on volume perceptions and the elongation bias (Raghubir and Krishna 1999), while also demonstrating questionnaire carry-over effects in sensory perceptions (Schwarz 1999). The next two studies turn to examining the diagnosticity of visual information as a cue to make weight judgments. Study 4 now goes on to examine the effect of an alternative source of information that is accessible and diagnostic: haptic input (Krishna 2006).

## *STUDY 4: VISUAL VS. HAPTIC INPUT*

Study 4 was designed to test H3. Specifically, we predict that the stability heuristic should be attenuated when participants have access to haptic information.

### *Method*

*Participants and design.* We recruited 124 undergraduates (82 females, $M_{age} = 21.50$, SD = 2.41) from a public university in return for a small payment. They were assigned at random to one of four conditions using a 2 (shape stability: more stable vs. less stable) × 2 (type of input: visual information cue vs. haptic information cue) between-subjects design.

*Procedure.* Upon arrival, all participants were directed to sit near a table. They were asked to estimate the weight of a paper box filled with chocolate balls. The box looked either more or less stable. The two paper boxes were custom-made by a professional packaging service for the study. In the more stable condition, the trapezoidal box had a 72mm*72mm top area and a 92mm*92mm bottom area. The less stable one is the reversed version, except that the box still opens on the top (Web Appendix B).

In the *visual information cue* condition, participants were asked to view the box from all angles but were prohibited from touching or lifting it. In the *haptic information cue* condition, the box was placed on the table covered by a brown tablecloth and was taken out after participants had been blindfolded. Participants were asked to lift the box (Krishna 2006). All participants were instructed to estimate the weight of the box in grams with reference information that an egg is about 50-60 grams. As an attention check, we also told participants that the chocolate box was heavier than the egg. To increase participants' motivation to make their best estimate, we informed all participants that the participant whose estimate was closest to the actual weight would win 50 RMB (≈ $7.5 USD).

***Results***

The actual weight of the box was 170 grams. Participants' estimates ranged from 35 to 800 grams, with an average of 194.98 (SD = 126.95) grams. Using the same screening criterion (Koo and Suk 2016; Krishna 2006), we excluded ten responses from further analyses, 3 of which deviated from the mean +3 SD and 7 who failed the attention check (estimate≤50 gms), leaving 114 participants in the final sample. Participants' weight estimates were submitted to a 2 (shape: more stable vs. less stable) × 2 (type of input: visual information cue vs. haptic information cue) ANOVA. This analysis revealed a significant main effect of shape stability ($F(1, 110) = 9.69$, $p = .002$, $d = .59$) such that participants in the more stable condition estimated the box to be heavier ($M = 218.19$ grams, $SD = 118.39$) than those in the less stable condition ($M = 164.46$ grams, $SD = 67.05$).

This main effect was qualified by a marginally significant interaction with type of input ($F(1, 110) = 3.52$, $p = .063$, $d = .36$). Follow-up contrasts showed that when the input to the decision was visual, participants estimated the more stable box ($M = 249.26$ grams, $SD = 122.36$) to be heavier than the less stable one ($M = 160.17$ grams, $SD = 53.09$; $F(1, 110) = 12.25$, $p = .001$, $d = .67$), replicating previous results. In contrast, when the input to the decision was haptic, participants' weight estimates did not significantly differ between the more stable ($M = 191.13$ grams, $SD = 109.68$) and the less stable box ($M = 169.07$ grams, $SD = 80.19$; $F < 1$, $p = .38$).

***Discussion***

The pattern of the results of this study are consistent with the idea that people's weight estimates are based on the visual stability of a container when they do not have other diagnostic information to make their judgment. It is possible that the marginal interaction was due to lower sample size in this study compared to other studies run. To garner additional evidence for the effect of the perceived diagnosticity of the lay theory, study 5 manipulates this directly.

## *STUDY 5: MANIPULATING THE DIAGNOSTICITY OF THE LAY THEORY*

Study 5 examines the effect of changing the perceived diagnosticity of the "heavy → stable" intuition. When the diagnosticity is lower because the intuition or lay belief is called into question, the stability effect should be attenuated (H4).

### *Method*

*Participants and design.* In exchange for course credit, 235 undergraduates (111 females, $M_{age} = 22.38$, SD = 4.56) were assigned at random to four conditions in a 2 (shape stability: more stable vs. less stable) × 2 (lay theory: support vs. against) between-subjects design.

*Procedure.* The study was divided into two parts. Participants first completed a lay theory manipulation task disguised as a "reading comprehension study." Depending on the condition, they were given a short paragraph titled either "Heavier objects are more stable" (*support lay theory* condition) or "Heavier objects are not always more stable" (*against lay theory* condition; see Appendix B). The paragraph contained evidence consistent with the title. After reading the paragraph, all participants were asked to summarize the article in one sentence. As a manipulation check, participants indicated the extent to which they agreed or disagreed with the same two statements that were used in the pretest (Rahinel and Nelson 2016; $r = .56$).

