The Effects of Measurement Unit Price

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ABSTRACT

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Past research has found that judgement of quantitative information is subject to various biases. Among these biases are the numerosity effect and the unit salience effect, whereby people are sensitive to the numerical magnitude but rely on other information (i.e., unit of measurement) when that information is salient. We investigate these effects in the real-world context of retail pricing, and investigate the extent to which consumers rely on the numerical magnitude of the price (e.g., 3.99) under conditions when a familiar measurement unit (lb/kg) varies in salience. Findings of five studies supported our hypotheses, and revealed that participants perceived prices with small numerical magnitudes, corresponding to a smaller unit of measurement, as less expensive than equivalent prices with large numerical magnitudes and larger units of measurement (e.g., 3.99/lb vs. 8.8/kg). We also found an interaction effect between numerical magnitude and unit salience such that by increasing the salience of the measurement unit, the differences between the equivalent measurement unit prices decreased. This study contributes to the literature on price perceptions and provides practical implications for retailers and regulators.

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1. Introduction

In grocery store setting, consumers frequently encounter unit prices that are based on measurement units. For example, the price of lettuce in a Montreal grocery store may be offered for sale in bulk as 1.36/lb or equivalently as 3/kg. In this research paper, we refer to the kind of price attached to a measurement unit as measurement unit price. For example, 3.99/lb is a price attached to a measurement unit of weight, which is pound. It means that every time people purchase an additional pound of a specific product, they need to pay additional money of 3.99. Different from the normal unit prices (e.g., 2/box) which the unit cannot be divided (e.g., people cannot buy half of a box of cereal), for measurement unit price, the measurement unit can be separated (e.g., people can buy half a pound of apples).

Countries across the world apply different measurement units for pricing bulk products: US prefers imperial units (e.g., lb), UK and Oceania tend to use metric units (e.g., kg), and China uses both the traditional units (e.g., Jin) and the metric units. Similarly, in Canada, due to the historical ties to England and proximity to the US, both the imperial system and metric system are prevalent in grocery stores. According to the "Labelling Requirement for Fresh Fruits and Vegetables (2014)" by Canadian Food Inspection Agency, net quantity of bulk fresh fruits and vegetables must be declared by weight, volume or numerical count, in metric units, Canadian units (e.g., pound), or in both metric and Canadian units. However, retailers still have considerable freedom in terms of how they display the price information in terms of fonts, sizes, color, and positioning.

Research on price presentation suggests that price display format influences judgement (Bagchi and Cheema, 2013; Bagchi and Davis, 2012; Miyazaki et al., 2000; Pelham et al., 1994), however, how prices in different measurement units are perceived by consumers is not well understood. Hence, we expect to fill the theoretical gap between this kind of price presentation and perception by examining how a price framed in small measurement unit (e.g., 3.99/lb) is viewed differently from an equivalent price framed in large measurement units (e.g., 8.8/kg). From a rational perspective, it seems that such price presentations should have no influence on price evaluation. However, a stream of research on the psychology of numerosity (Bagchi and Davis, 2016; Wertenbroch et al., 2007; Lowe et al., 2012; Gourville, 1998; Bagchi and Li, 2011) reveals that different prices expressed in different measurement units influence judgements because of the size of the associated numerical magnitude. According to numerosity theory,

when a numerical magnitude is presented together with unit information, people usually focus on the numerical magnitude and then make their judgement, without fully considering the unit information that constitutes the meaning of the whole quantitative information (Bagchi and Davis, 2016). Hence, when comparing between quantitative information with different units (e.g., 1 week vs. 7 days; Monga and Bagchi, 2012), people make their judgement primarily based on a comparison of the numerical magnitudes (e.g., $1 < 30$). As people are only paying attention to the numerical magnitude instead of the unit, the comparison becomes dimensionless (Pandelaere et al., 2011), quantitative information with a bigger number is considered as larger than quantitative information with a smaller number. Following this logic, when considering a price attached to a measurement unit, the price with larger numerical magnitude expressed in one measurement unit (e.g., 8.8/kg) should be perceived as more expensive than the equivalent price with smaller numerical magnitude expressed in another measurement unit (e.g., 3.99/lb). If it is the case that people overweight the numerical magnitudes when processing measurement unit prices, this paper will contribute to the literature of price presentation, and shed light on factors that may influence the measurement unit price perception.

Former research on numerosity investigated the effect of numerosity on price perception by using only perceived expensiveness (i.e., whether the price is inexpensive or expensive) as dependent variable (Shen and Urminsky, 2013). Throughout our studies, in addition to the perceived expensiveness, we used money allocation (i.e., how do people allocate the budget; Wertenbroch et al., 2007) as another dependent variable, which should elicit an opposite effect from perceived expensiveness (i.e., lower perceived expensiveness inference leads to higher money allocation and vice versa). By using different dependent variables, we hope to find support for the robustness of the numerosity effect

Prior study of numerosity effect (Bagchi and Davis, 2016; Wertenbroch et al., 2007; Lowe et al., 2012; Gourville, 1998; Bagchi and Li, 2011) delineates situations where the size of the numerical magnitude and the size of the unit are incongruent. That is, a small numerical magnitude always associates with a large unit, while a large numerical magnitude always associates with a small unit (e.g., 7.3 km vs. 7300 m, Wong and Kwong, 2000). However, in the context of measurement unit price, the size of the numerical magnitude and the size of the measurement unit are congruent. That is, a small numerical magnitude is always associates with a small measurement unit, while a large numerical magnitude always associates with a large

measurement unit (e.g., 3.99/lb vs. 8.8/kg). Therefore, by investigating the effect of measurement unit price, we hope to extend the numerosity theory and testify to its robustness in conditions where the size of the numerical magnitude and the size of the measurement unit are congruent.

Nevertheless, research on unit salience effect (Shen and Urminsky, 2013; Pandelaere et al., 2011) suggests that numerosity effect can be eliminated when the unit information becomes salient (e.g., enlarge the font size or change the color). Specifically, when the unit presentation becomes salient, people start to consider the meaning of the unit, be less sensitive to the numerical magnitude, and rely on the unit information for making judgement. In other words, the effect of the numerical magnitude on overall judgement is mitigated in the condition where the measurement unit is salient. Therefore, in this research paper, we investigate the possibility that the salience of the measurement unit interacts with the numerical magnitude, and generates different effects on perception. We expect that judgement towards the measurement unit price is sensitive to the numerical magnitude only when the measurement unit is not salient.

Former research on unit salience (Shen and Urminsky, 2013; Pandelaere et al., 2011) suggested that unit salience moderates the numerosity effect only when people encounter unfamiliar unit (e.g., horsepower, Brazilian currency). Otherwise, people rely on the numerical magnitude for making their judgement regardless of the salience of the unit. However, under the condition of measurement unit price, we propose that the salience of the measurement unit moderate the effect of numerical magnitude on price perception even though people are familiar with the measurement unit (e.g., pound, kilogram).

Overall, we attempt to investigate whether people are sensitive to numerical magnitude when considering a price attached to a measurement unit, and whether manipulation of the salience of the measurement unit shifts people's attention between the numerical magnitude and the measurement unit, which may cause different perception towards the same measurement unit price. If the numerosity effect and the unit salience effect dominate in the context of the measurement unit price, measurement unit prices with small numerical magnitude and non-salient measurement unit presentation should be regarded as less expensive than equivalent measurement unit prices with large numerical magnitude and salient measurement unit presentation. As deliberately enlarging font size of the numerical value but shrinking the font size of the measurement unit is a common tactic used by retailers across different grocery stores, we hope to raise awareness of the use of the measurement unit prices. Moreover, regulations on

presentation of measurement unit prices should be imposed in order to protect consumers' welfare.

2. Literature Review and Research Propositions

2.1. Different perceptions towards quantitative information

Prior research suggested that people might hold different evaluation towards the same quantitative information framed in different ways (Wong and Kwong, 2000; Yamagishi, 1997; Tversky and Kahneman, 1981). For example, people may perceive 7300m and 7.3km as significantly different (Wong and Kwong, 2000). A $3 pen is perceived to be significantly different from a $2.99 pen (Thomas and Morwitz). In order to explain these differences, researchers have posited various theories such as the anchoring and adjustment heuristic (Tversky and Kahneman, 1974) and the left-digit effect (Thomas and Morwitz, 2005). We discuss these below.

2.1.1. Anchoring and adjustment heuristic

One reason leading to perception bias to the quantitative information is anchoring and adjustment heuristic (Tversky and Kahneman, 1974). It describes the situation where individuals rely heavily on the perceived most important information (i.e. anchor) for making their judgement, and adjust the judgement by considering the rest information based on the decreasing order of their perceived importance (Yadav, 1994). In one study conducted by Tversky and Kahneman (1974), participants were asked to estimate the product either 1×2×3×4×5×6×7×8 or 8×7×6×5×4×3×2×1 in five seconds. Those who were asked to compute the product from an ascending order gave a lower answer than those who were asked to compute the product in a descending order. Therefore, the researchers concluded that people anchored on the first number in the sequence, while adjusting the rest insufficiently. Anchoring and adjustment allows individuals to make a general judgement under uncertainty in short time, particularly when something contains more than one pieces of information. However, due to the unequal evaluation of all the information, perception bias occurs and influences behaviors. For example, when comparing an offer of "$29 for 70 items" against the same offer of "70 items for $29", people anchor on the first piece of information, and adjust the second information insufficiently. Therefore, for the "$29 for 70 items" offer, people anchor on the price, and this leads to inferences of higher unit price, lower trial likelihood, and lower value, which affect choice (Bagchi and Davis, 2012).

2.1.2. Left-digit effect

The left-digit effect refers to the phenomenon that using a nine-ending versus a zero-ending changes the leftmost digit differently and that it is the differences of the leftmost digits, instead of the endings, that influence the magnitude perception (Thomas and Morwitz, 2005). For example, even though $2.99 is only one cent lower than $3, people perceive two prices significantly different as the leftmost digits of the two prices are different. According to Thomas and Morwitz (2005), the process of encoding a number occurs very rapidly and beyond consciousness, causing the encoding process starts as soon as the eyes encounter the leftmost digit and finishes before reading all the digits. Therefore, when judging a multi-digit number people anchor on the leftmost digit while ignore the rest digits. Furthermore, as people evaluate the number holistically (Thomas and Morwitz, 2005), anchoring on the leftmost digit leads to inference that the nine-ending number is much smaller than a one-cent-higher but zero-ending number.

2.2. Analog model of numerical cognition and measurement unit price perception

In this research paper, we suggest people overweight the numerical magnitude, rather the measurement unit, when evaluate a measurement unit price[1]. Similar to evaluation of the multi-digit number, for evaluation of the measurement unit price, people may generate perception primarily based on the numerical magnitude (especially the leftmost digit). Accordingly, when presented with two measurement unit prices to be compared, consumers may anchor on each of the numerical magnitude, even though the corresponding measurement units might be different. Consequently, overall judgement between measurement unit prices would mainly depend on the comparison between numerical magnitudes. The analog model of numerical cognition (Dehaene, 1997; Hinrichs et al, 1981; Thomas and Morwitz, 2005) suggests that, when presented with multi-digit numbers to be compared, individuals tend to assess the quantitative meaning of the numbers by mapping them onto an internal analog magnitude scale. By using the analog model, the process of encoding and retrieval of magnitude representations would be accomplished effortlessly, automatically, and unconsciously (Coulter and Coulter, 2005). For instance, when comparing between equivalent measurement unit prices such as 3.99/lb and 8.8/kg, as consumers might focus on the numerical magnitudes (i.e., 3.99 and 8.8), the numerical

[1] We discuss the reasoning in the next part.

magnitude would be automatically encoded onto mental magnitudes on an internal analog scale, with 3.99 to be mapped onto the lower end of the scale while 8.8 to be mapped onto the relatively higher end of the scale. Therefore, when only focusing on the numerical magnitudes of the measurement unit prices, consumers perceive 3.99/lb as less expensive than 8.8/kg, even though they are aware of the conversion factor.

