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Fooled by Numbers: Investigating the Role of Numerical Information in Judgments.

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NEDERLANDSTALIGE SAMENVATTING

Mensen worden dagelijks geconfronteerd met numerieke informatie: op productverpakkingen (bvb., garantie, batterijduur, calorie informatie), in reclamefolders (bvb. kortingen of prijzen), op loonbrieven, in kranten,... . Het is duidelijk dat numerieke informatie echt een centrale plaats in onze maatschappij bekleedt. Maar hoe verwerken mensen die numerieke informatie eigenlijk? En hoe beïnvloedt de manier van verwerken de uiteindelijke evaluaties en beslissingen? In dit doctoraal proefschrift onderzoeken we hoe mensen inkomens en product attributen verwerken en hoe mensen deze informatie in hun beslissingen opnemen. Het hoofddoel van deze dissertatie is om aan te tonen dat numerieke informatie bepaalde procedures, gedachten en zelfs gevoelens kan opwekken die dan op hun beurt gebruikt worden om beslissingen te maken. We tonen aan dat dit uiteindelijk soms kan leiden tot beslissingen die niet stroken met normatieve verwachtingen. Onze hypothesen zijn vooral gebaseerd op literatuur rond "numerical cognition" en "judgment and decision making". Door ons te baseren op principes van beide literaturen, hopen we de huidige kennis over dit onderwerp uit te breiden.

In het eerste essay "A 20% Income Increase for Everyone?": The Effect of Relative Increases in Income on Perceived Income Inequality", tonen we aan welke procedures er mogelijks toegankelijk worden wanneer inkomensverschillen worden beoordeeld. We kijken hierbij ook of deze percepties ook overeenkomen met wat met in sommige literatuur rond inkomensongelijkheid wordt verondersteld. Terwijl veel werk rond inkomensongelijkheid al heeft aangetoond dat stijgende inkomensongelijkheid grote consequenties kan hebben, is er relatief weinig geweten over welke factoren bijdragen tot de subjectieve percepties van inkomensongelijkheid. Een belangrijke assumptie van veel onderzoek rond inkomensongelijkheid is dat een stijging met een constant percentage geen effect heeft op de inkomensongelijkheid. We testen deze assumptie in dit essay. Ons onderzoek toont aan dat mensen wel degelijk vinden dat de inkomensongelijkheid stijgt wanneer de relatieve verschillen constant blijven maar de absolute verschillen tussen inkomens groter worden, zelfs wanneer we koopkracht constant houden. In drie studies tonen we aan dat mensen ook naar absolute verschillen kijken wanneer ze inkomensongelijkheid beoordelen. In een eerste studie tonen we dit aan door een mixed design te gebruiken: de gepercipieerde inkomensongelijkheid veranderde dus niet enkel in een within-subjects design maar ook in een between-subjects design. Wanneer alle inkomens verdubbelden vonden de deelnemers dat de inkomensongelijkheid groter was, ook al was de GINI coefficient in beide inkomensdistributies hetzelfde. In een tweede studie repliceren we deze bevindingen in een andere setting. Terwijl we in de eerste studie euro gebruikte als munteenheid gebruiken we in de tweede studie een fictieve munteenheid zodat we alle effecten die een bekende eenheid als euro teweeg kan brengen kunnen uitsluiten. In een derde studie tonen we aan dat het effect heel robust is voor framing effecten en ook opduikt wanneer de inkomensverhoging als een percentage of een absolute verhoging wordt gepresenteerd. Tenslotte toont deze laatste studie ook aan dat wanneer inkomens verhoogt worden met een scalar, de percepties van fairness dalen en gevoelens van afgunst stijgen.

In hoofdstuk III, “Are all Units Created Equal?: The Effect of Default Units on Product Evaluation”, verbreden we onze focus naar de eenheden waarin cardinale numerieke informatie is uitgedrukt. We richten onze focus met name op hoe het beschrijven van informatie in een andere eenheid kan leiden tot specifieke subjectieve gevoelens die, op hun beurt, evaluaties kunnen beïnvloeden. Eerder onderzoek over dit thema heeft al aangetoond dat mensen grotere kwantiteiten afleiden van kleinere eenheden, meestal met de veronderstelling dat de eenheden waarin informatie is uitgedrukt dezelfde betekenis hebben. In dit onderzoek baseren we ons op literatuur over categorisatie en numerieke cognities, en contesteren we de bovenstaande assumptie. We tonen aan dat mensen dikwijls favoriete eenheden hebben voor bepaalde attributen. Deze favoriete eenheden zijn dikwijls de meest optimale afweging tussen een voorkeur voor kleine nummers en een nood om precies te zijn (studie 1a). Daarom is het zo dat deze eenheden een bekend gevoel geven en worden ze ook meer gebruikt (studie 1b). In een tweede studie tonen we aan dat het uitdrukken van informatie in die favoriete eenheid een positief effect kan hebben op productevaluaties. In een derde studie, leveren we bewijs dat subjectieve gevoelens de oorzaak zijn voor dit effect door gebruik te maken van een misattributieparadigma, waarbij de subjectieve gevoelens gegenereerd door de eenheid worden gemisattribueerd aan achtergrondmuziek. In een vierde studie demonstreren we aanvullend bewijs voor dit mechanisme door middel van statistische mediatie. In dezelfde studie, sluiten we ook een alternatieve verklaring uit die stelt dat het effect ook door de subjectieve gevoelens van de nummers zou kunnen gegenereerd worden. In een laatste studie tonen we tenslotte aan dat dit effect vooral speelt wanneer een product op zichzelf wordt beoordeeld. Wanneer meerdere producten expliciet worden vergeleken dan is er geen effect van productinformatie in een favoriete eenheid te beschrijven.

In hoofdstuk IV, “When Precision Protects: Precise Product Information as a Source of Control”, kijken we naar een belangrijke factor die het gewicht van numeriek informatie kan verhogen. We richten onze focus op hoe mensen die even geen persoonlijke controle voelen over hun leven een bepaald doel kan activeren dat op zijn beurt het belang van numerieke informatie kan verhogen. In hun dagelijkse leven worden mensen immers dikwijls geconfronteerd met situaties waarin ze geen controle voelen. In dit essay proberen we aan te tonen hoe dit een invloed kan hebben op consumentenkeuzes. We tonen aan dat, vergeleken met mensen die controle hebben, diegenen die geen controle hebben meer op zoek gaan naar precieze informatie. Consumenten die controleverlies leiden kiezen ook meer op basis van precieze productinformatie en willen meer betalen voor een product dat in precieze, numerieke informatie is uitgedrukt. Deze voorkeur voor precieze informatie verdwijnt al vanaf informatie ook maar de minste vaagheid vertoont.

Als besluit kunnen we stellen dat deze dissertatie een beter zicht probeert te geven op hoe mensen numerieke informative verwerken. We maken hierbij gebruik van inzichten uit de numerieke cognitive literatuur en uit literatuur over hoe mensen beslissingen maken. In drie essays bekijken we verschillende omstandigheden waarin mensen numerieke informatie krijgen en bekijken we hoe deze informatie hun beslissingen beïnvloedt.

ENGLISH SUMMARY

People confront numerical information on a daily basis: on product packages (e.g., warranty, battery life, calorie information), on shopping websites (e.g., discounts), on paychecks, in newspapers (e.g., number of deaths in a terrorist attack). All in all, numerical information seems to have occupied a central place in our society. But how do people process numerical information and how does it affect judgments? In this dissertation, we investigate how people process numerical information in situations involving incomes and product attributes. We aim to demonstrate that numerical information may render specific procedures and thoughts accessible which people in turn use to make decisions. Interestingly, in some situations, this may lead people to make decisions that run counter to normative expectations. We draw our hypotheses from research on numerical cognition and judgment and decision making. By using principles from both literatures, we aim to advance knowledge of how people construct evaluations based on numerical information.