In the second part of the study, participants proceeded to an ostensibly unrelated laptop perception study. They were presented with a picture of a laptop which appeared as either more or less stable (Web Appendix B). After viewing the laptop, participants indicated their weight perception using the same three-item scale used in study 1 ($\alpha = .87$).

***Results and Discussion***

*Manipulation check.* A 2 × 2 ANOVA on the general lay theory measurements yielded only a main effect of lay theory manipulation ($F(1, 231) = 101.07$, $p < .001$, $d = 1.32$). Participants in the *support lay theory condition* ($M = 5.45$, $SD = 1.17$) indicated stronger agreement with the "heavy = stable" intuition than those in the *against lay theory condition* ($M = 3.74$, $SD = 1.39$). No other effects were significant ($F$s < 1, $p$s > .79). T-tests against the scale mid-point revealed that participants reported a "heavy = stable" lay belief in the *support lay theory* condition ($M = 5.45 > 4$; $t(234) = 14.34$, $p < .001$, $d = .94$), but not in the *against lay theory* condition ($M = 3.74 < 4$; $t(234) = -2.57$, $p = .011$, $d = .17$). Thus, the manipulation worked as intended.

*Weight perception.* A 2 (shape stability: more stable vs. less stable) × 2 (lay theory: support vs. against) ANOVA on weight perception yielded only a significant interaction effect ($F(1, 231) = 7.06$, $p = .008$, $d = .35$). Neither the main effect of shape stability ($F < 1$, $p = .80$) nor the main effect of lay theory ($F(1, 231) = 2.02$, $p = .16$) was significant.

Consistent with our prediction, and replicating previous results, when participants were primed with the "heavy = stable" lay theory, they perceived the more stable laptop ($M = 5.18$, $SD = 1.17$) to be heavier than the less stable one ($M = 4.66$, $SD = 1.27$; $F(1, 231) = 3.97$, $p = .048$, $d = .26$), but this effect was eliminated, and directionally reversed in the *against lay theory* condition (More stable $M = 4.45$, $SD = 1.46$ vs. less stable $M = 4.88$, $SD = 1.53$; $F(1, 231) = 3.10$, $p = .079$, $d = .23$).

*Discussion.* Study 5 directly manipulated the diagnosticity of the "heavy = stable" lay theory. The successful attenuation of the belief is consistent with the idea that the effect is due to conscious and controllable processes (Valenzuela and Raghubir 2015), rather than being non-conscious, as some biases due to visual cues have been shown to be (Raghubir and Krishna 1996).

Taken together, studies 4-5 provided triangulating process evidence of how the relative diagnosticity of the "heavy = stable" lay belief affects weight perception, showing that the effect is attenuated when other diagnostic haptic, rather than visual, cues are available as inputs for judgment (study 4), and the belief is discredited (study 5). We finally examine if these effects are contingent on product type.

## *STUDY 6: PRODUCT CHOICE*

The last study aimed to investigate a boundary condition for the downstream consequence of our findings, that is, valence of weight (H5). Specifically, heaviness could be either a positive (e.g., rich and creamy whole-milk yogurt) or a negative (e.g., light and low-fat yogurt) attribute for the same product. According to our theorizing and previous findings, more stable (less stable) packages should be preferred for the whole-milk (low-fat) yogurt. Participants were led to believe that they had a chance to get their preferred option and were later debriefed.

***Method***

*Participants and design.* We recruited 114 participants (60 females, $M_{age}$ = 37.98, SD = 11.45) from MTurk. They were assigned at random to either the heaviness is positive or heaviness is negative condition.

*Procedure.* Depending on condition, participants were informed that Wallaby and Green Mountain are two yogurt brands, both of which produce and sell either rich and creamy yogurt made with whole milk (heaviness is positive condition) or healthy and low-fat yogurt made with 2% milk (heaviness is negative condition). The order of presentation of the two yogurts was counterbalanced. To reveal true consumer preference, we informed all participants that the two brands were now offering free samples to selected consumers and collecting their feedback. But due to limited quantity, only some participants would receive these samples and each person could only receive one of them. They were asked to choose between two yogurts: one option featuring a more stable package (i.e., a relatively lower center of gravity) whereas the other featured a less stable package (i.e., a relatively higher center of gravity; Web Appendix B). The two options had the same volume (5.3 oz.). All participants were told that if they were selected, we would ship their chosen option to them. After making their choice, participants were asked to respond to the manipulation check: "Considering the yogurt positioning, to what extent do you think heaviness is a positive attribute?" (1 = not at all; 7 = very much).