Thomas and Morwitz (2005) mentioned that the perceived distance between the two analog magnitudes might affect the discrimination on the scale. That is, if the numerical values are perceived to be close to each other, the effort required for the comparison is greater, and the time required for the comparison is also greater. For example, it should take more time to notice the difference between $4 and $5 (distance is 1) than the difference between $4 and $10 (distance is 6; Thomas and Morwitz, 2005). In the context of measurement unit prices comparisons, given that the conversion factors are different between measurement units (e.g., 1kg=2.2lb=35.2oz), for the equivalent measurement unit prices, the numerical magnitudes are different based on different measurement units. Hence, the distances between pairs of measurement unit price are different as well. For equivalent measurement unit prices with small conversion factor (e.g., 2.2/kg vs. 1/lb), the distance is small (e.g., 2.2-1=1.2), while for equivalent measurement unit prices with large conversion factor (e.g., 16/lb vs. 1/oz), the distance is large (16-1=15). Therefore, it is easier for people to compare 16/lb to 1/oz than to compare 2.2/kg to 1/lb. However, this research paper is not intended to focus on the distance effect, but there may be a moderation effect of the perceived distance on measurement unit price perception.

2.3. Numerosity and measurement unit price perception

Numerosity heuristic refers to the tendency that people ignore other relevant information but rely on nominal values for making their judgement (Bagchi and Davis, 2016). Hence, according to the numerosity heuristic, when judging quantitative information, higher numerical magnitude represents greater quantity, while lower numerical magnitude represents lower quantity. For example, an 8-bedroom house is more likely to be perceived as larger than a 4-bedroom house as people tend to overweight the number of bedrooms in judgements (Bagchi and Davis, 2016).

An emerging literature (Bagchi and Davis, 2016; Wertenbroch et al., 2007; Lowe et al., 2012; Gourville, 1998; Bagchi and Li, 2011) suggests numerosity effect influences perception across different contexts such as currency, donation, and loyalty program.

Wertenbroch et al. (2007) suggested that consumers might overspend (underspend) when a target currency is more (less) numerous than a base currency. For example, when the target currency (S$) is 1.7 times more numerous than the base currency (US$), the differences between a target price of S$1.7 and a budget of S$17 (17-1.7=15.3) is larger than the differences between a base price of US$1 and a base budget of US$10 (10-1=9). Lowe et al. (2012) found similar results: prices presented in less numerous currencies (e.g. US dollar) are perceived to be less expensive than in more numerous currencies (e.g. Japanese yen) even though exchange rate was realized.

In the donation domain, Gourville (1998) mentioned that pennies-a-day transactions (i.e. a series of small daily or ongoing expenses; e.g., $1/day) were regarded more favourably than an aggregate transaction (i.e., a onetime expense, e.g., $350/year) since the former could lower consumers' perception of monetary magnitude, leading to higher compliance with the more favorable alternative.

In loyalty program context, Bagchi and Li (2011) found that magnitude of reward distance (e.g., accumulate 1000 [vs. 100] points,) and magnitude of the step size (e.g., earn 10[vs. 1] points/dollar) influenced consumers' post enrollment inferences, loyalty, and recommendation likelihood. For example, in the high (vs. low) magnitude conditions where the rewards distance and the step sizes were high (vs. low), when the step size was ambiguous, participants only focused on the reward distance. Those who were near the reward (e.g., earned 800 points, needed 200points [vs. earned 80 points, needed 20 points]) expressed high (vs. low) loyalty and recommendation likelihood than those who were far away from the rewards (e.g., earned 200 points, needed 800 points [vs. earned 20 points, needed 80 points]). This is because those who were near the reward felt that they already made big (vs. not that big) progress compare to those who were far away from the rewards.

Since quantitative information can be presented using different scales such as expanded scale and contracted scale (Bagchi and Davis, 2016), corresponding numerical magnitude can be varied from small numerical magnitude to large numerical magnitude. For instance, 7300m contains an expanded scale with a large numerical magnitude, while 7.3km contains a contracted

scale with a small numerical magnitude. When judging quantitative information, on the one hand, it is easier for people to consider only the numerical magnitude. Hence, the quantitative information can be encoded on the internal analog scale, which fastens the judging process compared to consider both the numerical magnitude and the meaning of the unit. On the other hand, for the same quantity, compared to the contracted scale, the expanded scale is always more numerous. Therefore, when the numerosity effect dominates, the quantitative information with the expanded scale (with large numerical magnitude) should be considered larger than the quantitative information with the contracted scale (with small numerical magnitude).

Similarly, under the context of measurement unit price, for the same total price of a product, the quantity is always more numerous when using an expanded measurement unit (e.g., /lb) than when using a contracted measurement unit (e.g., /kg). For example, suppose that measurement unit price of apples is either as 2/lb or 4.4/kg. Ten dollars' worth of apple equals to 5lb (more numerous) or 2.27kg (less numerous). It may lead to an inference that products priced using expanded measurement unit price provide more value than products priced using contracted measurement unit price. Furthermore, when using the expanded measurement unit, "step size" (i.e., money per measurement unit) is smaller compare to that of the contracted measurement unit price. That is, in order to get an additional measurement unit of the product, people pay less (vs. more) money when the measurement unit price is expanded (vs. contracted). For instance, for the expanded (vs. contracted) measurement unit price 3.99/lb (vs. 8.8/kg), in order to get an additional pound (vs. kilogram), people need to pay additional 3.99 (vs. 8.8). Therefore, expanded measurement unit price with small numerical magnitude leads to another inference that the price is less expensive than the contracted measurement unit price with large numerical magnitude.

Moreover, since the evaluation towards the measurement units (e.g., lb) is insufficient, giving the numerical value a great deal of influence for the price perception of measurement unit price, consumers may judge a measurement unit price primarily based on the numerical value. In an extreme example, when people only focus on the numerical magnitude and ignore the measurement unit, evaluation of a measurement unit price becomes dimensionless and can be evaluated using an internal analog scale. Therefore, measurement unit prices with smaller (vs. larger) numerical magnitudes will be mapped on the lower (vs. high) end of the internal analog scale, and be perceived as less (vs. more) expensive. By using the internal analog scale, a

measurement unit price with a bigger numerical magnitude should be considered as larger than an equivalent measurement unit price with a smaller numerical magnitude. Accordingly, compared to a measurement unit price with a large numerical magnitude, a measurement unit price with a small numerical magnitude should lead to lower price perception and higher money allocation (i.e., how do people allocate budget) tendency. Thus,

H1a: a price with a small numerical magnitude expressed in one measurement unit will lead to lower price perception than an equivalent price with a large numerical magnitude in another measurement unit.

H1b: people will allocate more money when a price is attached to a small numerical magnitude expressed in one measurement than when an equivalent price is attached to a large numerical magnitude in another measurement unit.

2.4. Unit salience and measurement unit price perception

Though prior research suggests that numerical magnitudes of quantitative information may have a sharp influence on people's perception, literature also illustrates situations where people become less susceptible to the numerical magnitude, but rely on other information, such as unit information, for making their judgement (Shen and Urminsky, 2013; Monga and Bagchi, 2012; Pandelaere at al., 2011; Bagchi and Davis, 2016).

Similar to the numerosity effect, Shen and Urminsky (2013) suggested deliberational blindness, which demonstrates the tendency that people fail to assess the meaningfulness of the unit information, but are over attentive to the numerical magnitude, even though the unit information is accurately read, recognized, remembered, and recalled. However, according to Shen and Urminsky (2013), people exhibit deliberational blindness in two distinct ways: first, when they encounter familiar unit information, people simply recognize it and primarily focus on the numerical magnitude regardless of the visual unit salience. For instance, when presented with $50 to a Canadian, he will not consider the meaning of the "$", but make his judgement based on the "50". This is how the normal numerosity effect occurs. As in the case with daily grocery shopping, when processing a measurement unit price in familiar format (e.g., 3.99/lb), people's judgments are usually sensitive to the numerical magnitude (e.g., 3.99) instead of the

measurement unit (e.g., /lb). Therefore, the numerical magnitude of the measurement unit price has a great influence on people's price perception.

Second, when the unit information is less familiar (e.g., people have not encountered the unit before, or the meaning of the unit is poorly understood; Shen and Urminsky, 2013), deliberational blindness depends on the salience of the unit. Specifically, when the unit information is less salient, people will continually rely on the numerical magnitude for making their estimation; on the other hand, when the unit information is more salient, people will start to consider the meaning of the unit information. Shen and Urminsky (2013) referred to this phenomenon as the unit-salience effect. Under the unit-salience condition, since people's attention shifts from the numerical magnitude to the unit information, the effect of the numerical magnitude on perception eliminates, while the unit information becomes influential on the overall quantitative information. Furthermore, due to the eliminated effect of the numerical magnitude, the differences between the same options framed in different formats decrease. In one study conducted by Shen and Urminsky (2013), participants were asked to evaluate a Brazilian hotel room rate presented either in a Brazilian currency (unfamiliar unit) format or in a US dollar (familiar unit) format. When the price was presented in the Brazilian currency format, participants evaluated the hotel rate as higher in the high numerical magnitude condition only when the font size of the unit information was smaller than the font size of the numerical magnitude (i.e., unit non-salience condition). However, when the unit font size was larger than the numerical magnitude font size (i.e. unit-salience condition), participants' evaluations towards the price were not different between the low and the high numerical magnitude conditions. When the price was presented in a US dollar format, participants' evaluation of the price was always sensitive to the numerical magnitude regardless of the font size of the unit. Therefore, when the unit is less familiar but more salient, people will start to rely on the unit information and be less sensitive to the numerical magnitude. Another study conducted by Pandelaere et al. (2011) showed similar results: participants were more likely to pay an additional price for an early delivery when the delivery duration was expressed in day format (large numerical magnitude format) instead of month format (low numerical magnitude format). However, preference for early delivery did not differ between different formats when participants were, first, engaged in a subjective estimation task relating to both the date formats, which provided them a chance to pay more attention to the unit presented.

Since people's judgement is subjected to the relative salience between the numerical magnitude and the unit information, we can summarized the numerosity effect and the unit-salience effect by saying that numerosity effect is driven by the salience of the numerical value, while the unit-salience effect is driven by the salience of the unit information. Under the condition of measurement unit price, we suggest that simply manipulating the visual salience of the measurement unit will shift people's attention between numerical magnitude and measurement unit, and moderate the effect of numerical magnitude on perception. Specifically, when the numerical magnitude is more salient than the measurement unit, as discussed above, people put more weight on the numerical magnitude instead of the measurement unit. In this case, the numerosity effect dominates: measurement unit prices with large numerical magnitudes will be perceived to be expensive than measurement unit prices with small numerical magnitudes; and measurement unit prices with small numerical magnitudes will be perceived to be less expensive. Nonetheless, when the measurement unit becomes salient, people start to pay more attention to the measurement unit than to the numerical magnitude, and consider the meaning of the measurement unit when making the judgement towards the measurement unit price. In this case, the unit-salience effect dominates: differences between measurement unit prices with large numerical magnitudes and measurement unit prices with small numerical magnitudes will decrease, or measurement unit price with large numerical magnitude will not necessarily indicate that the price is more expensive than measurement unit price with small numerical magnitude.

H2: unit salience moderates the effect of measurement unit price on price expensiveness whereby:

(a). when the measurement unit is not salient, a price attached to a small numerical magnitude will be perceived as less expensive than an equivalent price attached to a large numerical magnitude;

(b). when the measurement unit is salient, perceived price differences between equivalent prices with different numerical magnitudes will decrease.

H3: unit salience moderates the effect of measurement unit price on money allocation whereby:

(a). when the measurement unit is not salient, people will allocate more money if a price is attached to a small numerical magnitude than if an equivalent price is attached to a large numerical magnitude;

(b). when the measurement unit is salient, money allocation differences between equivalent prices with different numerical magnitudes will decrease.