In chapter II "A 20% Income Increase for Everyone?": The Effect of Relative Increases in Income on Perceived Income Inequality", we aim to show which procedures may become accessible when income differences are judged and how these perceptions may differ from what current literature on income inequality would assume. Although extant research shows that increasing income inequality has large consequences for people's lives, little is known about the factors that determine perceptions of income inequality. While most research on income inequality implicitly assumes that a fixed percentage increase in income across all income levels does not alter income inequality, the present paper tests this assumption. In this paper, we show that relative increases in income lead to increased perceptions of inequality, even when buying power is held constant. Across three studies, using different manipulations, we show that people also attend to absolute differences when judging income inequality. In a first study, we offered evidence for this proposition by employing a mixed design. In addition, we found that perceived inequality not only increases in a within subjects design, but also in a between subjects design. That is, participants rated an income distribution as more unequal when its values were doubled, despite keeping the GINI coefficient constant. In study 2, we extended these findings using a fictitious currency, thereby eliminating effects of using a familiar currency. In study 3, we showed that the effect was robust across different frames (percentage vs. absolute increase). Further, we demonstrate the downstream consequences in

terms of envy and fairness. More specifically, we found that when incomes are multiplied by a scalar, levels of fairness drop whereas malicious envy ratings increase.

In chapter III, "Are all Units Created Equal?: The Effect of Default Units on Product Evaluation", we expand our focus to the units in which cardinal numerical information is specified. We particularly focus on how specifying information in alternative units may give rise to specific subjective feelings which, in turn, may affect judgments. Previous research on this topic has shown that people often infer higher quantity from smaller units, usually with the assumption that the units used to specify this information elicit the same meanings. Drawing on literature on categorization and numerical cognition, we challenge this assumption and show that consumers often have preset units for attribute levels that strike an optimal balance between a preference for small numbers and the need for accuracy (study 1a). As such, these default units appear commonly (study 1b). In study 2, we demonstrate the default unit effect on product evaluations. Specifying attribute information in default units, relative to nondefault units, leads consumers to pay more, irrespective of the face value of the attribute. In study 3, we provide evidence for our premise that subjective feelings of fluency drive the default unit effect by employing a misattribution paradigm (Schwarz et al., 1991), in which the fluency generated by the default unit effect can be misattributed to an irrelevant source (i.e., background music). In study 4, we provide process evidence for the default unit effect. Specifically, the enhanced processing fluency associated with the default unit leads to enhanced product evaluations. In addition, we exclude the possibility that this effect is generated by the fluency associated with the numbers used in information specified in default units. In study 5, we more clearly delineate the factors that determine whether the number or the unit may dominate evaluations by showing that evaluation mode (Hsee, 1996) determines whether a default unit or a numerosity effect arises. In a separate evaluation, we replicate the default unit effect; in the joint evaluation though, numerosity may overrule the fluency generated by default units as a decision input.

In chapter IV, "When Precision Protects: Precise Product Information as a Source of Control", we focus on one important factor that might increase the weight of numerical information in judgments. Specifically, we highlight how depriving consumers from personal control may temporarily activate a goal that in turn may affect the importance of numerical information (number + unit) in general. Consumers seem regularly exposed to situations in which they lack personal control. The current study investigates how the experience of a control threat may influence consumer decisions, by noting its effects on the type of product information consumers prefer. Specifically, relative to people who have control, people who feel a lack of control tend to search more for precise information (study 1 – 2) and have a stronger preference for precise descriptions (study 3). Consumers who lack personal control also are more likely to choose a product when its superior attributes happen to be specified in a precise format (study 4 – 5). Consumers who experience a control threat even may be willing to pay more for a product, merely because its attributes are specified precisely (study 4b). The preference for specific attributes disappears though when the specification uses a tight range format, even if the expected value is the same (study 6).

In summary, using insights of literature on numerical cognition and decision making, the current dissertation aims to provide a clearer picture of how numerical cognition may affect evaluations of incomes, product attributes and products in general. In three essays, we aim to advance knowledge of how people make evaluations based on numerical information by identifying how numerical information might activate specific procedures, thoughts and subjective feelings which may ultimately affect decisions.

CHAPTER 1

INTRODUCTION

CHAPTER I: INTRODUCTION

The importance of numerical information can hardly be overstated. Simply consider where humanity would stand if numbers were not at our disposal. Numbers help us constructing buildings, calculating scores, measuring objects, making business deals, paying your employees, counting votes, launching space rockets, being on time for a date, manufacturing cars, communicating product information, etc…. All of this would have been much more difficult to accomplish if numbers were not available.

Probably because of the central place of numerical information in our society, it comes as no surprise that people are frequently confronted with numerical information in their daily lives. Consider for instance a typical morning of Sara. When she wakes up, her alarm clock indicates *7.00* am. When she grabs her breakfast, she quickly scans the calorie content of her cereal: a serving size of ½ cup (*27* gram) contains *50* calories of which *1*g of fat (*2*%), *120*mg of sodium, *270*mg potassium and *20*g of carbohydrates. While she is eating breakfast, she quickly checks the battery life of her Ipad: *12*% left. Just enough left to check her favorite online interior decoration store. She notes that her favorite vintage sofa has dropped *20*% in price. It is now available for only €*1600*. Maybe now she can convince her stingy boyfriend (income = €*2000*) to buy it. As this example clearly shows, people are constantly confronted with numbers describing a range of different types of information in a myriad of different formats.

But how do people process all this numerical information and how does processing this numerical information affect her judgments? Below a couple of relevant examples of the rest of Sara's day:

- When she arrives at work, Sara gets notified that everybody gets a wage cut of 20% due to an internal reorganization. Would she be happier if everybody had to give in €150?
- During lunch break, Sara eats lunch at her desk so she can surf the internet looking for a new smartphone. Sara wants to buy a new one to replace her old and slow one. She finds a promotion for a smartphone which specifies the warranty of the smartphone in days. While reading this promotion, she starts building up an evaluation of this smartphone. Would her evaluation be different when the exact same warranty was specified in years?

- After a long day at work, Sara steps in her car. She still needs to get some groceries before finally going home. Five minutes later, she is stuck in a major traffic jam. For half an hour, she felt a sharp decrease in her level of personal control over her life. She just had to wait until she passed the traffic jam. Would this experience affect her grocery choices? Specifically, would she rely more on quantitative attributes in her choices?

It may be in contrast with your own intuitions, but based on the results described in this dissertation, we may be inclined to say yes to most of the questions in these examples. In this dissertation, we investigate how people process numerical information in situations involving incomes and product attributes. We aim to demonstrate that numerical information may render specific procedures and thoughts accessible which, in turn, people may use to make decisions. Interestingly, in some situations, this may lead people to make decisions that run counter to normative expectations. In what follows, we define what numbers are and how they are represented in the brain; we introduce then first literature how people make judgments in general; next, we show how and when people make judgments based on numerical information. In the final section of this introduction, we introduce the current studies and how the dissertation advances current understanding of how numerical information is processed and how it affects people's judgments.

1. NUMBERS

Numbers play a central role in this dissertation. As such, it may be worthwhile to take one step back and look at the bigger picture: What are numbers exactly? How are numbers represented in the brain? Is this an exact representation or rather an approximate one? In this part of the introduction, we aim to answer these questions. In the first part, we give a short definition of what numbers are. In addition, we outline the most common uses of numbers. In the second and the third part, we identify the two main systems that govern number processing.

1.1 What are numbers?

Numbers are a set of symbols that are primarily used to count, rank order and label objects (Wiese, 2003). As you may note, numbers are defined here as "a set of symbols". The main reason is that the research reported in the current dissertation only concerns symbolic numbers. To be clear, this does not imply that the symbolic notation is the only way to represent numbers. For example, numbers can be represented visually by means of a series of dots or strokes. While the focus of this dissertation is not on non-symbolic numerosities, the importance of this type of numbers for the development of the current symbolic number system cannot be understated. As we will document below, the current symbolic system is strongly grounded in a non-symbolic number sense (Dehaene, 2011). Both systems are so strongly intertwined that the current symbolic system still displays properties of the ancient number processing faculty (see section 1.2).

The definition also makes the enormous flexibility of numbers apparent: numbers can be used to represent virtually anything in a cardinal, ordinal and nominal way (Wiese, 2003). When numbers are used *nominally*, numbers are used to label an object and to distinguish it from other objects. Stated differently, numbers are used as labels for empirical objects without any meaningful order or relationship between the objects (Wiese, 2003). The only criterion is that a number is exclusively used for one particular object. While numbers can be used as labels for identifying objects without any further meaning (i.e. nominal), most of the time numbers are not employed for identification but for representing relations between objects (cardinal and ordinal).