***Results and Discussion***

*Manipulation check.* A significant main effect from a one-way ANOVA ($F(1, 112) = 4.55$, $p = .035$, $d = .40$) showed that participants in the whole-milk yogurt condition ($M = 4.03$, $SD = 1.64$) were more likely to report heaviness as a positive attribute than those in the low-fat yogurt condition ($M = 3.39$, $SD = 1.58$). In addition, two one-sample t-tests revealed that participants, indeed, perceive heaviness as a less positive attribute in the low-fat yogurt condition ($M = 3.39 < 4$; $t(113) = -3.98$, $p < .001$, $d = .37$). However, there was no significant difference between the whole-milk yogurt condition and the mid-point ($M = 4.03 > 4$; $t(113) = .20$, $p = .84$). These results suggest that the weight valence was manipulated successfully.

*Choice.* We expected the choice share of the more stable Wallaby (vs. less stable Green Mountain) yogurt to be greater when the yogurt is whole milk versus low-fat. Supporting this prediction, participants in the heaviness is positive condition (i.e., whole-milk yogurt) were more likely to choose the more stable Wallaby yogurt (43/60 or 71.7%) than those in the heaviness is negative condition (i.e., low-fat yogurt) (26/54 or 48.1%; $\chi^2(1) = 6.58$, $p = .010$). Thus, study 6 provides further evidence for the stability heuristic and shows its downstream effect on product preference in a consequential setting.

## ***GENERAL DISCUSSION***

This research examined the proposition that consumers rely on shape stability as a heuristic for weight judgments. Specifically, objects that look more stable are judged to be heavier than less stable ones. Eight studies support this proposition, demonstrate the psychological mechanism underlying this effect, and identify several theoretically-derived boundary conditions. It merits mention that our findings are triangulated on a wide variety of product categories (e.g., chips, yogurt, chocolate, bottled juice, and laptop), different weight measures and scales (e.g., Likert scales, open-ended ratio-scales for grams and calories, sliding scales for PWP, choice), multiple operationalizations of stability (e.g., product orientation, elongation, center of gravity), and in two countries (e.g., the U.S. and China). The results of a mini meta-analysis (Goh, Hall, and Rosenthal 2016) using results from studies 1A-1C and study 2 (which focus on the main effect) as well as the conditions where the between-subjects designed stability heuristic effect is expected in studies 4 and 5 (i.e., the visual cue condition in study 4, and the support lay theory condition in study 5) show that the mean effect size is in the small-to-medium range and significant ($d$ = .48, $SE$ = .08, $Z$ = 5.99, $p$ < .001).

***Theoretical Implications***

This research makes several contributions to the literature.

*Weight perceptions.* First, we find a novel visual heaviness effect that more stable objects are judged to be heavier than less stable ones, and that this increased perceived heaviness affects downstream outcomes such as the calorie judgment and WTP. In doing so, this research informs the classic marketing literature on weight judgments that has recently seen renewed interest (Charpentier 1891; Deng and Kahn 2009; Dresslar 1894; Sunaga et al. 2016; Wolfe 1898). This literature has identified a number of factors affecting consumers' weight perceptions. For example, Deng and Kahn (2009) found that participants perceived products to be heavier when images were placed at the bottom (vs. top) on the package. They proposed that this location effect may be due to top-light and bottom-heavy correspondence: light objects, such as balloons, float upward, while gravity pulls heavy objects to the ground. While previous studies have focused on contextual factors, the present work shows how shape stability, which is an endogenous property of the object, can affect consumer weight judgments.

*Elongation bias.* Second, this work extends the elongation bias literature by identifying a new boundary condition for this well-established finding. Previous literature has investigated other boundary conditions for this effect. For example, Krishna (2006) showed that when participants are blindfolded or under visual load, the elongation bias is reversed as the width is more salient than height. Similarly, Folkes and Matta (2004) argued that people perceived thicker and irregular shaped objects to be more voluminous than thinner, regular ones because the former attract more attention. Extending this body of research, we reversed the elongation bias when weight estimates were made prior to volume estimates. Collectively, this work and prior research provide a more nuanced understanding of the elongation bias and, more broadly, how people estimate volume.

*Effect of shape stability.* In addition, this research also contributes to the research on shape stability which is a practically relevant shape property. In the one prior investigation of shape stability, Rahinel and Nelson (2016) found that an unstable-looking (vs. stable-looking) logo increases perceptions of an unsafe environment, which in turn increased participants' preference for safety-oriented products (e.g., hand sanitizer). The current inquiry suggests that stability can affect not only qualitative, but also quantitative judgments, such as weight in grams, calories and WTP.

*Integrating prior findings.* Further, stability is a relatively broad construct, which has the potential to integrate multiple other shape properties such as elongation, dynamism, completeness, and symmetry. Specifically, according to the definition of stability (Cholewiak, Fleming, and Singh 2015; Grimshaw et al. 2004; Whiting 2018), the more elongated, dynamic, incomplete, or asymmetric the shape, the less stable it is. Therefore, the current theorizing might have the potential to account for some earlier findings.

For example, Koo and Suk (2016) found that container elongation decreases calories perceptions such that the same amount of food packaged in a shorter container is perceived to be more caloric than that in a taller bottle, because of the association between a taller container and skinny body shape. We propose that the effect may additionally be due to the stability heuristic. For another example, Sevilla and Kahn (2014) demonstrated that participants perceived incompletely shaped foods as smaller, which in turn increases their consumption quantities. We propose a new lens to recast the finding that the incompletely (i.e., unstable) shaped food may lead to a lower weight perception and, thus, greater consumption quantities.