3. Methodology

3.1. Study 1: perceived expensiveness of organic fruits

The purpose of this study was to test our prediction that a price with small numerical magnitude is perceived as less expensive than a price with large numerical magnitude. We manipulated measurement unit prices (low [lbs] vs large [kgs]), and investigated the effects by measuring perceived expensiveness (Shen and Urminsky, 2013; Lynn and Wang, 2013; Garbarino and Slonim, 2003). Numerosity theory (Bagchi and Davis, 2016; Bagchi and Li, 2011; Lowe et al., 2012; Gourville, 1998; Raghubir and Srivastava, 2002) predicts that measurement unit prices with smaller numerical magnitudes are perceived to be less expensive than equivalent measurement unit prices with large numerical magnitudes.

3.1.1. Procedure

Participants were 81 students from Concordia University. They were intercepted on the first floor or the second floor in the John Molson School of Business building. We first explained to participants that we were conducting a study relating to consumers' purchasing behavior, and asked if they were willing to complete a short survey. After consenting to participate into the study, participants were randomly assigned to one of the two research conditions (i.e., low numerical magnitude condition vs. high numerical magnitude condition).

At the beginning of the questionnaire, participants were informed that "A manager from a grocery store wants to know people's opinion about the price of organic fruits". Following this, all the participants were presented a table containing normal prices and organic prices of four different kinds of fruit (i.e., orange, strawberry, apple, and blueberry; See Appendix 1). In the low numerical magnitude condition, all the prices were in pound format (e.g., 1.82/lb); while in the high numerical magnitude condition, equivalent prices were in kilogram format (e.g., 4/kg). After carefully reviewing the price information, participants were instructed to complete questions regarding the perceived expensiveness of the organic prices. Perceived expensiveness was measured using a 7-point Likert scale item (Lynn and Wang, 2013; Garbarino and Slonim, 2003) ranging from 1 to 7: "Compared to the normal price, I think the organic price is"; from 1 (Very cheap) to 7 (very expensive). At the end of the survey, demographic information was obtained.

3.1.2. Results

As different countries apply different measurement unit, people from different countries may have different sensitivity towards the numerical magnitude of the measurement unit price. As our research was conducted in Canada, in order to rule out the confounding factor, participants were limited to those who had been living in North America for at least one year. Therefore, two subjects were excluded from the database, leaving 79 subjects in total (*M*-age=40, *SD*=14.14; female=59.49 vs. male=40.51%). An independent sample t-test revealed the predicted effect: people perceived measurement unit prices as less expensive when they were in the low numerical magnitude condition (see Figure 1 and Table 1). Across four different kinds of fruit, participants rated measurement unit prices with small numerical magnitudes as less expensive than the equivalent measurement unit prices with large numerical magnitudes. Specifically, for orange, *Ms*=3.867 vs. 4.265, *SDs*=1.014 vs. 1.421, respectively; *t*(77)=-1.454, *p*=.15, *d*=.331; for strawberry, *Ms*=4.000 vs. 5.206, *SDs*=1.066 vs. 1.175, respectively; *t*(77)=-4.764, *p*<.000, *d*=1.086; for apple, *Ms*=4.400 vs. 5.059, *SDs*=1.214 vs. 1.127, respectively; *t*(77)=-2.463, *p*=.016, *d*=.561; for blueberry, *Ms*=5.000 vs. 6.265, *SDs*=1.297 vs. .931, respectively; *t*(77)=-4.821, *p*<.001, d=1.099.

Figure 1: Perceived Expensiveness as a Function of Numerical Magnitude

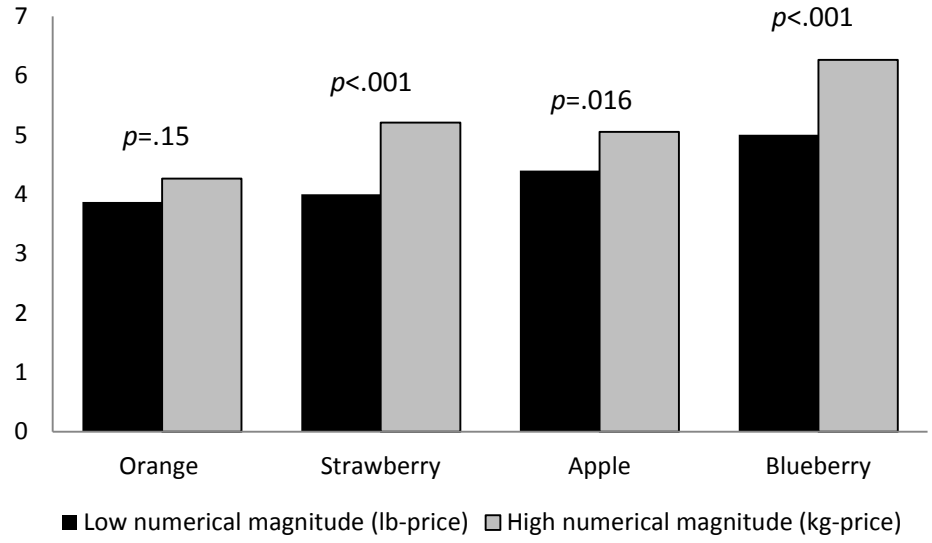


Table 1: Means of Perceived Expensiveness

	Low measurement unit price condition (/lb) (*n*=45)	High measurement unit price condition (/kg) (*n*=34)	*t*-value	*p*-value	Cohen's *d*
Orange	3.867	4.265	-1.454	.150	.331
Strawberry	4.000	5.206	-4.764	<.001	1.086
Apple	4.400	5.049	-2.463	.016	.561
Blueberry	5.000	6.265	-4.821	<.001	1.099

3.1.3. Discussion

Results from Study 1 support the numerosity effect hypothesis (H1a) that measurement unit price with smaller numerical magnitude is perceived to be less expensive than measurement unit price with larger numerical magnitude, even though they are equivalent.

Even though the results were significant in study 1, some confounding factors may exist and limit validity of the study. For example, when comparing the stimuli, apples may be regarded as local fruit, while oranges usually carry image of imported fruits. Furthermore, strawberry and blueberry might be seen as more hedonic fruits due to their natural high prices relative to the other two kinds of fruit. Therefore, when rating the perceived expensiveness of the fruits, participants may be influenced by associations and images inherent to the fruits, biasing the comparisons among the fruits. Therefore, in the following study we used a market basket method to investigate the effects of measurement unit price.

3.2. Study 2: market basket scenario 1 (with fruit category and vegetable category)

The purposes of study 2 were to make up for the weaknesses in study 1, and to obtain further support for hypothesis 1 by using a different method and an additional dependent variable (i.e., money allocation; Werthenbroch et al., 2007). In this study, participants were asked to evaluate two product categories (i.e., vegetable and fruit category and packaged food category), instead of specific products. Participants were told to imagine that they were shopping under a certain budget. After reading the products and corresponding prices, participants were asked to

indicate how they would allocate the budget on the product categories and stated the perceived expensiveness towards the two product categories.

We expected that when measurement unit prices were in small numerical magnitude format, people perceive the measurement unit prices as less expensive; thus, they would have more favorable feeling (i.e., tend to allocate more money) towards product category that is priced in small numerical magnitude format. Furthermore, by asking for spending allocation on product categories instead of on specific products (e.g., orange), confounding factors such as people's preference towards specific products and differences among different products could be ruled out. Accordingly, differences between the two research conditions were due to the use of measurement unit price formats. Additionally, in Study 2, price presentations were designed to be similar to the price tags used in local grocery stores.

3.2.1. Procedure

Participants were recruited from an online crowdsourcing website, namely CrowdFlower.com. After consenting to participate in the study, they were randomly assigned to one of the two research conditions (i.e., low numerical magnitude condition vs. large numerical magnitude condition). At the beginning of the study, all the participants were told to imagine that they were shopping with $20 budget for two product categories. One was vegetables category, the other was the fruit category (see Appendix 2). The price presentations of vegetables were presented as price per pound (e.g., 1.99/lb), and were not varied across the research conditions. We manipulated the price presentations of the fruits by using different measurement units. In the low numerical magnitude condition, pound was used for pricing the fruit category (e.g., 2.49/lb). However, in the high numerical magnitude condition, kilogram was used for pricing the fruit category (e.g., 5.50/kg). After viewing the products and their corresponding prices, participants were instructed to indicate how they would allocate the budget[2] between the vegetable category and the fruit category, respectively. Participants were also asked to rate the perceived expensiveness of each product category using a 7-point Likert scale (1=very cheap, 7=very expensive). At the end of the questionnaire, demographic information was obtained.

[2] In Study 2, participants were instructed to indicate money allocation in percentage. However, in Study 3, 4, 5, money allocation was indicated in exact dollar.

3.2.2. Results

Participants were limited to those who had been resident in Canada for at least one year. The sample size was 64 (*M*-age=35.625, *SD*=14.588; female=60.93% vs. male=39.07%). The independent variable was the numerical magnitude (i.e., low vs. high), and the dependent variables were money allocation and perceived expensiveness.

For money allocation, independent sample t-tests revealed a significant difference for money allocation on the fruit category across the two research conditions (*Ms*=42.581 vs. 35.9, *SDs*=11.465 vs. 14.3487, respectively; *t*[62]=-2.012, *p*=.049, *d*=.524). Specifically, in the low numerical magnitude condition, participants allocated more money on the fruit category than participants who were in the high numerical magnitude condition.

For perceived expensiveness, independent sample t-tests also revealed a significant difference for perceived expensiveness of the fruit category across the two research conditions (*Ms*=4.968 vs. 5.625, *SDs*=.948 vs. 1.04, respectively; *t*[62]=2.62, *p*=.011, *d*=.671). Specifically, in the low numerical magnitude condition, participants perceived the fruit category as less expensive than participants who were in the high numerical magnitude condition. The effect occurred in spite of the fact that, in the high numerical magnitude condition, vegetable and fruit categories were priced using different measurement units, and participants had an opportunity to notice the differences, yet they could not convert measurement unit prices, and were influenced by the numerical magnitudes.

3.2.3. Discussion

Similar to Study 1, the results from Study 2 suggested that people perceive measurement unit prices that are in small numerical magnitude as less expensive than measurement unit prices that are in large numerical magnitude (H1a). Furthermore, in study 2, we introduced a new dependent variable (i.e., money allocation) and tested the effects of measurement unit price. The results were also consistent with our prediction: people allocated more money on products that were priced in small numerical magnitude format than products that were priced in large numerical magnitude format (H1b). However, the design of Study 2 might confuse participants by presenting measurement unit prices in both the small and large measurement units simultaneously in the large numerical magnitude condition. Participants might notice the different measurement units, and have the inference that products that were priced in large measurement unit format were supposed to be more expensive, which led to the predicted results.

3.3. Study 3: market basket scenario 2 (with measurement unit price category and per-unit price category)

In order to rule out confounding factors in Study 2, we conducted an additional study with stronger manipulation of measurement units. We hope to seek further support for hypothesis 1 by using both perceived expensiveness and money allocation as dependent variables, and test the effects of measurement unit price. In this study, participants were instructed to allocate $55 on either vegetables and fruits category (e.g., broccoli) that is habitually priced based on measurement unit price, or packaged food category (e.g., pasta) that is habitually priced based on unit price ($/unit). We then manipulated the use of measurement unit (i.e., lb and kg) of the vegetables and fruits category. By classifying stimuli into vegetables and fruits category (or measurement unit price category) and prepackaged food category (or unit price category), participants in one research condition would only be presented to one kind of measurement unit (either lb or kg).