Aside from being used in a nominal way, numbers can be employed to represent *ordinal* relations between objects. Objects can be ordered according to a number of criteria. When objects are represented ordinally, there is a temporary focus on one criterion out of all the criteria on which the objects can be ordered (Wiese, 2003). For example, one can impose an ordinal structure on a lot of apples by assigning each apple a number on the basis of their size. Apple 1 may then be the largest, apple 2 being the next largest until apple N (the smallest apple). In other words, we use numbers to rank order objects within a sequence.

Most people however, associate numbers with *cardinal* values (Diester & Nieder, 2007; Ma & Roese, 2013). That is, in many cases, quantifying objects is not simply a matter of ordering objects according to specific properties. Ranking objects may still leave room for ambiguity about the exact relationship between objects. For example, merely rank ordering apples would not tell us anything about the exact size differences between the apples. It might be that there is a large difference between apple 1 and 2 whereas there is hardly any difference between 2 and 3. Using cardinal number assignments clears the air substantially because now the number refers to “a number of units” that, for example, separates the objects on weight or size. Importantly, we can distinguish between two types of cardinal number assignments (Wiese, 2003). For the first type of cardinality, the unit pertains to a number of elements in a set (e.g., number of apples). For the second type of cardinality, the unit does not refer to the cardinality of a number of elements, but rather to a number of measurement units (e.g., one apple weighs 120 grams). Note that, in a sense, the second type of cardinality still uses the cardinality of a set of elements (i.e. set of measurement units). Using this latter type of cardinality removes most ambiguity from ranked set of apples: Apple 1 weighs 130 grams; Apple 2 weighs 121 grams, etc…. Please note that the relation between cardinal numbers can be further specified as interval (i.e. only meaningful difference between two values, but no meaningful ratios between two values; e.g., degrees Celsius) or ratio (i.e. meaningful difference between two values and meaningful ratios between two values; degrees Kelvin).

While we primarily focus on *symbolic*, *cardinal* numbers in the current dissertation, developing an understanding of how non-symbolic representations of numerosities may prove to be useful in order to understand how individuals process symbolic numbers. In the next section, we give a concise overview of the approximate number system (ANS) that we share with most animals and is already present from early age.

1.2 Approximate Number System

Humans share a basic number sense with most animals (Dehaene, 2011). This claim may seem especially striking because most animals seem to have a limited ability to produce language. Intuitively, language may seem to be a key part of how numbers are represented. In contrast with this assumption, research has shown that animals (and also humans) have a preverbal faculty to represent quantities (for a review see Nieder & Dehaene, 2009). In one study, rats had to discriminate between two sequences of tones that consisted of different numbers of tones (Meck & Church, 1983). While the one sequence consisted of two tones, another sequence contained eight tones. After hearing one of two sequences, the rats could choose to press one of two levers to receive food. Particularly, in order to receive food, the rats had to press the left lever when they had heard two tones, and press the right lever when the eight tone sequence was played. Results showed that rats continued to press the left lever when they heard two tones, and the right lever when they heard eight tones. Strikingly, the results were not tied to one specific modality such as auditory signals but also to other modalities such as vision. For example, when a flash was added to one single tone, the rats perceived this as two events and subsequently pressed the left lever. Similar results have been found with many other animal species including monkeys (Brannon & Terrace, 1998; Nieder & Miller, 2004; Sawamura, Shima, & Tanji, 2002), dolphins (Kilian, Yaman, von Fersen, & Güntürkün, 2003) and salamanders (Uller, Jaeger, Guidry, & Martin, 2003).

Interestingly, human infants seem to rely on a similar faculty when dealing with quantities (Dehaene, 2011). This language independent number capacity allows them to discriminate between small numerosities as early as a couple days old (Izard, Sann, Spelke, & Streri, 2009). In a seminal experiment, Starkey and her colleagues (1983) showed that infants were able to associate visual numerosities with the appropriate auditory numerosities (e.g., three objects with drumbeats). In another classical article, Wynn (1992) demonstrated that babies were able to add and substract small numerosities. Specifically, she found that babies spent more time looking at mathematically nonsensical additions and substractions (1 + 1 = 1) than mathematically sound operations (1 + 1 = 2). For example, when two puppets were added one at a time behind a screen, the babies were more surprised to see only one puppet when the screen was lowered than when they saw two puppets.

Taken together, these results suggest that animals and infants have a similar basic number sense. Importantly, this number sense has clear limits. While this system is able to generalize numerosities across modalities, it does not rely on symbolic notation. Specifically, animals and infants seem to be limited in their capacity to associate arbitrary symbols with specific numerosities. As such, the accuracy of this system drops sharply when numerosities are larger than three (Feigenson, Dehaene, & Spelke, 2004). In addition, when differences between numerosities become smaller, animals and infants have a harder time distinguishing between these quantities (Nieder & Miller, 2003; Xu & Spelke, 2000). This finding is referred to as the distance effect (Dehaene, Dehaene-Lambertz, & Cohen, 1998). The ANS is also characterized by a second effect: the magnitude effect. The magnitude effect refers to the finding that it is harder to discriminate between two numerosities when their numerical size increases (Dehaene et al., 1998; van Oeffelen & Vos, 1982). For example, it is more difficult to distinguish 34 and 36 dots than it is to distinguish 4 and 6 dots.

Although preverbal numerical cognition is not as developed as our current symbolic system of number representation, it is well-established that processing of symbolic numerical information originates from this basic number sense (Dehaene & Cohen, 2007). In the next section, we provide a more detailed picture of how symbolic numbers are processed.

1.3 Symbolic Number System

In the course of history, many cultures seemed to have realized that solely relying on non-symbolic representations of numerosities would severely limit their capacity to represent quantities and do calculations with those quantities. Slowly, many civilizations developed a system of symbolic notation of number (Ifrah, 2000). By leveraging such a symbolic number system, humans became able to precisely represent quantities without any hint of ambiguity. This allowed them to perform mathematical operations with those quantities. One may assume that having a symbolic number notation may have ridded humanity from the limits of the ANS. Although this claim may have some intuitive appeal, it may be further from the truth than one would expect. While a symbolic notation helps to distinguish precisely between quantities, people still display (although to a lesser extent) similar biases as the approximate number system.

Analogous to the processing of non-symbolic numerosites, the distance effect has been obtained with Arabic digits (Moyer & Landauer, 1967, 1973). Specifically, Moyer and Landauer (1967) showed that people have larger reaction times when comparing two digits are closer than when to digits are farther apart from each other. For example, people are faster to indicate the largest of “1” and “5” than “1” and “3”. Likewise, research also suggests that the symbolic number system also exhibits a magnitude effect (Dehaene et al., 1998; Dehaene, 2003; Parkman, 1971; Shepard, Kilpatrick, & Cunningham, 1975). That is, people have a harder time discriminating between two large numbers than two small ones. The mental representation of numbers thus becomes less precise when they convey larger magnitudes. For example, people decide more quickly that 7 is larger than 5 than they can decide that 107 is larger than 105 (Parkman, 1971) and rate 8 and 9 as more similar than 2 and 3 (Shepard et al., 1975).

In sum, research suggests that the processing of symbolic numbers is still strongly influenced by an ancient preverbal number system. As such, when humans are presented with symbolic numbers, people may almost immediately convert them into an internal representation of this quantity. For example, when one is presented with the number “9”, one may immediately retrieve a magnitude representation of a quantity “9” with all its properties (e.g., being larger than 8 but smaller than 10). This can be thought of as being a mental number line on which quantities are represented. This mental number line follows Weber-Fechner’s law, which posits that the threshold of discrimination between two stimuli increases linearly with stimulus intensity. Thus, the mental number line is characterized by a distance (i.e. difficulty to distinguish nearby numbers) and magnitude effect (i.e. difficulty to distinguish large numbers).

It is of great importance to stress that the degree of linearity of the number line may not be fixed. Recent research has shown that it may vary on factors such as education level (Booth & Siegler, 2008; Dehaene, Izard, Spelke, & Pica, 2008; Siegler & Opfer, 2003). While kindergarteners may still display compressed logarithmic mapping (i.e. following Weber-Fechner's law), recent studies suggest that older children shift to more linear representations of number (Booth & Siegler, 2008; Siegler & Opfer, 2003). In addition, the mental number line of an Amazonian tribe with no formal education has been shown to be less linear compared to American participants both with sets of dots and symbolic numbers (Dehaene et al., 2008). Interestingly, recent evidence points to a bidirectional relationship between the ANS and education of symbolic number. Specifically, when a group of the Amazonian tribe was exposed to education, this intervention affected their performance on tasks typically relying on ANS such as discriminating visual numerosities (Piazza, Pica, Izard, Spelke, & Dehaene, 2013).