*Cross-modal sensory perceptions.* The current work contributes to the growing body of literature on sensory marketing, testifying to the robustness and generalizability of cross-modal influences (Krishna and Morrin 2008; Lowe and Haws 2017; Lwin et al. 2016). For instance, Krishna and Morrin (2008) showed that haptic cues can affect taste judgments:

participants evaluated water served in a firm cup to be tastier than water served in a flimsy cup. In another example, Lowe and Haws (2017) delineated the cross-modal correspondence between sound and vision, revealing that higher pitch sounds can reduce size perceptions. Notably, our work enriches this line of literature by demonstrating how the stability of different visual inputs can influence haptic (weight) judgments.

*Accessibility-diagnositicity framework.* Beyond visual information and sensory judgments, the paper adds to the literature on the manner in which consumers integrate contextual cues as a function of their accessibility and diagnosticity, in the domain of sensory perceptions. It adds to the literature on question order carry-over effects (Schwarz 1999), by showing how weight and volume judgments can reverse as a function of order-of-elicitation.

***Managerial Implications***

By providing a more nuanced understanding of how package shapes affect consumer perceptions, this research has implications for practitioners. Specifically, depending on the specific situation, marketers can strategically employ corresponding shape characteristics to communicate certain product attributes or benefits more effectively. For example, under circumstances where heaviness is a positive attribute (e.g., full fat yogurt, cast iron cookware or floor-standing speaker), it might be advantageous to use design packages, and/ or advertising images that are visually more stable. In contrast, when consumers prefer lightness (e.g., light yogurt, laptops), it might be better to include less stable elements in marketing design and communications. Given that the same shape might lead to divergent outcomes depending on which judgment (weight or volume) is made first (study 3), marketers need to understand which type of judgment is the most salient when consumers make decisions, which are likely to be product and context specific.

Our findings may also have implications for several types of consumer judgments that are conceptually connected with weight such as calorie estimates, PWP, and choice.

In terms of calorie perceptions, we suggest that if marketers want to associate their products with lightness and healthiness (rather than heaviness), employing less visually stable elements would be helpful (Study 6). Interestingly, this intuition appears to be consistent with actual practice (Appendix A).

Prior literature has shown that individuals tend to judge an issue to be more important when it is associated with physical heaviness (Jostmann et al. 2009). Following this logic, our results would imply that when marketers want to emphasize an important message, it might be more effective to use bold rather than italic fonts (Jostmann et al. 2009; Proffitt et al. 2003). However, this is an area for future research which we turn to next.

***Future Research***

Weight judgment is an area that has not yet received much attention in the marketing literature, as compared to other quantity assessments such as *magnitude* (Coulter and Coulter 2005; Coulter and Norberg 2009; Thomas and Morwitz 2009), *size* (Hagtvedt and Brasel 2017; Krider, Raghubir, and Krishna 2001; Sevilla and Kahn 2014), and *volume* (Folkes and Matta 2004; Raghubir and Krishna 1999) judgments. The current studies examined the role of shape stability. Future investigations could investigate other factors that influence weight judgments in line with Kahn, Deng, and Krishna's (2010) suggestions, including depth (i.e., front vs. back), curve (i.e., concave vs. convex), and moving direction (e.g., inward vs. outward).

Future research could also examine the external validity of the current findings. Would the effects hold in the presence of objective weight information? The answer would depend on how much attention is paid to product labels. Krukowski et al. (2006) estimated that 44% to 57% of participants do not use the label information.

Even when consumers pay attention to weight information, they may not have the capability to accurately interpret it. For example, studies show that participants misestimate the 50 grams Mini Oreo Cookies labeled as a small package contain fewer cookies than the 30 grams one which is labeled as large (Aydinoğlu and Krishna 2011). These findings imply that the stability heuristic may still be used when weight information is provided, but is a question that remains to be empirically tested.

In addition, when consumers have multiple cues to make weight judgments, the extent to which the effect of stability will emerge may also depend on individual and contextual differences. Take style of processing (visual vs. verbal) for instance. Because visualizers prefer processing visual information while verbalizers tend to process information semantically (Childers, Houston, and Heckler 1985), the effects may be more pronounced among individuals who are prone to visual-processing and mitigated among verbalizers. These are interesting questions for future research.