3.3.1. Procedure

Participants were recruited from an online crowdsourcing website, namely CrowdFlower.com. After consenting to participate in the study, they were randomly assigned to one of the two research conditions (i.e., low numerical magnitude condition vs. large numerical magnitude condition). At the beginning of the study, participants were told to imagine that they were shopping in a grocery store. They needed to allocate $55 budget on either vegetables and fruits category or packaged food category. After the instruction, a list containing four products with corresponding measurement unit prices (two vegetables and two fruits) and four unit-price products (i.e., packaged food) with corresponding unit prices were presented to all participants. In the low numerical magnitude condition, vegetables and fruits were presented in pound-format (e.g., 2.49/lb). While in the large numerical magnitude condition, vegetables and fruits were presented in equivalent kilogram-format (e.g., 5.48/kg). For the packaged food category, price presentations were in the same format (e.g., 4.99/box) (see Appendix 3). After viewing the products and their prices, participants were asked to indicate how they would allocate $55 on vegetables and fruits category and prepackaged food category, respectively. Participants were also asked to rate the perceived expensiveness of each product category using a 7-point Likert

scale (1=very cheap, 7=very expensive). At the end of the questionnaire, demographic information was obtained.

3.3.2. Results

Participants (*M*-age=42.29, *SD*=13.123; female=58.3% vs. male=41.7%) were limited to those who had been resident in Canada for at least one year. Therefore, two observations were excluded, leaving 60 observations in the database. The independent variable was the numerical magnitude (low vs. large), and the dependent variables were money allocation and perceived expensiveness.

For money allocation, independent sample t-tests revealed a significant difference for money allocation on vegetables and fruits category across the two conditions (*Ms* =30.387 vs. 24.464, *SDs*=10.471 vs. 9.134, respectively; *t*[58]=2.291, *p*=.025, *d*=.607). Since the budget available was fixed (i.e., $55), and participants were asked to allocated the budget on either vegetables and fruits category or packaged category, there was also significant difference for money allocation on prepackaged food category across the two research conditions (*Ms* =24.613 vs. 30.536, *SDs*=10.471 vs. 9.134, respectively; *t*[58]=2.291, *p*=.025, *d*=.607).

For perceived expensiveness, there was significant difference for perceived expensiveness of vegetables and fruits category across the two research conditions (*Ms* =5.032 vs. 5.828, *SDs*=1.538 vs. 1.358, respectively; *t*[58]=-2.113, *p*=.038, *d*=.600). However, there was no difference for perceived expensiveness of packaged food category across the two research conditions (*Ms* =5.161 vs. 5.138, *SDs*=1.128 vs. 1.093, respectively; *t*[58]=.081, *p*=.935, *d*=.021).

3.3.3. Discussion

In Study 3, we included two dependent variables: money allocation and perceived expensiveness. Consistent with Study 1 and 2, people perceived measurement unit prices with low numerical magnitudes less expensive than measurement unit prices with large numerical magnitudes, even though they were economically equivalent (H1a). Moreover, given a certain budget, when products were priced in low numerical magnitude format, people were more likely to allocate more money than when the products were priced in large numerical magnitude (H1b).

We suggest the underlying mechanism is that people are sensitive to the numerical magnitude instead of the measurement unit when processing a measurement unit price. Therefore, even though economically equivalent, measurement unit price with small numerical magnitude is perceived to be less expensive than measurement unit price with large numerical magnitude.

3.4. Study 4: Effects of Unit salience 1 (present one measurement unit price)

In Study 4, we replicated the results obtained by Shen and Urminsky (2013), and testified the robustness of the unit salience effect under the context of measurement unit price. The purpose of Study 4 was to find interaction effects between numerical magnitude and unit salience under the condition of the measurement unit price. Specifically, we hypothesized when the presentation of the measurement unit is not salient, people are more sensitive to the numerical magnitude. Thus, measurement unit prices with small numerical magnitudes should be regard as more favorable than measurement unit prices with large numerical magnitudes. Nevertheless, when the presentation of the measurement unit is salient, people put more weight on the measurement unit, and are less sensitive to the numerical magnitude. Hence, the differences between the measurement unit price with small numerical magnitude and the measurement unit price with large numerical magnitude should be reduced. Accordingly, Study 4 was in a 2 (numerical magnitude: low vs. high) x 2 (unit salience: low vs. high) between subject design. We manipulated the numerical magnitude by using equivalent measurement unit prices in different measurement unit formats, and manipulated the salience of the measurement units by using different font sizes. Similar as Study 3, this study used money allocation and perceived expensiveness as dependent variables to investigate the effects on consumers' judgement. However, different from the previous studies, the price presentations were in price tag format. It was an imitation of the real life price presentation, which helped to increase external validity.

3.3.1. Pretest

To confirm that participants perceived different font sizes of the measurement units as different salient levels, we conducted a pretest with 31 people recruited from an online crowdsourcing website, namely CrowdFlower.com. First, participants were presented two measurement unit (lb) price tag images: one with large font size of measurement unit, the other one with small font size of measurement unit (See Appendix 6). Then, participants were asked "select the one that you think the unit (lb) of the price is more obvious" by using a Bipolar scale. As we expected, participants indicated that the measurement unit with bigger font size as more obvious than the measurement unit with smaller font size (83.87%). Therefore, we concluded that different font size (small vs. large) of the measurement units represents different perceived salience (low vs. high).

3.4.2. Procedure

Participants were recruited from an online crowdsourcing website, namely CrowdFlower.com. After consenting to participate in the study, they were randomly assigned to one of the four research conditions (i.e., C1: low numerical magnitude and low unit salience, C2: low numerical magnitude and high unit salience, C3: high numerical magnitude and low unit salience, C4: high numerical magnitude and high unit salience). At the beginning of the study, participants were told to imagine that they were shopping for either fruits or packaged food with a budget of $35. After the instruction, four price tags containing two kinds of fruit (i.e., apple and grape) and two kinds of packaged food (i.e., cereal and bread) were presented to all participants. Across all the research conditions, the price presentations of the packaged food were the same; we only manipulated the price presentations of the fruits (target products). In the low numerical magnitude conditions (i.e., C1 and C2), measurement unit prices were presented as prices per pound (e.g., 2.49/lb). While in the high numerical magnitude conditions (i.e., C3 and C4), measurement unit prices were presented as prices per kilogram (e.g., 5.48/kg). In the low unit salience conditions (i.e., C1 and C3), the font sizes of the numerical magnitudes were about ten times bigger than the font sizes of the measurement units, a replication of a local grocery store's price tag design[3]. While in the high unit salience conditions (C2 and C4), the font size of the numerical magnitude was the same as the font size of the measurement unit. After reading the price tag information, participants were asked to indicate how they would allocate $35 on each of the product category. Participants were also asked to rate the perceived expensiveness of each product category using a 7-point Likert scale (1=very cheap, 7=very expensive). At the end of the survey, demographic information was obtained.

3.4.3. Results

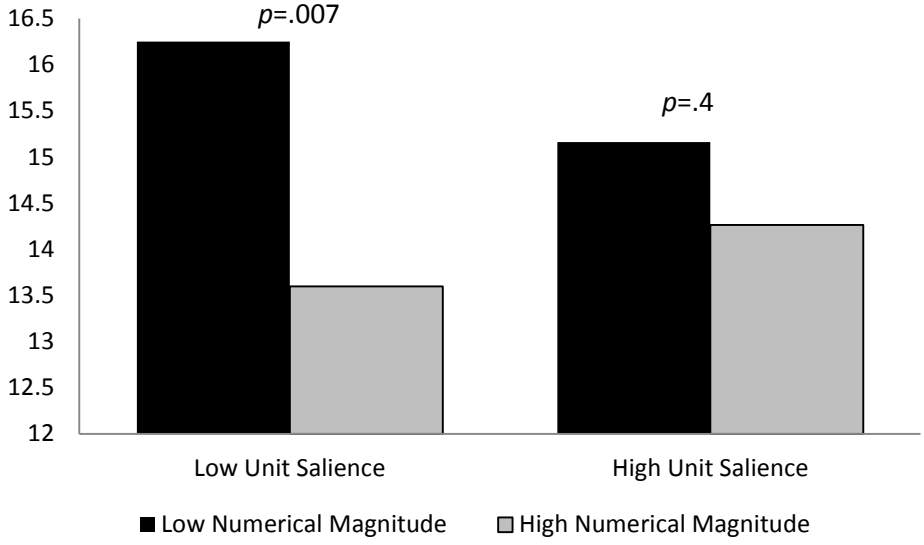
Participants (*M*-age=42.29, *SD*=13.123; female=58.03% vs. male=41.97%) were limited to those who had been resident in Canada for at least one year, therefore, 355 subjects (N1=92, N2=92, N3=86, N4=85) were included in the database. Independent variables were the numerical

[3] We reviewed the presentations of measurement unit price based on three grocery stores in downtown Montreal. The size ratios of the numerical magnitude to the measurement unit ranged from 3: 1 to 26:1. Across all the conditions, the font sizes of the numerical magnitude were bigger than or the same as the font sizes of the measurement unit. See "Additional review: measurement unit price presentation in Montreal and across different countries"

magnitude (i.e., low vs. high) and the unit salience (i.e., low vs. high), while the dependent variables were money allocation and perceived expensiveness.

For money allocation, a two-way ANOVA revealed a marginal significant interaction between numerical magnitude and unit salience, $F(3, 351)=2.233$, $p=.084$ (See Figure 2). Based on the post hoc tests, in the non-salient unit conditions, participants who were presented low magnitude measurement unit prices were more likely to allocate more money on the fruit category than those who were presented high magnitude measurement unit prices (*Ms*=16.250 vs. 13.598, *SDs*=5.785 vs. 7.103, respectively), $t(176)=2.732$, $p=.007$, $d=.413$. However, money allocation did not differ significantly between participants who were presented low magnitude measurement unit price and high magnitude measurement unit price in the unit-salient conditions (*Ms*=15.161 vs. 14.262, *SDs*= 6.63 vs. 7.585, respectively), $t(176)=.843$, $p=.400$, d=.127. The results suggested that by increasing the unit salience, the effect of numerical magnitude on money allocation was eliminated.

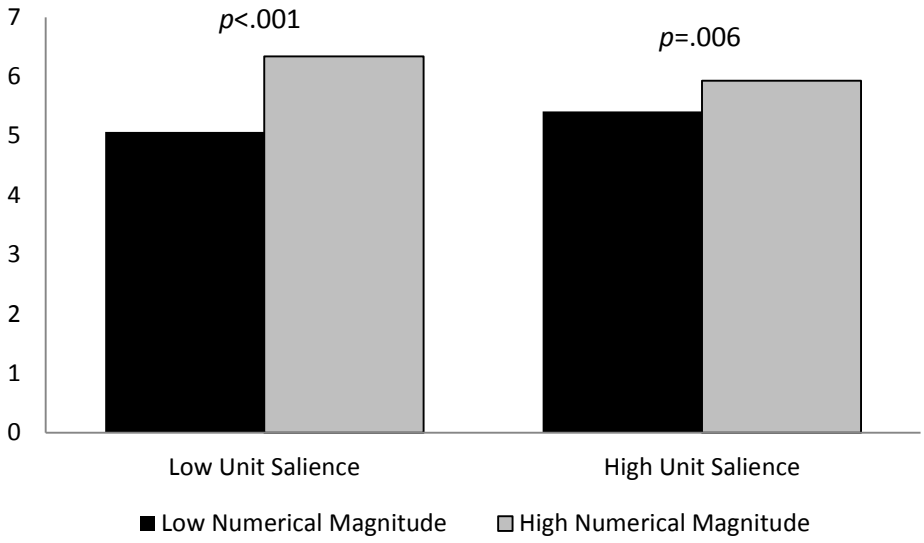
Figure 2: Money Allocation as a Function of Numerical Magnitude and Unit Salience



For perceived expensiveness, a two-way ANOVA revealed a significant interaction between numerical magnitude and unit salience, $F(3, 351) =8.879$, $p<.001$ (See Figure 3). Based on the post hoc tests, in the non-salient unit conditions, participants who were presented low magnitude measurement unit prices were more likely to indicate the fruit category as less expensive than those who were presented equivalent high magnitude measurement unit prices (*Ms*=5.065 vs. 6.341, *SDs*=1.518 vs. .81, respectively), $t(176)=6.896$, $p<.001$, $d=1.042$.