In conclusion, it seems that while symbolic numbers allow for great precision, the representation of symbolic numbers is still profoundly impacted by an old preverbal faculty. In the current dissertation, we aim to show that numerical cognition may affect how people process and rely on numerical information and, in turn, affect their decisions.

2. USING NUMERICAL INFORMATION FOR JUDGMENTS

In the previous section, we discussed how individuals process numbers. Of course, numbers are seldom judged in a contextual vacuum. Typically, numbers are specified in a context that gives meaning. Examples of contexts include the use of numbers for specifying incomes, product attributes and prices. These examples are consistent with the focus of this dissertation on the cardinal meaning of numbers. In this case, the number represents a number of units in which an attribute is measured. When numbers are used in a cardinal way, they can be employed to quantify incomes or product attributes. One central goal of this quantification is to use this information to make judgments and decisions.

In this dissertation, we aim to advance the current understanding of how quantified attributes are used in decision making. To that end, we aim to integrate both literatures on numerical cognition and judgment and decision making in order to present a more general picture of the three essays in this dissertation. Before elaborating on essays presented in this dissertation, we will first introduce the relevant judgment and decision literature by introducing some foundational concepts of this research stream (Wyer, 2011). In the second section, we propose that judgments involving numerical information may trigger their own specific procedures and thoughts. We aim to show that many of these activated procedures and thoughts may have roots in how numbers are represented in the brain (see section 1).

2.1 Making Evaluations

How do consumers judge information and make decisions? A normative perspective would argue that people simply weigh cost and benefits and subsequently make the best decision (Summerfield & Tsetsos, 2014). However, tons of research has shown that people violate this normative assumption in many situations (for a review see Kahneman, 2011). Sometimes people have not enough information to make a good decision, other times people are simply not motivated or capable of processing all the information available. As such, research has identified many instances in which judgments and decisions are influenced by normatively irrelevant cues (Kahneman, Slovic, & Tversky, 1982). For example, several studies demonstrate the impact of framing of product information. Framing effects occur when consumers react differently to identical information, only because this information is described differently. For instance, consumers make different choices when outcomes are framed as gains rather than losses (Tversky & Kahneman, 1974).

In a recent review, Wyer (2011) identifies three interrelated principles that influence the procedures that individuals employ in making decisions: cognitive efficiency, knowledge accessibility and subjective experience. First, individuals tend to not engage in more cognitive processing than they consider necessary (cognitive efficiency). That is, people tend to put as minimal effort in cognitive processing as they think is necessary to achieve their goal. For many low involvement purchases such as cleaning products or corn flakes, most consumers do not feel a strong need to engage in elaborate thinking. For more high involvement products such as a car or a laptop, consumers may feel more strongly inclined to engage in more elaborate processing.

Second, individuals tend to use the criteria that are most accessible in memory (knowledge accessibility). Specifically, individuals typically judge information by using procedures and information that are most accessible. The accessibility of procedures and information can be affected by a range of factors such as frequency of prior use (Wyer 2011) and the task at hand (Simonson, Bettman, Kramer, & Payne, 2013). For example, when a football player is presented with a ball, it is likely that thoughts about football become accessible. Likewise, different procedures for judging products might become accessible depending on whether an alternative is jointly versus separately evaluated (Hsee, 1996).

Third, individuals tend to misattribute irrelevant subjective reactions to objects they are judging regardless of the source of these experiences (subjective experience). Individuals frequently have a difficult time to correctly attribute their feelings to the actual source of these feelings. As such, when drawing on feelings for making judgments, it may happen that people confuse feelings generated by object X as being generated by object Y. In a seminal study, Schwarz and Clore (1983) showed that people were more satisfied with their life *in general* on a sunny day than on a rainy one. More abstractly, participants seemed to have inferred from their good mood, generated by the nice weather, that their quality of life was good.

Interestingly, when providing people with an alternative, salient source to which they could attribute the metacognitive feelings they experience (Schwarz & Clore, 1983), their experienced metacognitive feelings may no longer be attributed to the product they are evaluating, and no affective transfer to the product occurs. For example, Schwarz and colleagues (Schwarz, Strack, Klumpp, Rittenauer-schatka, & Simons, 1991) told participants that their affective reactions to forthcoming stimuli might be influenced by background music; this manipulation undermined the informational value of their affective reactions, because participants attributed them instead to the background music, and fluency effects on judgments no longer arose. It is interesting to note that feelings take little effort to rely on (cognitive efficiency) and are frequently accessible when judging objects (knowledge accessibility).

In sum, this literature suggests that when people make judgments, multiple thoughts and procedures might become accessible. Next, from this pool of accessible information, people select the information which satisfies their threshold of cognitive efficiency and allows them to make judgments. Since people seem to have difficulties recognizing the source of information that is accessible, they may even rely on seemingly irrelevant subjective feelings. In the next section, we turn our focus to judgments involving numerical information and when and how numerical information may affect accessibility, cognitive efficiency and subjective feelings.

2.2 Making Evaluations Based on Numerical Information

In the prior section, we documented how people make judgments in general. In the current section, we discuss how people make evaluation based on numerical information. We outline how the general principles discussed in the prior section apply to judgments involving numerical information. More importantly, we aim to identify how numerical information might activate specific procedures, thoughts and subjective feelings which may ultimately affect decisions.

In the first part, we discuss the procedures that guide comparisons of numbers. That is, we outline what procedures might become accessible and how people decide which procedures to use when comparing numbers.

In the second part, we broaden our original focus on numbers to the units in which cardinal numerical information is often specified. Specifically, we delineate the factors that determine whether the number or the unit may dominate evaluations. Factors that might shift accessibility and cognitive efficiency may pertain to specific tasks (e.g., joint vs. separate evaluation), characteristics of the stimulus (e.g., font size), but also to the level at which events are construed.

In the third part, we take another step back and focus on factors that, in general, might increase the weight of numerical information in judgments. Specifically, we highlight how the temporal activation of goals may affect the importance of numerical information (number + unit). In doing so, we focus on one key advantage of specifying information in a numerical format. That is, using numerical information allows people to compare objects very precisely, without any ambiguity. As such, when people are in a state in which they feel a strong need to have precise information, it is more likely that numerical information will be attended to.

Number Comparison

Numbers are frequently presented with other numbers which allows people to compare numbers. How do people typically compare numbers? For example, when comparing 5 and 15 versus comparing 115 and 125, individuals have roughly two options (Simonson et al., 2013). One possibility is that people may simply attend to the absolute differences and conclude that both differences are 10 and thus are totally identical. In this case, individuals display perfect *absolute* thinking.

While people may attend to absolute differences, our prior discussion on how numbers are represented may provide a different picture (section 1.3). As mentioned before, our symbolic number system may still display some traces of the older, more approximate number system. From the perspective of the approximate number system, it seems evident that magnitude representations become less precise when magnitudes increase (i.e. magnitude effect). As a result, a difference between 5 and 15 may seem larger than a difference between 115 and 125. Thus, a second possible comparison is to judge the difference of 10 relative to a referent value (i.e. 15 and 125). When this perspective is applied, people may conclude that the former difference seems larger. Recent neurological research confirms the neuron-based basis for relative thinking (Dehaene, 2003; Nieder & Miller, 2003). Given that relative thinking might seem fundamental and hardwired, it might be that relative thinking might also affect perceptions of numerical differences. Indeed, in a classic demonstration, Tversky and Kahneman (1981) demonstrated that people are more willing to save $5 on a $15 priced item than on a $125 priced item. As such, when comparing numbers, individuals may also attend to relative differences (Azar, 2007, 2011; Miller, 1962; Saini & Thota, 2010).

Which of these foci may dominate people's judgments of numerical differences? As highlighted in section 2.1, this depends on criteria such as cognitive efficiency and accessibility. In some contexts, absolute thinking might dominate, while in other contexts, relative thinking may take the upper hand. For example, cognitive load has been shown to exacerbate the effect of relative thinking on decisions (Saini & Thota, 2010). One interpretation of this result might be that cognitive load shifts people's threshold of what they consider to be cognitively efficient strategy to make choices. Also for hedonic products, relative to more utilitarian products, the level of relative thinking is increased (Saini & Thota, 2010). Here, it might be that the type of product (hedonic vs. utilitarian) may affect which thoughts are rendered accessible when making judgments about these products.