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**Figure 1: Results of Weight and Volume Estimations (Study 3)**

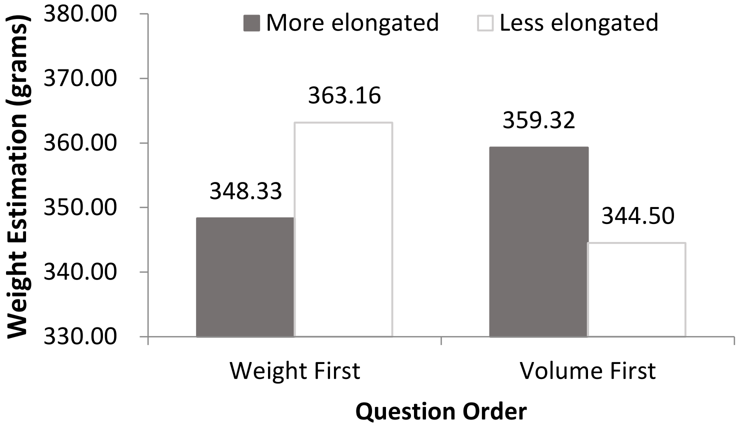



Figure 1a: Weight estimation

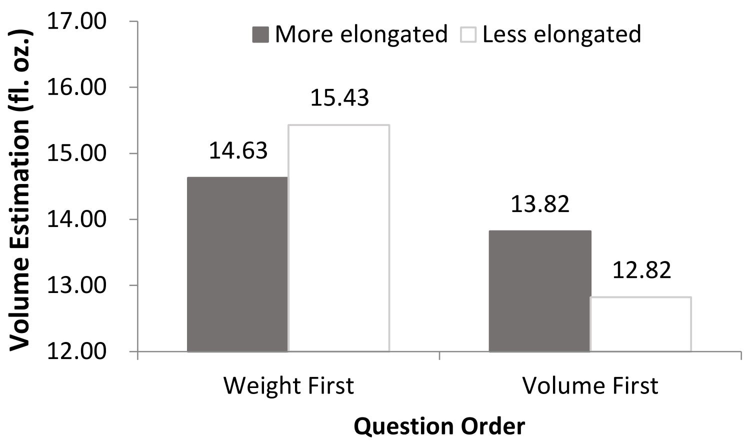



Figure 1b: Volume estimation

## Appendix A: Real-World Examples Supporting Our Findings


**Fast Food Brands Logo Changes**


**Example of Variations in Yogurt Containers in the Marketplace**

## Appendix B: Lay Theory Manipulation in Study 5

- **Support the "heavy = stable" lay theory condition:**

The heavier objects are more stable

Current research shows that the weight of objects positively influences their stability!
Weight is a force caused by gravity. This force is F = mg, where m is mass of body and g is acceleration due to gravity. Basing on the law of gravity, the heavy objects with strong gravity are close to the ground, thus increasing their stability. For example, the heavy stones are stable, while the light balloons are unstable.

- **Against the "heavy = stable" lay theory condition:**

The heavier objects are not always more stable

Current research shows that the weight of objects does not influence their stability, they are spuriously related!
Weight is a force caused by gravity. This force is F = mg, where m is mass of body and g is acceleration due to gravity. Weight has little to do with stability. For example, the Leaning Tower of Pisa is very heavy but unstable, while a bathmat is very light yet stable.

## Web Appendix A: Measures and Results of Constructs in All Pretests

### (1) Measures of Constructs in All Pretests:

*Perceived stability*[1] (1 = strongly disagree; 7 = strongly agree)
The XX appears to be very stable.
The XX is likely to fall over (reverse coded).

*Perceived slimness* (1 = not at all; 7 = very)
To what extent do you think the XX is associated with slimness?

*Attention*[2] (1 = strongly disagree; 7 = strongly agree)
The XX captures my attention.
The XX is attention getting.

*Height salient* (1 = not at all; 7 = very)
To what extent do you think the height of the XX is salient?

*Width salient* (1 = not at all; 7 = very)
To what extent do you think the width of the XX is salient?

*Attractiveness* (1 = not attractive at all; 7 = very attractive)
How attractive do you think the XX is?

*Liking* (1 = not at all; 7 = very much)
How much do you like this XX?

*Novelty* (1 = not novel at all; 7 = very novel)
How novel is this XX?

*Mood*[3] (1 = negative/unhappy; 7 = positive/happy)
How did you feel when seeing the product image?

***Note.*** correlation coefficients ($r$) in *perceived stability, attention, and mood.*

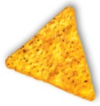
1: *Perceived stability*: $r$ =.56, .53, .55, .57, .67, .56, .57, .55 respectively in study 1A, 1B, 1C, 2, 3, 4, 5, 6.

2: *Attention*: $r$ =.94, .79, .87 .79, .89, .88, .88, .93 respectively in study 1A, 1B, 1C, 2, 3, 4, 5, 6.

3: *Mood*: $r$ =.94, .82, .88, .71, .87, .91, .88, .87 respectively in study 1A, 1B, 1C, 2, 3, 4, 5, 6.