Consistently, in the unit-salient conditions, participants who were presented low magnitude measurement unit prices were also more likely to indicate the fruit category as less expensive than those who were presented equivalent high magnitude measurement unit prices (*Ms*=5.413 vs. 5.930, *SDs*=1.224 vs. 1.244, respectively), $t(176)=2.795$, $p=.006$, $d=.423$. The results suggested that by increasing the unit salience, the effect of numerical magnitude on perceived expensiveness was attenuated.

Figure 3: Perceived Expensiveness as a Function of Numerical Magnitude and Unit Salience



3.4.4. Discussion

The results in Study 4 demonstrated the unit salience effect: people's purchasing behaviors are more sensitive to the numerical magnitude when the measurement unit is less salient. However, when the measurement unit is more salient, people put more weight on the measurement unit, and the effect of numerical magnitude on price perception is attenuated. To be specific, when the measurement unit is less salient, people tend to indicate measurement unit price with lower numerical magnitude as less expensive, and measurement unit price with larger numerical magnitude as more expensive (H2a). Moreover, people are more likely to allocate more money for products that are priced using small numerical magnitudes (H3a). Nonetheless, the difference between low magnitude measurement unit price and large-numerical-magnitude measurement unit price is reduced when the measurement unit is salient (H2b and H3b).

Therefore, we may draw a conclusion that there is an interaction effect between numerical magnitude and unit salience.

In Study 4, we presented only one kind of measurement unit price in one research condition, which often happens in countries such as UK and US[4]. In countries such as Canada, retailers often present both the low and high measurement unit prices (i.e., 3.99/lb and 8.8/kg) on the price tag. However, they might control the salience of the price information (such as enlarge the font size of low measurement unit price and shrink the font size of high measurement unit price), hence, shifting consumers' attention to the more salient price information. Therefore, in the following study, we presented participants equivalent measurement unit prices simultaneously, manipulated the salience of the price information, and investigated the effects on price perception.

3.5. Study 5: Effects of Unit salience 2 (present two measurement unit prices)

The results of Study 4 supported the unit salience hypothesis (H2 and H3): when only one kind of measurement unit price is presented, people's judgement is sensitive to the numerical magnitude when the measurement unit is not salient. However, they put more weight on the measurement unit and less sensitive to the numerical magnitude when the measurement unit is salient. Nevertheless, grocery stores in countries such as Canada usually present more than one kind of measurement unit prices simultaneously, and the small measurement unit prices are usually more salient than the equivalent large measurement unit prices (e.g., $/lb vs. $/kg)[5]. The effect of unit salience may also applicable such that, when the equivalent small and large measurement unit prices are presented simultaneously, people pay less attention to the non-salient information and are more attentive to the salient information. Therefore, the purpose of Study 5 was twofold: first, consistent with Study 4, we wanted to search further support for the

[4] According to our research, in most of the times, grocery stores in UK present prices per kilogram, grocery stores in US present prices per pound, and grocery stores in Canada present both prices per pound and prices per kilogram. See "Additional review: measurement unit price presentation in Montreal and across different countries".

[5] We conducted a field study of grocery stores presenting more than one measurement unit prices for bulk products in downtown Montreal. The size ratios of the small measurement unit price to the large measurement unit price ranged from 1.372: 1 to 9.259:1. Across all the conditions, the font sizes of the small measurement unit prices were bigger than or the same as the font sizes of the large measurement unit prices. See "Additional review: measurement unit price presentation in Montreal and across different countries".

numerosity effect and unit salience effect. Second, we wanted to determine whether by manipulating the salience of measurement unit prices could influence consumers' judgment in a situation when both the equivalent measurement unit prices were presented simultaneously. It was expected that people pay more attention to the salient measurement unit price. To be more specific, when the large measurement unit price is less salient than the equivalent small measurement unit price (e.g., $/lb vs. $/kg), people pay less attention to the large measurement unit price, and make their judgement mostly based on the small measurement unit price. In such a case, according to the numerosity hypothesis, people may indicate the measurement unit price as less expensive. Nonetheless, as the large measurement unit price becomes more salient, people's attention shifts from the small measurement unit price to the large measurement unit price, and indicate the same measurement unit price as more expensive.

The design of Study 5 was similar to that of Study 4 in terms of the cover story, stimuli and dependent variables; however, participants were presented equivalent low and high measurement unit prices (i.e., $/lb and $/kg) simultaneously. Since in reality, the price in pound is always shown more prominently than the equivalent price in kilogram on the price tag, we wanted to imitate the practice in our research. Across all the research conditions, the salience of the small measurement unit prices remained the same, but we manipulated the salience of the large measurement unit prices in three levels (low, medium and high). Across all the research conditions, the small measurement unit prices were always more salient than the equivalent large measurement unit prices. Moreover, consistent with the real life grocery stores' price presentations, the salience of the small measurement unit prices would be more profound than the salience of the large measurement unit prices.

3.5.1 Pretest

To confirm that participants perceived different font sizes of the measurement unit prices as different salient levels, we conducted a pretest with 31 people recruited from an online crowdsourcing website, namely CrowdFlower.com. Stimuli were price tags with both the small measurement unit price (/lb) and the large measurement unit price (/kg; See Appendix 7). While font size of the small measurement unit price was controlled, we manipulated font sizes of the large measurement unit price in three different levels (i.e., small vs. medium vs. large). First, participants were presented two measurement unit price tag images (small vs. medium), and were asked "select the one that you think the kg-unit price is more obvious" by using a Bipolar

scale. Then, participants were presented two measurement unit price tag images (medium vs. large), and were asked "select the one that you think the kg-unit price is more obvious" by using a Bipolar scale. Finally, participants were presented two measurement unit price tag images (small vs. large), and were asked "select the one that you think the kg-unit price is more obvious" by using a Bipolar scale. As we expected, most of the participants indicated that medium font size were more obvious than small font size (87.1%), large font size were more obvious than medium font size (70.97%), and large font size were more obvious than small font size (83.87%). Therefore, we concluded that font sizes (small vs. medium vs. large) represents perceived salience (low vs. medium, high).

3.5.2. Procedure

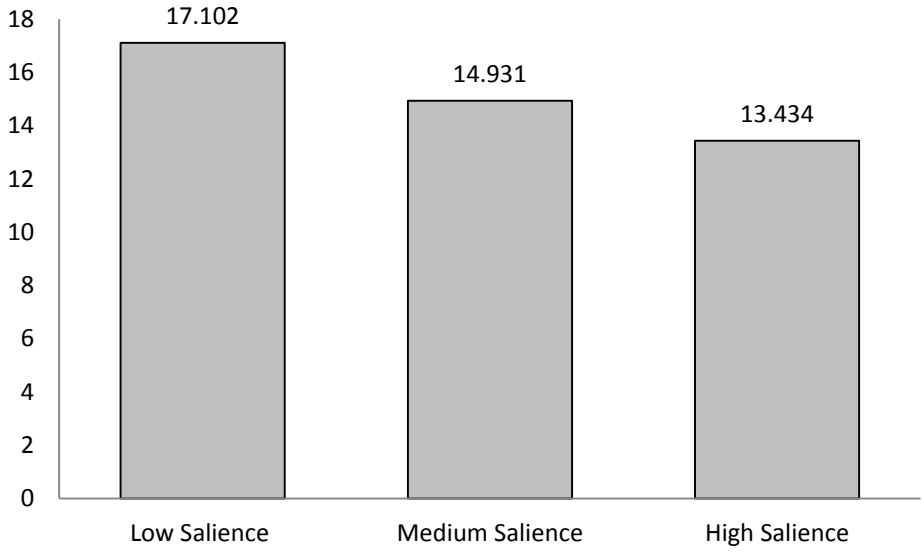
Participants (*N*=90; 30 participants in each research condition) were recruited from an online crowdsourcing website, namely CrowdFlower.com. After consenting to participate in the study, they were randomly assigned to one of the three salient conditions (i.e., low, medium, and high). At the beginning of the study, participants were told to imagine that they were shopping for either fruits or packaged food with a budget of $35 dollar. After the instruction, four price tags containing two kinds of fruit (i.e., apple and grape) and two kinds of packaged food (i.e., cereal and bread) were presented to all participants. Across all the research conditions, the size of the small measurement unit price was about one tenth of the size of the price tag. While the proportion of the low measurement unit price to the proportion of the high measurement unit price were 9:1, 5:1 and 1.3:1 in the low, medium, and high salience condition, respectively. After reading the price tags, participants were asked to indicate how they would allocate $35 on each of the product category. Participants were also asked to rate the perceived expensiveness of each product category using a 7-point Likert scale (1=very cheap, 7=very expensive). At the end of the survey, demographic information was obtained.

3.5.3. Results

Participants were limited to those who had been resident in Canada for at least one year, therefore, 87 subjects (*N*1=30, *N*2=31, *N*3=26; N=61; *M*-age=35.25, *SD*=12.902; female=54% vs. male=46%) were included in the database. Independent variable was the salience of the large measurement unit price (i.e., low, medium and high), while the dependent variables were money allocation and perceived expensiveness.

For money allocation, a one-way ANOVA revealed a marginal significant effect across three different salience conditions (F[2, 84]=2.649, p=.074). Specifically, participants who were in the low salience condition were the most likely to allocate more money on fruit category than those who were in the medium and high salience conditions. While participants who were in the high salience condition allocated least money to the fruits category compared to those who were in the low and medium salience condition (Ms=17.1017 vs. 14.9306 vs. 13.4338, SDs=5.897 vs. 5.813 vs. 6.272, respectively; See Figure 4). Based on the post hoc tests, there was significant differences between the low salience condition and the high salience condition (p=.025). However, there was no difference between the low salience condition and the medium salience condition, (p=.16) and between the medium salience condition and the high salience condition (p=.349).

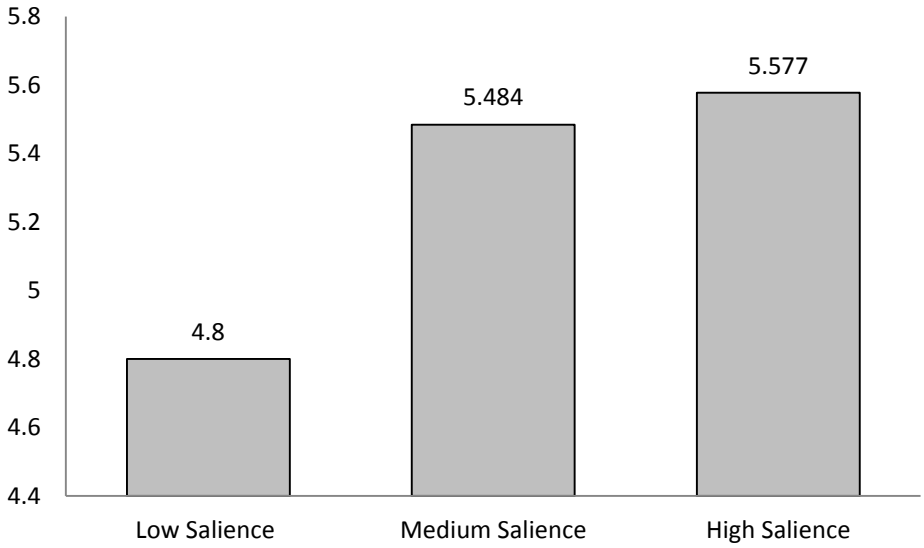
Figure 4: Money Allocation as a Function of Unit Salience



For perceived expensiveness, a one-way ANOVA revealed a significant effect across three different salience conditions (F[2, 84]=4.201, p=.018). Specifically, participants who were in the low salience condition indicated the fruit category as the least expensive compared to participants who were in the other two salient conditions. While participants who were in the high salience condition perceived the fruit category as the most expensive compared to participants who were in the other two conditions (Ms=4.800 vs. 5.4839 vs. 5.577, SDs=.925 vs. 1.122 vs. 1.301, respectively; See Figure 5). Based on the post hoc tests, there was significant differences between the low salience condition and the high salience condition (p=.011) and

between the low salience condition and the medium salience condition (p=.019). However, perceived expensiveness did not differ significantly between the medium salience condition and the high salience condition (t[55]=-.29, p=.775.).