While most of this research has focused on prices, little research has looked at how incomes are judged. One particularly relevant setting is how income distributions are evaluated. This is a particularly intriguing topic because income inequality has been largely conceptualized as relative. For example, when income inequality is measured in the GINI coefficient (i.e. one of the most widely used measures on income inequality), it is assumed that a fixed percentage increase in income across all income levels does not alter income inequality. In the first paper of this dissertation, we examine whether people actually display perfect relative thinking when judging incomes.

Numbers and Units

Most people associate numbers with *cardinal* values (Diester & Nieder, 2007; Ma & Roese, 2013). As we mentioned before, using numbers in a cardinal way often implies the use of units of measurement. Evidently, both unit and number should be attended to when making decisions. However, an emerging literature tends to suggest that people tend to pay more attention to numbers and tend to ignore the units (Monga & Bagchi, 2012; Pandelaere, Briers, & Lembregts, 2011). Pandelaere and colleagues (2011) asked participants to evaluate the difference between two television sets, for which participants received quality information with the unit manipulated: on a 10-point scale or a 1000-point scale. The results indicate that an attribute difference looms larger when it is expressed in large numbers (i.e., small units) rather than small numbers (i.e., large units). A possible explanation for this so-called unit effect is that consumers associate bigger numbers with bigger quantities (i.e., numerosity heuristic; Josephs, Giesler, & Silvera, 1994; Pelham, Sumarta, & Myaskovsky, 1994). Despite the potential usefulness of this heuristic, it can lead to misestimated outcomes, because people fail to take the *type of unit* into account when evaluating numerical information. Instead, they rely only on the *number of units*.

Taken together, one may conclude that relying on the number is seen as an accessible and the most cognitively efficient strategy to individuals. However, recent research suggests that, under some circumstances, attention may shift to units (Monga & Bagchi, 2012; Shen & Urminsky, 2013). In a series of studies, Monga and Bagchi (2012) show that adopting an abstract mindset may shift attention towards unit, thereby reversing the unit effect. Likewise, manipulating font size may lead people to realize their overemphasis on the number (Shen and Urminsky 2013). Recent research even suggests that merely presenting two attribute levels sequentially may suffice to eliminate the unit effect (Schley, Lembregts, & Peters, 2015). More generally, these results can be considered as examples of shifts in what is considered to be the most relevant accessible input for judging numerical information. That is, when comparing two attribute values, the numbers seem to be most accessible (and cognitively efficient) input, which results in the unit effect. However, instructing people to pay attention to the unit by a construal level or a font size manipulation renders the unit to be the most accessible decision input.

This prior research has not yet investigated how specifying information in alternative units may affect subjective (metacognitive) feelings. Particularly, prior literature seems to assume that the units for conveying information do not differ in evoked meaning, such that the choice of specific unit to express attribute levels may seem arbitrary. In contrast, in the second essay of this dissertation, we argue that for many attribute levels, default units exist that represent the units most people would use to express information on a particular attribute. We propose that specifying information in default units may render irrelevant subjective feelings accessible which, under some circumstances, may affect product evaluations. Interestingly, we argue that default units stem from how numbers are represented in the brain. Given that small numbers seem to be more precisely represented on the mental number line (i.e. magnitude effect), people may prefer information to be in a unit that gives small numbers.

Numbers and Precision

In most choices, consumers have access to multiple product attributes on which they can rely for their decisions. When consumers are presented with multiple attributes, they may decide to attach different decision weights to the benefits that the attributes provide depending on their goals. Consider, for example, consumer A who goes for a daily 2-hour run. When looking at heart-rate monitors, he or she probably looks more at the battery life than a consumer B who uses it indoors for medical purposes. A runner has a different goal when buying a heart-rate monitor than somebody who uses it for medical purposes. Importantly, these goals are not always stable and may be shifted momentarily by situational variables (van Osselaer & Janiszewski, 2012a). For example, temporarily depriving consumer B of electricity may increase the importance of battery life for this consumer. A goal can be satisfied when a particular product with the right set of benefits is chosen. Rephrased in terms of our prior discussion on how people make judgments (section 2.1), activated goals might change what individuals consider to be cognitively efficient to make a satisfying judgment. In the example of depriving a consumer of electricity may shift the importance of battery life and might even increase the threshold for what is considered to be a satisfying value for battery life.

One may wonder whether goals might not only be satisfied by products or their attributes or whether they may extend to seemingly irrelevant features such as how a product attribute is described. Specifically, some attributes may be specified in a numerical format (e.g., 2 years warranty; 12 hours battery life), while other attributes may be specified in a verbal format (e.g., “intuitive interface”; “10 – 14 hours battery life”). One key property of our current symbolic number system is its precision. Specifically, describing information in exact numbers and units allows us to distinguish between objects more precisely than we could ever attain with the approximate number system. For example, how would you ever distinguish between a weight of 120 and 121 grams? Or, how would you feel a difference between a temperature of 10 degrees Celsius and 11 degrees Celsius?

In the final essay of this dissertation, we propose that temporarily depriving consumers of personal control increases their motivation to satisfy the goal for a predictable environment through an increased need for precise, numerical information. Furthermore, the activation of this personal control goal increases the importance granted to quantitative (i.e.,precise) information, relative to other types. As such, merely framing of product information (e.g., in a quantitative format) may help satisfy a temporarily activated goal (e.g., need for predictability).

3. DISSERTATION OUTLINE

To sum up, research on numerical cognition and judgment and decision making have been very successful in generating an enormous body of knowledge within their own fields. While both literatures are extensive, relatively little research has been conducted at the intersection of both fields (but see Cai, Shen, & Hui, 2012; Coulter & Coulter, 2005, 2010; Coulter & Norberg, 2009; Thomas & Morwitz, 2005). In the current dissertation, we aim to provide a modest attempt to connect these two fields by using both literatures in each of the essays. In three essays, we aim to advance knowledge of how people construct evaluations based on numerical information. By using principles from literatures on judgment and decision making and numerical cognition, we aim to identify how numerical information might activate specific procedures, thoughts and subjective feelings which may ultimately affect decisions.

In chapter II “A 20% Income Increase for Everyone?": The Effect of Relative Increases in Income on Perceived Income Inequality”, we aim to show which procedures may become accessible when income differences are judged and how these perceptions may differ from what current literature on income inequality would assume. Although extant research shows that increasing income inequality has large consequences for people’s lives, little is known about the factors that determine perceptions of income inequality. While most research on income inequality implicitly assumes that a fixed percentage increase in income across all income levels does not alter income inequality, the present paper tests this assumption. Across three studies, using different manipulations, we show that people also attend to absolute differences when judging income inequality. That is, an income distribution consisting of incomes with higher face values (i.e. fixed percentage increase) was judged to be more unequal than an income distribution consisting of incomes with lower face values, despite having an identical income inequality in relative terms. In a first study, we offered evidence for this proposition by employing a mixed design. In addition, we found that perceived inequality not only increases in a within subject design, but also in a between subject design. That is, participants rated an income distribution as more unequal when its values were doubled, despite keeping the GINI coefficient constant. In study 2, we extended these findings using a fictitious currency, thereby eliminating effects of using a familiar currency. In study 3, we showed that the effect was robust across different frames (percentage vs. absolute increase). Further, we demonstrate the downstream consequences in terms of envy and fairness. More specifically, we found that when incomes are multiplied by a scalar, fairness rating drop whereas levels of malign envy increase.

In chapter III, “Are all Units Created Equal?: The Effect of Default Units on Product Evaluation”, we expand our focus to the units in which cardinal numerical information is specified. We particularly focus on how specifying information in alternative units may give rise to specific subjective feelings which, in turn, may affect judgments. Previous research on this topic has shown that people often infer higher quantity from smaller units, usually with the assumption that the units used to specify this information elicit the same meanings. Drawing on literature on categorization and numerical cognition, we challenge this assumption and show that consumers often have preset units for attribute levels that strike an optimal balance between a preference for small numbers and the need for accuracy (study 1a). As such, these default units appear commonly (study 1b). In study 2, we demonstrate the default unit effect on product evaluations. Specifying attribute information in default units, relative to nondefault units, leads consumers to pay more, irrespective of the face value of the attribute. In study 3, we provide evidence for our premise that subjective feelings of fluency drive the default unit effect by employing a misattribution paradigm (Schwarz et al., 1991), in which the fluency generated by the default unit effect can be misattributed to an irrelevant source (i.e., background music). In study 4, we provide process evidence for the default unit effect. Specifically, the enhanced processing fluency associated with the default unit leads to enhanced product evaluations. In addition, we exclude the possibility that this effect is generated by the fluency associated with the numbers used in information specified in default units. In study 5, we more clearly delineate the factors that determine whether the number or the unit may dominate evaluations by showing that evaluation mode (Hsee, 1996) determines whether a default unit or a numerosity effect arises. In a separate evaluation, we replicate the default unit effect; in the joint evaluation though, numerosity may overrule the fluency generated by default units as a decision input.