### (2) Results of All Pretests:

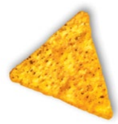
**Table**

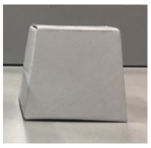
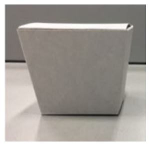
| | Study 1A (Tortilla Chips, N = 51) | | | | Study 1B (Chocolates, N = 76) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Constructs |  M (SD) |  M (SD) | F-value | *p* |  M (SD) |  M (SD) |  M (SD) | F-value | *p* |
| Stability | 5.66 (1.54) | 4.66 (1.62) | 5.00 | .03 | 5.54 (1.33) | 3.10 (1.48) | 3.50 (1.85) | 17.63 | <.001 |
| Slimness | 2.69 (1.79) | 3.14 (2.03) | .69 | .41 | 2.88 (1.90) | 3.08 (2.22) | 2.85 (2.09) | .09 | .91 |
| Attention | 4.76 (1.88) | 3.98 (1.80) | 2.25 | .14 | 5.37 (1.28) | 5.06 (1.35) | 5.23 (1.54) | .30 | .75 |
| Height salient | 4.10 (1.78) | 3.59 (1.76) | 1.05 | .31 | 4.27 (1.64) | 4.29 (1.71) | 4.38 (1.36) | .04 | .96 |
| Width salient | 4.21 (1.70) | 4.05 (1.70) | .11 | .74 | 5.04 (1.22) | 4.21 (1.59) | 4.62 (1.30) | 2.29 | .11 |
| Attractiveness | 4.72 (1.98) | 3.91 (1.93) | 2.17 | .15 | 5.38 (1.24) | 5.42 (1.28) | 5.38 (1.36) | .005 | 1.0 |
| Liking | 5.24 (1.70) | 4.32 (2.06) | 3.07 | .09 | 5.31 (1.74) | 5.21 (1.35) | 5.58 (1.50) | .39 | .68 |
| Novelty | 2.97 (2.03) | 3.36 (1.92) | .51 | .48 | 4.46 (1.58) | 4.04 (1.83) | 4.62 (2.06) | .65 | .53 |
| Mood | 5.41 (1.26) | 4.82 (1.68) | 2.10 | .15 | 6.10 (.82) | 5.60 (1.05) | 5.67 (1.29) | 1.57 | .21 |
| | Study 1C (Yogurts, N = 102) | | | | Study 2 (Boxes of chocolate, N = 98) | | | | |
| |  M (SD) |  M (SD) | F-value | *p* |  M (SD) |  M (SD) | | F-value | *p* |
| Stability | 6.16 (.99) | 4.61 (1.64) | 33.84 | <.001 | 5.20 (1.06) | 4.64 (1.41) | | 4.96 | .029 |
| Slimness | 3.82 (1.55) | 3.79 (1.70) | .01 | .92 | 3.12 (1.50) | 3.18 (1.48) | | .04 | .84 |
| Attention | 4.71 (1.48) | 4.78 (1.42) | .06 | .81 | 5.00 (1.20) | 5.12 (1.17) | | .26 | .61 |
| Height salient | 4.12 (1.29) | 4.04 (1.24) | .11 | .75 | 4.51 (1.58) | 4.35 (1.45) | | .28 | .60 |
| Width salient | 4.10 (1.46) | 3.79 (1.36) | 1.24 | .27 | 4.88 (1.27) | 4.47 (1.43) | | 2.23 | .14 |
| Attractiveness | 5.04 (1.44) | 4.63 (1.47) | 1.98 | .16 | 4.98 (1.22) | 4.96 (1.32) | | .01 | .94 |
| Liking | 5.40 (1.44) | 4.94 (1.60) | 2.29 | .13 | 4.98 (1.18) | 5.18 (1.30) | | .66 | .42 |
| Novelty | 3.94 (1.73) | 3.98 (1.57) | .02 | .90 | 4.73 (1.29) | 4.55 (1.28) | | .50 | .48 |
| Mood | 5.61 (1.11) | 5.03 (1.37) | 5.49 | .02 | 5.60 (.97) | 5.39 (.95) | | 1.23 | .27 |
| | Study 3 (Bottles, N = 96) | | | | Study 4 (Paper Boxes, N = 101) | | | | |
| |  M (SD) |  M (SD) | F-value | *p* |  M (SD) |  M (SD) | | F-value | *p* |
| Stability | 6.03 (1.12) | 4.86 (1.62) | 16.76 | <.001 | 5.45 (1.34) | 4.46 (1.33) | | 13.85 | <.001 |
| Slimness | 2.06 (1.18) | 2.62 (1.44) | 4.30 | .04 | 2.24 (1.35) | 2.55 (1.38) | | 1.30 | .26 |
| Attention | 3.56 (1.75) | 3.73 (1.70) | .24 | .63 | 3.39 (1.87) | 2.70 (1.58) | | 4.08 | .05 |
| Height salient | 3.71 (1.49) | 4.06 (1.55) | 1.27 | .26 | 3.76 (1.42) | 3.43 (1.37) | | 1.39 | .24 |
| Width salient | 3.98 (1.55) | 4.21 (1.55) | .55 | .46 | 4.08 (1.29) | 3.55 (1.53) | | 3.55 | .06 |
| Attractiveness | 3.18 (1.70) | 3.72 (1.70) | 2.41 | .12 | 2.98 (1.78) | 2.63 (1.48) | | 1.17 | .28 |
| Liking | 3.35 (1.51) | 4.11 (1.56) | 5.87 | .02 | 3.20 (1.73) | 2.88 (1.63) | | .90 | .34 |
| Novelty | 2.55 (1.66) | 3.26 (1.80) | 3.98 | .05 | 3.50 (1.78) | 2.71 (1.65) | | 5.42 | .02 |
| Mood | 4.22 (1.04) | 4.64 (1.49) | 2.47 | .12 | 4.30 (1.42) | 4.26 (.82) | | .02 | .88 |
| | Study 5 (Laptops, N = 97) | | | | Study 6 (Yogurts, N = 102) | | | | |