Figure 5: Perceived Expensiveness as a Function of Unit Salience



Furthermore, even though not significant, we also found a pattern of the effect on price perception towards packaged food category (F=1.691, p=.191). Consistent with the effect on price perception towards the fruit category, participants who were in the low salience condition indicated the packaged food category as the least expensive compared to participants who were in the other two salience conditions. While participants who were in the high salience condition perceived the packaged food category as the most expensive compared to participants who were in the other two conditions (Ms=4.8667 vs. 5.2258 vs. 5.3462, respectively).

3.5.4. Discussion

Study 5 could be seen as an extension of the unit salience effect, and the results were consistent with our expectation that people pay more attention to the more salient price information even though both the measurement unit prices are presented, and that manipulation of the salience of the price information influences people's judgement. More specifically, when the large measurement unit price was not salient, people focused on the small measurement unit price and were sensitive to the small measurement unit price. Therefore, according to the numerosity hypothesis, people formed low-price perception, and were more likely to spend money. However, when the presentation of the large measurement unit price became salient,

people put more weight on the large measurement unit price, and were less attentive to the small measurement unit price. Therefore, people formed high-price perception and were less likely to spend money.

Another interesting finding was the potential effect on perceived expensiveness towards packaged food category. One possible explanation is related to anchoring and adjustment theory (Tversky and Kahneman, 1974) which demonstrates the tendency that individuals rely heavily on the perceived most important piece of information (i.e. anchor) and adjust the rest information based on the decreasing order of their perceived importance (Yadav, 1994). According to Wong and Kwong (2000), people may bias a subsequent numerical judgement when they have already anchored on an arbitrary number. Since in our study design, the prices of the fruit category were always presented to participants first (i.e., price tags of the fruit category were on the left, while price tags of the packaged food category were on the right), it is highly possible that the judgement towards the fruits category would bias the judgement towards the packaged food category. Moreover, as the low measurement unit prices were always more salient than the equivalent large measurement unit prices, participants might anchor on the numerical magnitude of the low measurement unit price, and adjust the numerical magnitude of the large measurement unit price. However, across different research conditions, the salience of the large measurement unit prices was different, thus the adjustment might become even insufficient when the large measurement unit price is less salient. Therefore, compared to participants in the high salience condition, participants in the low salience condition might adjust the magnitude of the large measurement unit price insufficiently, leading to more reliance with the magnitude of the small measurement unit price. Consequently, compared to participants in the high salience condition, participants in the low salience condition were more likely to form low-price perception towards the fruits category, and transfer the image to the packaged food category. Even though in Study 5, this assumption was not significantly supported, we expect the effect become significant if future study increase sample size or redesign the study.

4. General Discussion and Theoretical Implication

Though there is sufficient evidence about the effect of numerical value on magnitude perception, the effect of numerical value on price perception is under-investigated. Thus, the primary objectives of this project were to fill this gap by identifying how consumers' price perceptions are affected by the measurement system in which prices are presented, and explicating the theoretical processes which lead to the biased perceptions. In Study 1, 2 and 3, we applied different methods to investigate the numerosity effect under the condition of measurement unit price. We found that, when judging a measurement unit price, people rely heavily on the numerical magnitude, while underweight the meaning of the measurement unit. Therefore, a measurement unit price with smaller numerical magnitude is evaluated as less expensive than equivalent measurement unit price with larger numerical magnitude. Prior study of numerosity theory focuses on numerosity effect when the numerical magnitude and the unit information are in the opposite direction. That is, large numerical magnitude affixes to small unit, whereas small numerical magnitude affixes to large unit (e.g., 7300m vs. 7.3km; Wong and Kwong, 2000). The findings in this research paper not only testify robustness of the numerosity theory, but also extend the theory in condition as measurement unit price, where the numerical magnitude and the unit information are in the same direction. That is, small numerical magnitude affixes to small unit, whereas large numerical magnitude affixes to large unit (e.g., 3.99/lb vs. 8.8/kg).

According to Wertenbroch et al., (2007) and Shen and Urminsky (2013), sensitivity to the numerical magnitude is attributed to failing to consider the measurement unit. Therefore, we hypothesized that, by manipulating the salience of the measurement unit, peoples' attention shifts from the numerical magnitude to the measurement unit. Hence, the meaning of the measurement unit can be considered into the overall judgement of the measurement unit price. The results of Study 4 and 5 shown interaction effect between numerical magnitude and measurement unit, and imply that subtly making the measurement unit more salient (via relative font size) increases attention to the measurement unit. To be specific, when measurement unit is less salient, people's judgement towards the price is sensitive to numerical magnitude; however, when measurement unit becomes salient, the effect of the numerical magnitude to judgement is attenuated. These findings shed light on how people reason between numerical magnitude and

measurement unit, and have important implications for how numerical information and measurement unit are presented and used in decision making.

5. Managerial Implication

Serval managerial implications could be generated from this article. First, though metric scale is widely accepted in most of the countries, using different measurement scales for the same product in the same country, even in the same store still happens. For example, in China, people use both the traditional measurement scales (e.g., Jin and Liang) and the metric scale. Hence, consumers who are presented to different kinds of measurement unit might be affected by the numerical magnitude and the salience of the measurement unit. In retailers' position, in order to lower consumers' price perception, they are suggested to apply small measurement unit price (e.g., $/100g) for pricing expensive products, such as bulked coffee bean, and loose nuts. Meanwhile, retailers could also sub-pack the expensive product into a small container, and price the product based on per container in order to avoid measurement unit price. For example, blue berry, raspberry, blackberry, and strawberry are usually sold in a small plastic box.

Second, for the same total price of a product, being priced into low measurement units has a larger nominal quantity than that being priced into large measurement units. Let's say the measurement unit price for apple is $2/lb which is $4.4/kg, $10 worth apple is about 5 pounds or 2.27 kilograms. Therefore, lower measurement unit price may make consumers to emerge inference that spending the same money can receive higher value.

Third, when shopping abroad, consumers are more likely to encounter unit price with different measurement units. For instance, gas price in Canada is based on cent per liter; while the gas price in USA is based on dollar per gallon. Consumers may get confused when encounter these measurement unit prices with unfamiliar measurement system. Hence, it would be better and more convenient if retailers could present the prices in different measurement units such as metric scale that is used by most of the countries in the world.

Fourth, regulations on how to use measurement unit price should be imposed. In order to lower consumers' price perception and mitigate profitability, retailer may take advantage of using small measurement unit price and controlling the salience of price information. Moreover, people of low educational level and from poorer sections might be more susceptible to the numerosity effect, and make sub-optimal decision because it is difficult for them to convert between measurement unit prices. For the sake of contributing to a fair and competitive marketplace for consumers and retailers, regulators should pay attention to the effect brought by measurement unit price, and regulate the use of measurement unit price. For example, retailers in

Canada are required to use metric scale for pricing bulk products such as vegetables and fruits; however, using the imperial scale is also tolerable. However, retailers still have a considerable freedom in terms of how they display the information of the measurement unit price. Therefore, rules should also be invented for controlling the price presentation in terms of positioning, proportion, size, font and color of the numerical magnitude and the measurement unit.

6. Limitation and Directions for Future Research

The present research is concerned with demonstrating and explaining numerosity effect on perception of measurement unit prices with different measurement units under controlled experimental conditions at the individual consumer level. Even though we tried to imitate reality by presenting participants price tags in the research, the findings generated may still lack external validity. It would be useful for future research to examine market-level (scanner) data on consumer purchases across different countries for evidence of the interaction effect between numerical magnitude and unit salience described here.

Furthermore, across our research, we manipulated the salience of measurement unit by manipulating font sizes. Literature shows that beyond font sizes, other cues, such as color (Shen and Urminsky, 2013), physical and psychological distance, construal level (Monga and Bagchi, 2012), may also lead to similar effects. It would be very beneficial and interesting for future research to investigate the potential links between our work and other emerging approaches to understand how other representations affect perception of measurement unit price.

Also note that left-digit and ending-digit might also have effect on perception (Thomas and Morwitz, 2005; Manning and Sprott, 2009). For example, people perceive two prices that differ by 1 cent (e.g., 3.99 and 4) significantly different (Thomas and Morwitz, 2005). Therefore, when comparing measurement unit prices such as 3.99/lb and 8.8/kg, in addition to the numerosity effects, the comparison might also be affected by the left-digit effect. However, this possible confounding factor could not be ruled out in our research, leading to a potential inference that 3.99/lb is even more low-priced. Hence, it would be helpful to examine the interaction effect between numerosity and left-digit effect.

Moreover, at the final part in study 1, we asked participants to estimate the price of a box of 450-gram cereal in both of the low numerical magnitude condition (i.e., lb) and the high numerical magnitude condition (i.e., kg). Those who were in the low numerical magnitude condition gave a lower estimation than those who were in the high numerical magnitude condition (Ms=5.1627 vs. 10.27, respectively; p=.004). Therefore, it is highly possible that for grocery stores that are using small measurement unit, customers anchor on the small measurement unit price (e.g., 3.99/lb), and emerge an inference that other unrelated products are also in low prices. Therefore, future research can look into possibility of the effect of measurement unit price presentation on price perception of other unrelated products.

Additional, individual differences, such as personality traits or education level, may also have effect on how people perceive a measurement unit price. For instance, Rick et al. (2008) suggested the "spendthrift-tightwad" scale for testing individual differences in the pain of paying. They proposed that people who are spendthrift feel less pain of paying when making a purchase decision. Hence, this kind of consumers tends to spend more money than the ideal status. By contract, people who are tightwad feel pain of paying easily, they, therefore, tend to spend less money. Under the context of measurement unit price, since spendthrift consumers feel less pain of paying, they may not be influenced by the numerical magnitude and unit salience intensively. However, for the tightwad consumers, they may be affected by subtle changed of the numerical magnitude and the unit salience easily. Future research can investigate the potential individual differences that could moderate the numerosity effect and the unit salience effect under the context of measurement unit price.

7. Conclusion

In Canada, both pound and kilogram are used for pricing bulked products such as fruits and vegetables. Other countries may apply other kinds of measurement system for pricing the same products. What's more, when setting the measurement unit price, retailers often emphasize on the numerical magnitude; while the measurement unit, sometimes, is hard to be noticed. The current research adds to the understanding of the measurement unit price effects by demonstrating that, when measurement unit is less salient, consumers tend to ignore measurement units, and over attentive to the numerical magnitude. Therefore, large measurement unit price with higher level of measurement unit and larger numerical magnitude is regarded as more expensive than equivalent small measurement unit price with low level of measurement unit and small numerical magnitude. Nevertheless, when the measurement unit is more salient, consumers are less sensitive to the numerical magnitude, and more reliance on measurement unit. Since measurement unit price is under-investigated by researches, the current research serves as an important early step in understanding this effect on price perception.

8. Additional review: measurement unit price presentation in Montreal and across different countries

In order to understand how retailers present measurement unit prices, in this part, we presented measurement unit price presentation across three different grocery chains in downtown Montreal, Canada. In addition, given that different counties apply different measurement systems, we collected information from the Internet about presentation of the measurement unit prices on flyers and other promotional materials across different countries. We hoped to compare differences, and found interesting insights for our research design.

8.1. Measurement unit price presentations in Montreal, Canada

We visited three different grocery chains (i.e., Chain A, Chain B and Chain C) in downtown Montreal, and took photos of seven different kinds of presentation of the measurement unit price on price tags. We calculated the proportion of numerical magnitude of the pound-price to the measurement unit of the pound-price, and the proportion of the pound-price to the kilogram-price.