In chapter IV, “When Precision Protects: Precise Product Information as a Source of Control”, we focus on one important factor that might increase the weight of numerical information in judgments. Specifically, we highlight how depriving consumers from personal control may temporarily activate a goal that in turn may affect the importance of numerical information (number + unit) in general. We test our predictions in nine experiments. In study 1, we offer preliminary evidence for our basic contention that, relative to those who have control, people who lack personal control display a stronger need for more precise information. In study 2, we provide behavioral evidence by showing that when they make product decisions, consumers who lack personal control are more motivated to search for more precise information; specifically, when they gain access to more precise information during decision making, they make more use of it. In addition, we exclude alternative explanations based on a difference in general motivation or decision difficulty. In study 3, we conceptually replicate the findings of study 1 and study 2 by demonstrating that consumers who experienced a control threat have a stronger preference for precise product description. With study 4a, we demonstrate that, relative to having control, lacking personal control leads to a stronger preference for an alternative that is superior on attributes described precisely. Then in study 4b and a follow-up study, we exclude a mood explanation and confirm the robustness of the effect across stimuli and manipulations. We replicate the effect in study 5a and reveal that the preference for specific attributes is attenuated when attributes are specified in less precise, verbal terms. Study 5b also shows that, relative to consumers who do not, those who experience a control threat are even willing to pay more for a product merely because its attributes are specified in precise specifications. Finally, with study 6 we detail how the effect of a control threat on preferences for attributes specified in a precise format (e.g., 13 hours) dissipates if the same attributes are specified in a tight range (e.g., 12–14 hours), with the same expected value.

CHAPTER 2

"A 20% INCOME INCREASE FOR EVERYONE?": THE EFFECT OF RELATIVE INCREASES IN INCOME ON PERCEIVED INCOME INEQUALITY[1]

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CHAPTER II: A 20% INCOME INCREASE FOR EVERYONE?": THE EFFECT OF RELATIVE INCREASES IN INCOME ON PERCEIVED INCOME INEQUALITY

Over the past several decades income inequality has risen dramatically (e.g., Denavas-walt, Proctor, & Smith, 2012). This rising income inequality is reason for concern because it may lead to diminishing levels of trust (Rothstein & Uslaner, 2005), increased feelings of envy (Ordabayeva & Chandon, 2011), increased obesity (Pickett, Kelly, Brunner, Lobstein, & Wilkinson, 2005) and increased levels of violence (Wilkinson & Pickett, 2009; Wilkinson, 2004). Although extant research shows that increasing income inequality has large consequences for people's lives, little is known about the factors that determine perceptions of income inequality. Specifically, while most research on income inequality implicitly assumes that a fixed percentage increase in income across all income levels does not alter income inequality, the present paper tests this assumption. In three studies, we show that relative increases in income lead to increased perceptions of inequality, even when buying power is held constant. In addition, we show that this occurs because people partly focus on absolute income differences, which increase when every income is increased with a constant fraction.

1. THEORETICAL BACKGROUND

1.1 Income Inequality and Scale Independence

Income inequality is typically approached from a relative point of view (Cowell, 1985). According to the most widely used conceptualizations of income inequality, income inequality does not change by multiplying or dividing all incomes by a constant (Lingxin & Naiman, 2010; Litchfield, 1999). All inequality measures that are normalized using the mean income, total income or any arbitrary income possess this property (Lingxin & Naiman, 2010). Some authors even present this scale independence as an axiom of inequality measures (Litchfield, 1999). Scale independence implies that absolute changes in income affect income inequality, but relative changes do not. For example, the inequality of an income distribution consisting of three equally sized groups earning 1000, 2000 and 3000 euro is changed when incomes are raised or decreased with 100 euro because 100 euro is more in relative terms for the lowest income group than for the highest income group. Income inequality does not change, however, when each group receives a 10% income increase.

The notion of scale independence is consistent with a host of research showing that people are particularly sensitive to relative differences. In a classic demonstration, Tversky and Kahneman (1981) demonstrated that people are more willing to save $5 on a $15 priced item than on a $125 priced item (see also Frisch, 1993; Thaler, 1980). This sensitivity to relative differences has also been shown to induce preference reversals (Wong & Kwong, 2005). In one study, participants were asked to decide between two Hi-Fi systems, A or B. Hi-Fi system A could hold fewer CDs but had a better sound quality than Hi-Fi system B. While the absolute difference in sound quality (.007) was held constant across conditions, the relative difference was manipulated by employing a framing manipulation. In one condition, when sound quality was specified in large numbers (99.997% vs. 99.99% of audio signal delivery), the majority of the participants favored system B. However, when sound quality was framed in small numbers (.003% vs. .01% of audio signal distortion) the majority opted for system A. Despite an identical difference in absolute terms, a strong sensitivity to relative differences led people to view a difference specified in smaller numbers as larger.

One explanation for these effects is rooted in the Weber-Fechner law, which holds that people respond to changes in physical stimuli like loudness and weight by comparing it to the original value. As a result of this reference dependence, people become less sensitive to the same absolute difference when comparing larger numbers. This diminishing sensitivity is also reflected in prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981, 1991). More specifically, a difference between smaller numbers falls on the steep slope of the subjective value function, which translates in a large subjective difference. Conversely, an identical difference (in absolute terms) between larger numbers falls on the shallow part of the slope of the subjective value function, which translates in a smaller subjective difference.

1.2 Partial Relative Thinking

While extant research documents a strong sensitivity to relative differences, some research has shown that people also take absolute differences into account. Azar (2007) showed that people are more likely to exhibit partial relative thinking (i.e. considering both relative and absolute thinking) rather than full relative thinking. In one study, he examines how the willingness to pay for improved quality is affected by reference price (Azar, 2011). Results showed that people are indeed influenced by the reference good, thereby indicating relative thinking. However, in contrast to a full relative thinking account, raising the good's price by 200% generally increased the average valuations by less than 200%, thus suggesting that people exhibit partial relative thinking.

Further supporting partial relative thinking, several studies have shown that magnitude estimates change when they are represented in a different metric. More specifically, specifying quantitative information in alternative units leads people to consider an identical difference (in both absolute and relative terms) to be larger when specified in a smaller unit (i.e. in larger numbers; (Burson et al., 2009; Monga & Bagchi, 2012; Pandelaere et al., 2011). As such, relative to a difference specified in smaller numbers (i.e. in larger units), people perceive a difference described in larger numbers (i.e. in smaller units) as being larger because they seem to interpret the latter as larger in absolute terms.

For example, when an attribute description uses a contracted scale (e.g., quality rating on a 10-point scale) rather than an expanded one (e.g., quality rating on a 1000-point scale), consumers perceive an identical difference between two options as greater in the latter situation (Burson et al., 2009; Pandelaere et al., 2011). In a similar vein, research on the compression effect (Gamble, 2006; Gaston-Breton, 2006; Marques, 1999) demonstrated that people may perceive larger price differences when prices are specified in a smaller currency. For example, French consumers perceived the price gap between national brands and the private labels as smaller when prices were expressed in euros versus in French francs, resulting in an increased transaction value for the national brands (Gaston-Breton, 2006). One explanation for these findings is that people ignore unit information when presented with quantitative information. This is consistent with a host of research demonstrating that with the introduction of the Euro, people were mostly influenced by face values rather than real monetary values (Gamble, Gärling, Charlton, & Ranyard, 2002; Gamble, Gärling, Västfjäll, & Marell, 2005; Jonas, Greitemeyer, Frey, & Schulz-hardt, 2002).