| |  M (SD) |  M (SD) | F-value | *p* |  M (SD) |  M (SD) | | F-value | *p* |
|---|---|---|---|---|---|---|---|---|---|
| Stability | 5.21 (1.43) | 3.30 (1.41) | 43.89 | <.001 | 5.64 (.82) | 4.61 (1.66) | | 16.37 | <.001 |
| Slimness | 6.00 (1.47) | 6.56 (1.03) | 4.74 | .03 | 3.40 (1.56) | 3.85 (1.78) | | 1.86 | .18 |
| Attention | 5.21 (1.32) | 5.42 (1.05) | .74 | .39 | 4.27 (1.69) | 4.14 (1.60) | | .17 | .68 |
| Height salient | 4.28 (1.47) | 4.34 (1.35) | .05 | .83 | 3.69 (1.44) | 4.34 (1.31) | | 5.62 | .02 |
| Width salient | 4.49 (1.38) | 4.34 (1.27) | .31 | .58 | 3.95 (1.41) | 4.15 (1.32) | | .56 | .46 |
| Attractiveness | 5.21 (1.40) | 5.44 (1.03) | .84 | .36 | 4.51 (1.59) | 4.30 (1.55) | | .46 | .50 |
| Liking | 5.28 (1.56) | 5.02 (1.52) | .68 | .41 | 4.49 (1.68) | 4.15 (1.57) | | 1.12 | .29 |
| Novelty | 4.34 (1.67) | 4.10 (1.37) | .60 | .44 | 3.24 (1.67) | 3.72 (1.84) | | 1.97 | .16 |
| Mood | 5.48 (1.33) | 5.15 (1.26) | 1.55 | .22 | 5.11 (1.10) | 5.12 (1.23) | | .001 | .97 |

***Note.*** There exists some marginally significant difference on alternative accounts in some of the pretests, but they were not as sizeable as that for perceived stability and not reliable as it did not present in all the pretests.