8.1.1. Chain A

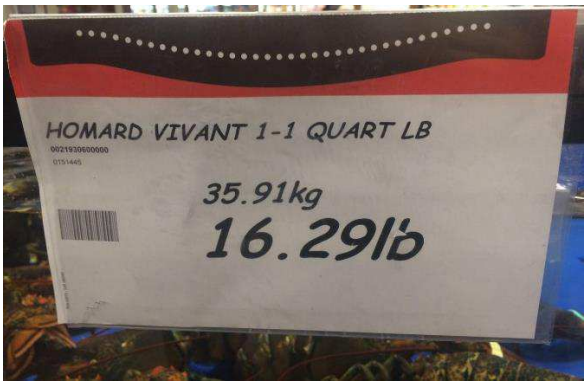
Pound numerical magnitude: measurement unit =15.81:1

Pound price: kilogram price =3.73:1

Pound numerical magnitude: measurement unit =26:1

Pound price: kilogram price =N/A

8.1.2. Chain B



Pound numerical magnitude: measurement unit =3:1

Pound price: kilogram price =3.24:1

Pound numerical magnitude: measurement unit =5.425:1

Pound price: kilogram price =7.64:1

Pound numerical magnitude: measurement unit =16.76:1

Pound price: kilogram price =9.259:1

8.1.3. Chain C

Pound numerical magnitude: measurement unit =9.1875:1

Pound price: kilogram price =1.372:1

Pound numerical magnitude: measurement unit =11.378:1

Pound price: kilogram price =1.614:1

8.1.4. Conclusion

Based on visual appearance and statistical information, we found that:

All the price tags presented the small measurement unit prices (i.e., $/lb). Six out of seven price tags also presented the equivalent large measurement unit prices (i.e., $/kg) simultaneously.

For the low measurement unit prices, the proportions of the numerical magnitudes were always higher than the corresponding proportions of the measurement unit. To be specific, the proportion of the numerical magnitude to the measurement unit ranged from 3: 1 to 26:1.

The proportions of low measurement unit prices were always higher than the proportion of the equivalent large measurement unit prices. Specifically, the proportion of the low measurement unit price to the proportion of the high measurement unit price ranged from1.372:1 to 9.259:1

Presentations of measurement unit prices were not consistent even in the same grocery store.

8.2. Measurement unit price presentations across different countries

We collected information of measurement unit price presentations used by several major grocery chains in Canada, US, China, UK and Oceania. Noted, the pictures below are not in the original size, some of them were magnified for observational convenience.

8.2.1. Canada

Chain	Product	Measurement unit used
1		lb
2		Lb and kg
3		Lb

4		Lb and kg
5		Lb
6		Lb and kg
7		Lb and kg
8		Lb and kg

Findings:

In Canada, both pound-price (small measurement unit price) and kilogram-price (large measurement unit price) are prevalent across different grocery chains.

Across all the conditions, retailers present small measurement unit price.

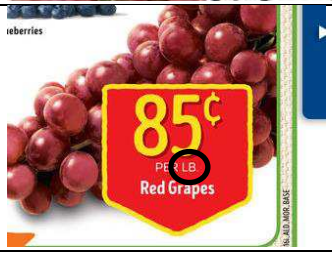
In three out of eight conditions, retailers present only small measurement unit prices. In five out of eight conditions, retailers present both small measurement unit prices and large measurement unit prices.

For the small measurement unit prices, font sizes of numerical magnitudes are bigger than font sizes of measurement units.

When both the small and the large measurement unit prices are presented, the proportions of the small measurement unit prices are always higher than the proportions of the large measurement unit prices. In extreme conditions such as condition 4 and condition 8, the large measurement unit prices are too small to be noticed easily.

In some cases, such as packaged product, except from unit prices, retailers also mention measurement unit prices even though the products are impartible (e.g., $1.6/100g; see example below).

8.2.2. US

Chain	Product	Measurement unit used
1		lb
2		lb

3		lb
4		lb
5		lb
6		lb
7		lb

Findings:

In US, pound-price (small measurement unit) is the only measurement unit used in grocary chains for pricing bulked products.

Across all the conditions, font sizes of the numerical magnitudes are bigger than font sizes of the measurement units.

Numerical magnitudes are emphasized by using different font, font sizes, and colors.

8.2.3. China

Chain	Product	Price	Measurement unit used
1		4.5/g	gram
2		12.8/500g	500 gram
3		6.9 /Jin	Jin (=500g)
4	N/A		Liang (=50g)
5		35/kg 17.5/500g	Kilogram 500g

Note: due to the geograpgic distance and the underdeveloped of the online grocery information, we were unable to find pictures for each kinds of presentation information of measurement unit prices. However, the measurement units mentioned above are used intensively by Chinese grocery stores.

Findings:

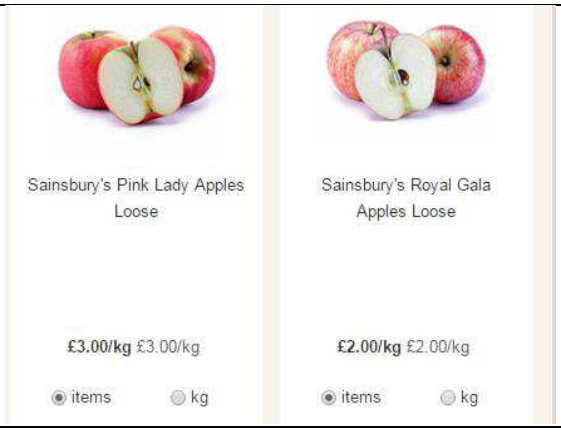
Both international measurement units and traditional measurement unit are used in Chinese grovery stores.

Based on different locations and product categories, retailers apply different measurement units for pricing bulked products: /500g is the most prevalent measurement units for pricing bulked products in large grocery stores; Local grocery markets often use traditional measurement units, such as Jin and Liang; Online grocery such as Taobao, retailers often use Jin or kg for pricing vegetables and fruits; When pricing for herbal medicine and other traditional and expensive products, Liang is the most often used measurement unit.

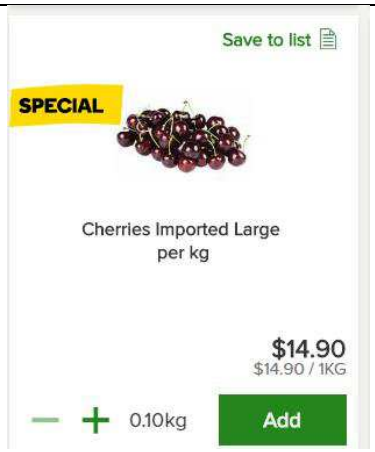
In the old days, 500G=1 Jin =16 Liang. Since it was difficult for calculation, Chinese government changed the conversion factors to 500G=1Jin = 10 Liang nowadays. However, the old conversion factors are still popular in several industries, for example Chinese herbal medicine, but not in grocery store anymore.

8.2.4. UK

Chain	Product	Measurement unit used
1		kg
2		kg

3		kg

8.2.5. Oceania

Chain	Product	Measurement unit used
		kg
		kg
		kg

Findings:

In UK, kg is the most prevalent measurement unit used in grocery stores.

In Oceania, kg is the most prevalent measurement unit used in grocery stores.

In Oceania, font sizes of the numerical magnitude magnitudes are bigger than font sizes of the measurement unit.

8.2.6. Insight

Retailers are more inclined to present small measurement unit prices with smaller numerical magnitude in order to lower consumer's price perception. Also, it seems that retailers tend to use small font size for the measurement units, even when the small measurement unit price is the only measurement unit price presented to consumers. The purpose might be: since total price is based on both measurement unit price and quantities, emphasizing on the numerical magnitude instead of the measurement unit might leads consumers underestimate the quantities.

For people who have visual problems or people who do not read the prices carefully, it is very difficult for them to notice the large measurement unit prices. Therefore, they might be more susceptable to the numerical magnitude, and more likely to form price perception based on numerical magnitude of the small measurement unit price. If small measurement unit price is regarded as less expensive, consumers may have higher tendency to puchase products priced in small measurment unit.

For retailers who sell loose products, using small measurement unit price may increase sales volumn, since smaller measurement unit price may induce the inference that product is less expensive.

For policy makers, they should invent related policy and rugulate the uses of measurement unit price, in order to make the price information more transparent.

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10. Appendices

10.1. Appendix 1: Scenario description and stimuli of Study 1

A manager from a grocery store may want to know people's opinion about the price of organic fruits. Following, you are going to review a list of fruits, and their normal and organic prices. Please read carefully, and answer the following questions.

Low measurement unit price condition (pound)

	Normal price	Organic price
Orange	1.82/lb	2.21/lb
Strawberry	4.99/lb	5.73/lb
Apple	1.85/lb	2.5/lb
Blueberry	5/lb	6.75/lb

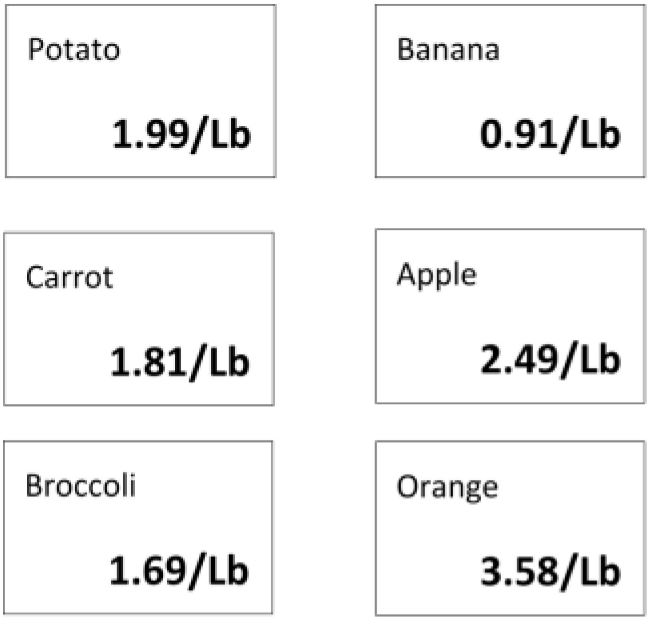
High measurement unit price condition (kilogram)

	Normal price	Organic price
Orange	4/kg	4.68/kg
Strawberry	10.98/kg	12.61/kg
Apple	4.07/kg	5.5/kg
Blueberry	11/kg	14.85/kg

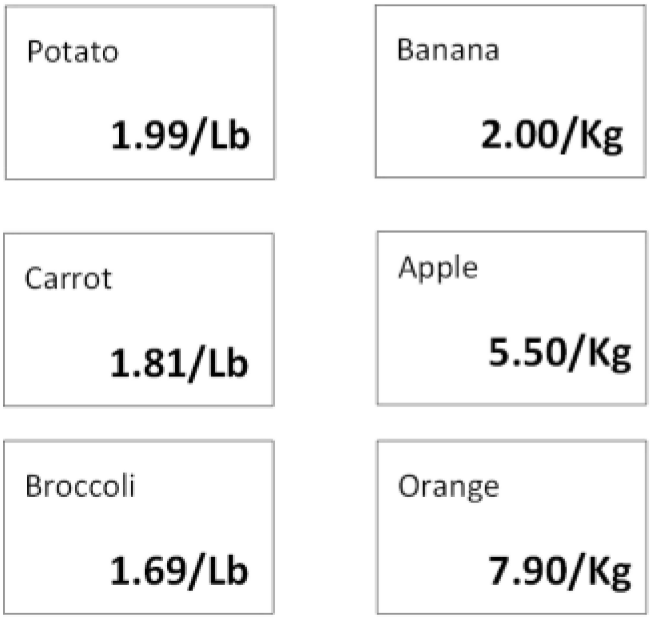
10.2. Appendix 2: Scenario description and stimuli of Study 2

Imagine that you are shopping in a grocery store for vegetables and fruits with a budget of $20. Below is information relating to products and prices. Please read carefully and answer the questions.

Low numerical magnitude condition (pound)



Large numerical magnitude condition (kilogram)



10.3. Appendix 3: Scenario description and stimuli of Study 3

Imagine that you have a $55 weekly budget. You may want to budget some money on grocery store for food, either prepackaged food (such as a box of cereal) or vegetables and fruits. Below, we provide some common products and their prices, taken from nearby grocery stores. Please indicate your likely purchase behavior.