We propose that these findings may have consequences for the dominant conceptualization of income inequality as being primarily relative. More specifically, we advance the idea that perceived differences between incomes may change when actual income inequality in terms of the most widely used inequality measures such as the GINI coefficient is held constant. As such, we provide evidence that people also attend to absolute differences when judging incomes. As a result, raising incomes with fixed percentage may alter people's perceptions about income inequality, even when buying power is held constant. For example, in the case of 10% increase, people previously earning a $1000 income would now receive a $1100 income. Likewise, an identical percentage increase would turn a $2000 income into a $2200 income. Although income gaps are identical in relative terms, we propose that people will perceive that income differences have widened. In addition, given that people often ignore units when thinking about money, income differences that are equivalent in relative terms may seem larger when expressed in smaller units. For example, a 500 euro income gap may be perceived as larger in South Korea because this difference translates in a 707,000 Korean Won gap, possibly resulting in a higher perceived income gap in South Korea.

A small body of research (Amiel & Cowell, 1999; Amiel, 1998; Cowell, 1985, 1995) has looked on how people view inequality. More specifically, this research investigated whether people comply with the basic axioms of inequality measurement (such as scale independence). People's agreement with the basic axioms about income inequality was examined by having participants compare income distributions (Amiel and Cowell, 1992). Next, participants were asked a range of questions probing for knowledge of the basic axioms. Most relevant for our current investigation, Cowell (1985) reports that most of the respondents supported scale independence. That is, participants were more likely to give answers that support a relative view on inequality.

At first blush, these results seem to be at odds with our main proposition. However, we believe that there are four major differences with our work. First, this research only used within participants designs. Participants were asked to compare multiple income distributions. Comparing distributions may invoke a more comparative focus and may produce different results. In contrast, our studies do not exclusively require the explicit comparison of distributions. Second, while Amiel and Cowell (1992; 1999) almost exclusively looked at how people view income inequality axioms, we also examine the downstream consequences of changing perceived income inequality through scalar multiplication. More specifically, we investigate how perceptions of fairness and envy are affected by a fixed percentage change in income. Third, we examine whether framing of a fixed percentage change may affect perceived income inequality. Particularly, we look whether framing a relative income increase in percentages (e.g., a 20% increase for each group) or in absolute numbers (e.g., an increase of 200 euro for 1000 euro income group; 300 euro increase for 1500 euro income group;…) may have different effects on perceived income inequality. Fourth, we attempt to control for differences in buying power using different approaches. In prior research, no explicit mention was made of differences in buying power, which made it difficult to isolate the effect of a fixed percentage increase.

2. STUDY OVERVIEW

This manuscript greatly extends research on inequality by showing that absolute income differences may be more important for people's perception of income inequality than previously assumed. Despite the clear usefulness of defining wealth inequality in scale invariant terms, one may wonder whether these measures fully capture how people *actually* think about inequality. We test our proposition in three studies. In a first study, we conduct a first experiment to assess whether people perceive greater income inequality when incomes are multiplied by a fixed scalar. In the second study, we replicate the effect using a fictitious currency to eliminate the effects of a familiar currency. Study 3 has two main contributions: First, we demonstrate that increasing the perceived inequality by a fixed percentage increase is sufficient to affect feelings of fairness and envy. Second, we show that the effect seems to be unaffected by the way the income increase is framed (i.e. in percentages vs. absolute numbers).

3. STUDY 1

In a first study, we aim to find support for our premise that the perception of inequality is affected when all incomes are raised by a fixed percentage. More specifically, we expect that, while we keep buying power constant, an income distribution consisting of identical relative differences, but larger absolute differences is considered to be more unequal, despite an identical GINI coefficient.

3.1 Method

In total, 309 students (M_{age} = 23 years, 110 women) were recruited for this experiment: 203 students were recruited from our online student pool in exchange for a chance of winning a gift certificate and 106 students were recruited in exchange for a course credit for a series of unrelated studies, including the current one. Participants were randomly assigned to one of two between subjects conditions: an individual income and a family income distribution (see figure 1 for overview of the full experimental set-up).

In the individual income condition, participants were presented with an income distribution of an unspecified country. They were told that the country is divided in five equally sized income groups (see table 1, distribution A). Participants were asked to complete five items which measured perceived income inequality on a seven-point scale (1 = do not agree at all; 7 = totally agree; “This is a country with a large income inequality”; “There are large differences between wages”; “In this country, there are little income differences.”; “The incomes in this country lie close together.”; “In this country, there is large income equality.”). Participants in this condition also evaluated a second distribution as part of a within subjects manipulation (see table 1, distribution B). More specifically, they were shown another distribution in which incomes were multiplied by a factor of 1.5. Participants were asked to fill out the same items as for the first distribution. To be sure that the effects found were not caused by a difference in perceived buying power, we clearly mentioned that buying power did not differ between worlds. To check whether participants understood that buying power was held constant, we asked two open-ended control questions (“If a piece of bread costs 2 euro in world 1, how much would it cost in world 2?”; “If a newspaper costs 1 euro in world 1, how much would it cost in world 2?”). Because we did not expect all participants to calculate the actual price exactly, we only excluded participants who failed to give an increased price.

In the family income condition, participants were told that they would be judging a distribution of family incomes (a two person-household; see table 1, distribution C). We asked participants to assume that there were no economies of scale relative to individual incomes. By using family incomes, we could unobtrusively double the face value of the incomes (of distribution A) without raising any suspicion about the size of the incomes. Participants were also asked to complete the five perceived income inequality items. To test whether participants understood that they were judging family incomes, we included one additional question (“Now imagine that somebody is part of group 1 and makes as much as his or her partner. How much would this person approximately make?”). To be clear, in this condition, participants were asked to judge only one income distribution.

Note that all three income distributions (original individual income, changed individual income, family income) had a GINI coefficient of 14.8.

Figure 1. Set-up Experiment: Study 1

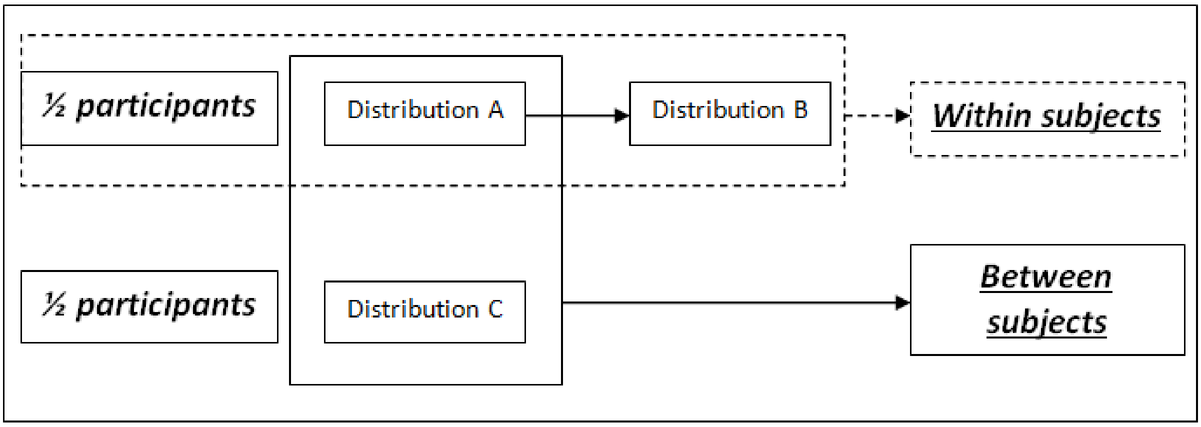


Table 1. Income Distribution: Study 1

	Distribution A Original individual income	**Distribution B** Changed individual income	**Distribution C** Family income
G1	1175 euro a month	1763 euro a month	2350 euro a month
G2	1520 euro a month	2280 euro a month	3040 euro a month
G3	1865 euro a month	2797 euro a month	3730 euro a month
G4	2210 euro a month	3315 euro a month	4420 euro a month
G5	2555 euro a month	3832 euro a month	5110 euro a month

3.2 Results and discussion

First, we analyzed the within subjects part of the experiment (N = 157). In total, 83% of the respondents (N = 130) correctly answered the two buying power questions; only those who correctly indicated that prices went up were included in the analysis. The five items for each income distribution were averaged into a composite measure (α1 = .91; α2 = .91) of perceived income inequality. A paired sample t-test yielded the expected main effect of income distribution on perceived income inequality ($t(129) = -6.53$, $p < .001$). When all incomes were raised by 50 percent, participants judged this income distribution ($M = 4.67$, $SD = 1.38$) to be more unequal compared to the first income distribution ($M = 4.07$, $SD = 1.38$).