## Web Appendix B: Summary of Stimuli and Results Across Studies

| Study | Sample N | Measure | More Stable Condition Mean (SD) | Less Stable condition Mean (SD) | | Test Result |
|---|---|---|---|---|---|---|
| Pilot | 112 MTurkers | "The heavier objects are more stable" and "It is hard to tip over the heavy objects." (1-7; $r$ = .54) | | | | $M$ = 5.55, $SD$ = 1.22; $t(111)$ = 13.49, $p$ < .001, $d$ = 1.27 |
| Study 1A | | Stimuli: Tortilla Chip |  |  | | |
| | 90 MTurkers | Weight perception ($\alpha$ = .88)[1] | 3.90 (1.28) | 3.35 (1.16) | | $F(1, 88)$ = 4.59, $p$ = .035, $d$ = .45 |
| Study 1B | | Stimuli: Hershey's Kisses |  |  |  | |
| | 240 Undergraduates | Weight perception ($\alpha$ = .71)[1] | 3.03 (1.33) | 2.63 (1.13) | 2.43 (1.19) | $F(2, 237)$ = 4.88, $p$ = .008, $d$ = .41 |
| | | Calorie judgments[2] | 4.05 (1.72) | 3.44 (1.79) | 3.41 (1.52) | $F(2, 237)$ = 3.66, $p$ = .027, $d$ = .35 |
| Study 1C | | Stimuli: Yogurt |  |  | | |
| | 90 MTurkers | Stability perception ($r$ = .55)[3] | 5.96 (0.95) | 5.32 (1.37) | | $F(1, 76.311)$ = 6.51, $p$ = .013, $d$ = .54 |
| | | Weight perception ($\alpha$ = .66)[1] | 4.16 (0.90) | 3.70 (1.03) | | $F(1, 88)$ = 5.14, $p$ = .026, $d$ = .48 |
| Study 2 | | Stimuli: Chocolate |  |  | | |
| | 101 Consumers | Weight perception (grams) | 240.00 (177.69) | 173.61 (117.49) | | ($F(1, 70.734)$ = 4.59, $p$ = .036, $d$ = .44) |
| | | Incentive-compatible WTP (RMB)[4] | 59.09 (22.85) | 49.84 (21.98) | | $F(1, 99)$ = 4.25, $p$ = .042, $d$ = .41 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Study 3 | 2 (bottle shape: less elongated vs. more elongated; within) × 2 (question order: weight first vs. volume first; between) mixed factorial design. | Stimuli: Orange Juice | |  |  | | |
| | 95 MTurkers | Weight estimation (grams) | Weight first | 363.16 (132.35) | 348.33 (115.21) | | $F(1, 93) = 9.86$, $p = .002$, $d = .65$ |
| | | | Volume first | 344.50 (137.86) | 359.32 (126.27) | | |
| | | Volume estimation (fl. oz.) | Weight first | 15.43 (6.62) | 14.63 (5.22) | | $F(1, 93) = 11.53$, $p = .001$, $d = .70$ |
| | | | Volume first | 12.82 (5.35) | 13.82 (5.44) | | |
| Study 4 | 2 (shape stability: more stable vs. less stable) × 2 (type of input: visual cue vs. haptic cue) between-subjects design. | Stimuli: Paper Box Filled with Chocolate Ball | |  |  | | |
| | 114 Undergraduates | Weight estimation (grams) | Visual cue | 249.26 (122.36) | 160.17 (53.09) | | $F(1, 110) = 3.52$, $p = .063$, $d = .36$ |
| | | | Haptic cue | 191.13 (109.68) | 169.07 (80.19) | | |
| Study 5 | 2 (shape stability: more stable vs. less stable) × 2 (lay theory: support vs. against) between-subjects design | Stimuli: Laptop | |  |  | | |
| | 235 Undergraduates | Weight perception ($\alpha = .87$)[1] | Support | 5.18 (1.17) | 4.66 (1.27) | | $F(1, 231) = 7.06$, $p = .008$, $d = .35$ |
| | | | Against | 4.45 (1.46) | 4.88 (1.53) | | |
| Study 6 | | Stimuli: Yogurt | Whole-milk yogurt |  |  | | |
| | | | Low-fat yogurt |  |  | | |
| | 114 MTurkers | Purchase Choice[5] | Whole-milk yogurt | 43/60 or 71.7% | 17/60 or 28.3% | | $\chi^2(1) = 6.58$, $p = .010$ |
| | | | Low-fat yogurt | 26/54 or 48.1% | 28/54 or 51.9% | | |

***Note.***

1: Estimated using three 7-point scales anchored at 1 (unsubstantial/weightless/feathery) and 7 (substantial/weighty/hefty; Deng and Kahn 2009)

2: Rated one item: "How calorific is the chocolate?" on a 7-point scale (1 = very low; 7 = very high).

3: Rated two items: "The XX appears to be very stable" and "The XX is likely to fall over (reverse coded)" on a 7-point scale (1 = strongly disagree; 7 = strongly agree; Rahinel and Nelson 2016).

4: Indicated WTP: "What is the maximum price you are willing to pay for the chocolate?" on a sliding scale (0 RMB—100 RMB) using an incentive-compatible BDM (Wertenbroch and Skiera 2002).

5: Indicated choice: "Which yogurt would you prefer?" (1 = Wallaby; 2 = Green Mountain).

**Web Appendix C: Summary Statistics of the Outliers**

| Studies 2, 3, and 4 | | | Mean (SD) of the raw data | Range of the raw data | Range of the outliers | *N* of the outliers | Mean (SD) of the outliers | Mean (SD) of the data without outliers |
|---|---|---|---|---|---|---|---|---|
| Study 2 (grams) | | | 225.54 (199.34) | 30 ≤ M ≤ 1000 | M ≥ 823.56 | 3 | 1000 (0) | 202.53 (149.67) |
| Study 3 | Weight estimate (grams) | Less elongated | 401.87 (400.21) | 10 ≤ M ≤ 4000 | M ≥ 1602.49 | 1 | 4000 (*NS*) | 365.89 (173.34) |
| | | More elongated | 372.35 (182.01) | 10 ≤ M ≤ 1480 | M ≥ 918.38 | 2 | 1340 (197.99) | 352.80 (117.94) |
| | Volume estimate (fl. oz.) | Less elongated | 21.95 (51.74) | 6 ≤ M ≤ 400 | M ≥ 177.17 | 2 | 380 (28.28) | 14.72 (7.37) |
| | | More elongated | 24.76 (63.70) | 6 ≤ M ≤ 520 | M ≥ 215.86 | 2 | 443 (108.89) | 16.31 (19.45) |
| Study 4 (grams) | | | 194.98 (126.95) | 35 ≤ M ≤ 800 | M ≤ 50 or M ≥ 575.83 | 10 | 231.20 (305.43) | 191.80 (99.93) |

***Note.*** One participant's volume estimate was identified as an outlier in both less elongated (360 fl. oz.) and more elongated (366 fl. oz.) condition in study 3. So, in sum, there are six outliers in study 3.