Low numerical magnitude condition (pound)

Vegetables and Fruits	**Price**
Apple	2.49 / lb
Broccoli	2.55 / lb
Bell Pepper	3.99 / lb
Grape	4.52 / lb
Etc.	

Packaged Food	**Price**
Pasta	2.29 / packet
Cereal	4.99 / box
Bread	3.79 / loaf
Spaghetti Sauce	4.49 / can
Etc.	

Large numerical magnitude condition (kilogram)

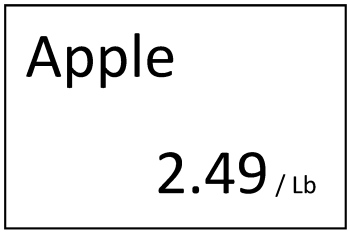
Vegetables and Fruits	**Price**
Apple	5.48 / kg
Broccoli	5.61 / kg
Bell Pepper	8.80 / kg
Grape	9.94 / kg
Etc.	

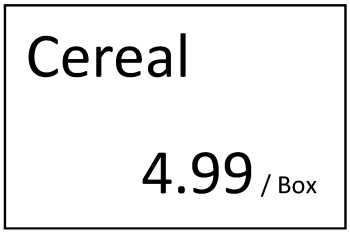
Packaged Food	**Price**
Pasta	2.29 / packet
Cereal	4.99 / box
Bread	3.79 / loaf
Spaghetti Sauce	4.49 / can
Etc.	

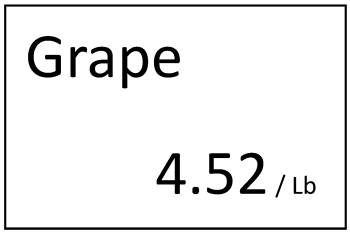
10.4. Appendix 4: Scenario description and stimuli of Study 4

Imagine that you have a $35 weekly budget for food, either fruits or packaged food. Below, we provide the price information of several common products, taken from nearby grocery store. Please indicate your likely purchase behavior.

Condition 1: low numerical magnitude and low unit salience

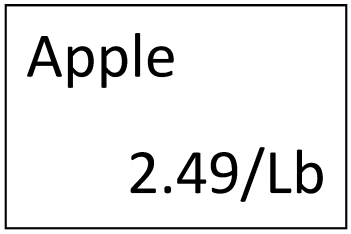


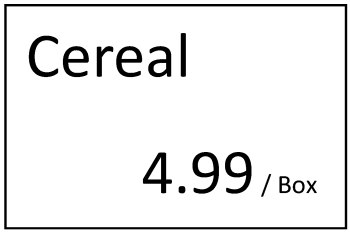


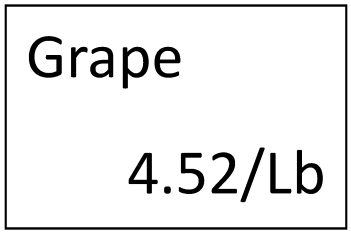


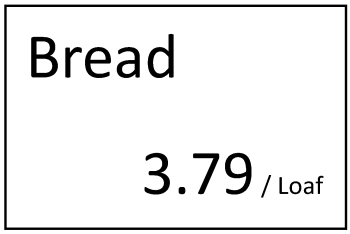
Etc. **Etc.**

Condition 2: low numerical magnitude and high unit salience



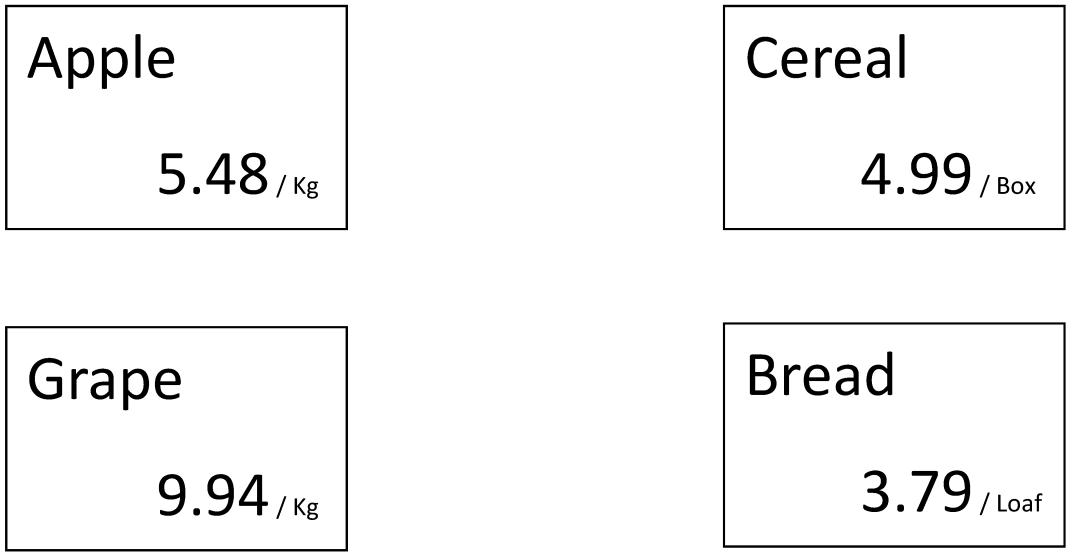






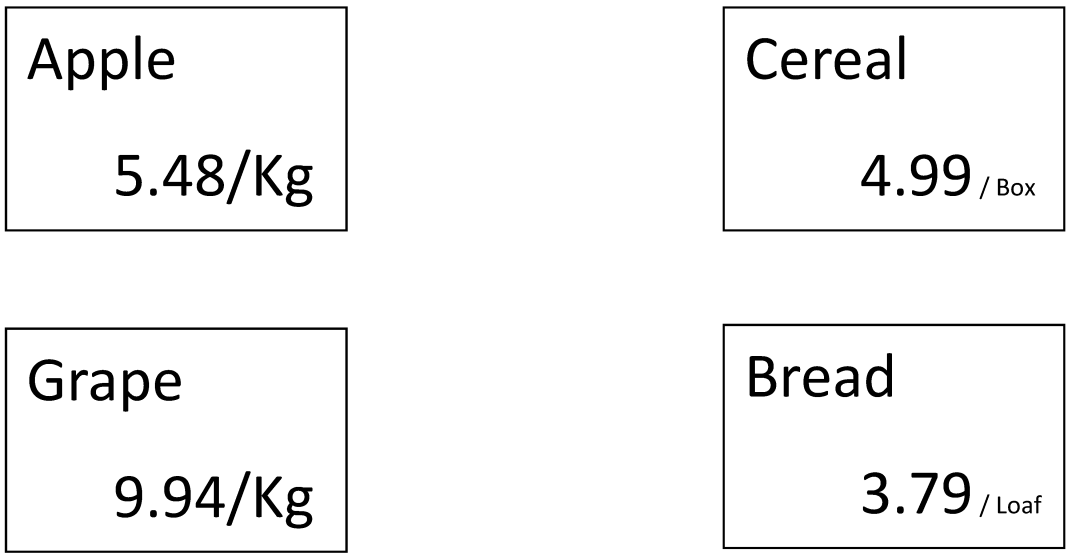
Etc. **Etc.**

Condition 3: high numerical magnitude and low unit salience



Etc. **Etc.**

Condition 4: high numerical magnitude and high unit salience

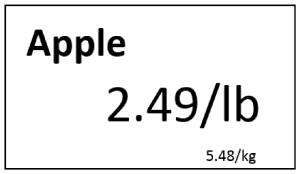


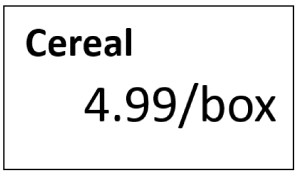
Etc. **Etc.**

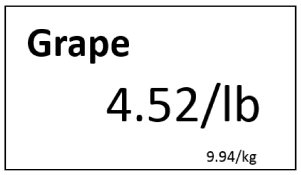
10.5. Appendix 5: Scenario description and stimuli of Study 5

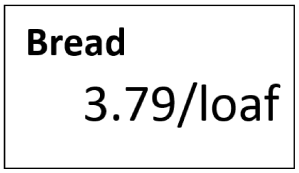
Imagine that you have a $35 weekly budget for food, either fruits or packaged food. Below, we provide the price information of several common products, taken from nearby grocery store. Please indicate your likely purchase behavior.

Condition 1: low salience



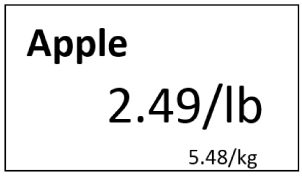


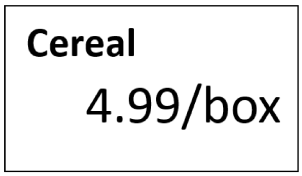


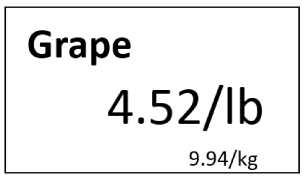


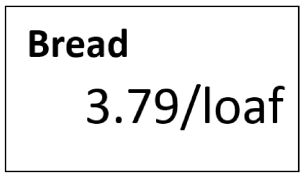
Etc. **Etc.**

Condition 2: medium salience



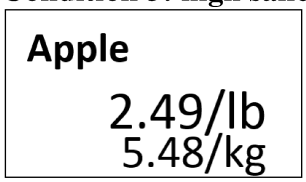


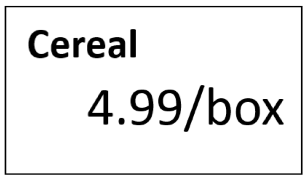


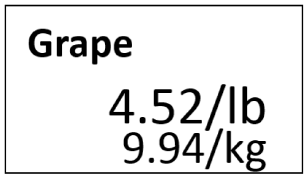


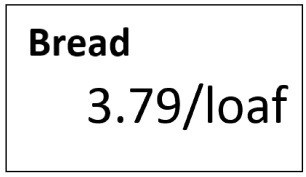
Etc. **Etc.**

Condition 3: high salience





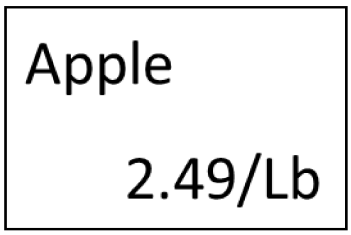




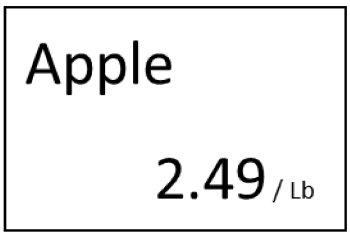
Etc. **Etc.**

10.6. Appendix 6: Stimuli used for Pretest in Study 4

Large font size

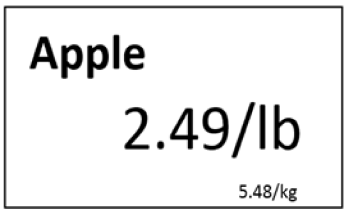


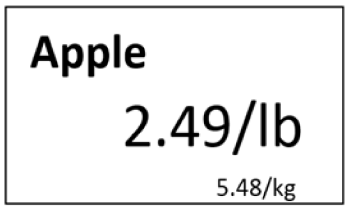
Small font size



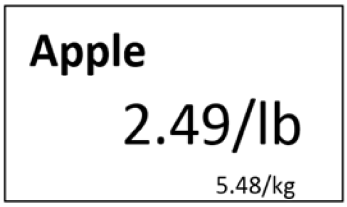
10.7. Appendix 7: Stimuli used for Pretest in Study 5

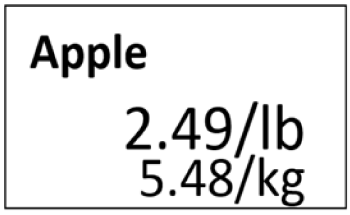
Small font size vs. medium font size





Medium font size vs. large font size





Small font size vs. large font size