To test whether conducting the experiment online or in the lab affected the results, we performed a mixed-design ANOVA on subjective inequality ratings with income distribution (base vs. 50% increase) as within subjects factor and experimental setting (lab vs. online) as between subjects factor. While this analysis revealed that, compared to online participants (*M* = 4.67, *SD* = 1.18), lab participants showed lower subjective inequality ratings in general (*M* = 3.80, *SD* = 1.27; $F(1,128) = 15.27$, $p < .001$), there was no significant interaction with income distribution ($F(1,128) = 2.43$, $p = .122$). This indicates that the effect did not change as a function of whether it was conducted online or in the lab.

In the family income condition, 31 participants who failed to correctly answer the check (i.e. did not yield an answer close to the correct answer: 1175 euro) were excluded from the analysis. Comparing the two between subject conditions revealed a significant difference ($t(276) = -2.18$, $p = .030$). Doubling incomes led participants to judge an income distribution as more unequal ($M_{\text{indiv}} = 4.03$, *SD* = 1.38; $M_{\text{family}} = 4.40$, *SD* = 1.37), despite both distributions being equal in terms of GINI coefficient. Again, to test whether conducting the experiment online or in the lab affected the results, we performed a two-way ANOVA on subjective inequality ratings with income distribution (individual vs. family income) and experimental setting (lab vs. online) as between subjects factors. This analysis revealed that, compared to online participants (*M* = 4.44, *SD* = 1.31), lab participants showed lower subjective inequality ratings in general (*M* = 3.69, *SD* = 1.39; $F(1,274) = 18.81$, $p < .001$). More importantly, there was no significant interaction with income distribution ($F\ (1,274) = .002$, $p = .969$). Again, this indicates that the effect did not change as a function of whether it was conducted online or in the lab.

In sum, this study provides within- and between-subjects support for the proposition that the perceived differences between incomes may change when actual income inequality in terms of the most widely used inequality measures such as the GINI coefficient is held constant. More specifically, we show that an income distribution consisting of identical relative differences, but larger absolute differences is considered to be more unequal.

4. **STUDY 2**

Study 1 showed that not only relative differences, but also absolute differences matter to people when judging income inequality. A potential problem is that we employed a familiar currency in this study. In order to provide a more robust test of our proposition, a fictional currency is used in study 2. By employing a fictional currency, we exclude the possibility that our previously found effects are an artifact of the use of a familiar currency (Lembregts & Pandelaere, 2013). In addition, we use an alternative method for holding buying power constant. Note that in this study and in study 3, we exclusively use undergraduate business students as participants. Using this relatively knowledgeable population provides a more stringent test of our proposition.

4.1 Method

In total, 73 students (M_{age} = 22 years, 54 women) were recruited from an online panel in exchange for a chance of winning a gift certificate. All participants were asked to imagine that they live in a country similar to theirs, but with a different currency (the “xx”) of which the exchange rate with the euro was unknown. All participants were presented with three equally sized income groups (low, medium and high income group) with an average income for each group. Participants were randomly assigned to one of two conditions. In the low face value condition, monetary values were specified in a low numbers (10 xx; 15 xx; 20 xx). In the high face value condition, monetary values were specified in numbers that were 100 times as large (1000 xx; 1500 xx; 2000 xx). Buying power was held constant by not only showing incomes but also prices of products. Before evaluating an income distribution, participants were presented with a range of products (see table 2). We told participants that they should remember these prices since they would receive questions about the prices later in the experiment. In the low numbers condition, prices were proportionally smaller compared to the higher numbers condition; in other words, both income levels and prices were 100 times larger in the high face value condition. If participants followed these instructions well, this task would ensure that buying power was held constant across conditions.

Next, participants were presented with an income distribution. The income distribution consisted of three equally sized groups. The GINI coefficient in both conditions was 14.8. As in study 1, we asked participants to complete five items which measured perceived income inequality on a seven-point scale (same items as in study 1; 1 = do not agree at all; 7 = totally agree). Afterwards, we asked participants to give the prices that were shown earlier in the experiment. Analysis of these answers showed that the vast majority of the participants correctly remembered the prices. Excluding one participant who failed to remember the majority of the prices did not change the results.

Table 2. List of Products: Study 2

Product	**Price**		**Product**	**Price**
Cornflakes 	0.04 XX (4 XX)		Car 	150 XX (15 000 XX)
1.5 liter Coca Cola 	0.015 XX (1.5 XX)		TV 	8 XX (800 XX)
Rent apartment 	5 XX (500 XX)		Shoes 	0.5 XX (50 XX)
Regular T-shirt 	0.1 XX (10 XX)		Painkiller 	0.07 XX (7 XX)
Loaf of bread 	0.021 XX (2.1 XX)		Cellphone 	1.5 XX (150 XX)

4.2 Results and discussion

As in study 2, the five items for each income distribution were summed into a composite measure (α = .87) of perceived income inequality. An independent samples t-test revealed a difference between the two experimental conditions ($t(71) = -2.73$, $p = .008$). A high face value income distribution ($M = 4.59$, $SD = 1.07$) was judged to be more unequal than the low face value income distribution ($M = 3.86$, $SD = 1.20$) in spite of an identical purchase power.

In this study, we replicate the effect of study 1 while employing a fictional currency. More specifically, we again show that an income distribution consisting of larger absolute differences, but identical relative differences is judged to be more unequal.

5. **STUDY 3**

In the two previous studies, we show that people perceive larger income differences when a fixed percentage is added to them. This final study has two main goals. The primary goal is to highlight the downstream consequences of this increased subjective income inequality. Particularly, we aim to connect this research to work on envy (Dupor & Liu, 2003; Ordabayeva & Chandon, 2011) and perceived fairness (Messick & Schell, 1992). Consistent with people's tendency to compare themselves to other people (Festinger, 1954), research has documented that people experience increasing levels of envy when the possession gap with other people increases (Dupor & Liu, 2003; Ordabayeva & Chandon, 2011). We aim to investigate whether merely by adding a fixed percentage to all incomes may suffice to increase feelings of envy. Following recent research on envy (van de Ven, Zeelenberg, & Pieters, 2009; Van de Ven, Zeelenberg, & Pieters, 2011), we distinguish between malicious and benign envy. In general, benign envy leads to a inclination of moving upwards (improving one's own position), whereas the malicious envy leads to a pulling-down motivation aimed at damaging the position of the superior other (van de Ven et al., 2009). Although we may expect that envy levels will increase in general, we have no a priori expectations regarding any different effect on malicious versus benign envy. Consistent with previous literature on income inequality and envy (Ordabayeva & Chandon, 2011), we focus on the lowest income groups.

In addition, given the importance of fairness in economics (Fehr & Schmidt, 1999), it may be fruitful to investigate whether adding a fixed percentage to an income distribution may also affect fairness perceptions. More specifically, if perceived inequality is affected by a fixed percentage increase, we expect that people may feel that such an increase renders the income distribution to be less fair.

A second goal of this study is to investigate whether the strength of these effects depends on how the fixed percentage increase is framed (Messick & Schell, 1992). Particularly, we examine whether framing the income increase in percentage terms (e.g., 20% for group 1, 20% increase for group 2, …) or in absolute terms (e.g., an increase of 200 euro for 1000 euro income group; 300 euro increase for 1500 euro income group;…), affects perceived income inequality. We propose that people might consider a percentage frame as less unequal than an absolute frame for the lowest income group. This prediction is based on two arguments. First, research on information processing has repeatedly shown that percentage information is more difficult to process than absolute numbers (e.g., Chen & Rao, 2007; Kruger & Vargas, 2008). Given this enhanced difficulty for percentage information, people may mistakenly confuse a 20% increase as if it adds an equal amount of money to each income. Second, other work suggests that people tend to ignore the unit and disproportionately look at the number (e.g., Pandelaere et al., 2011). As such, quantities become dimensionless and people may think that income inequality may stay constant since that everybody appears to receive “20” more. Conversely, expressing an income raise of 20% as absolute amount increase for every income group may exacerbate perceptions of inequality because each income group receives a different quantity (e.g., one income group may receive “200”, another income group “300”; …).

5.1 Method

In total, 132 undergraduates (M_{age} = 22 years, 66 women) were recruited in exchange for a course credit for a series of unrelated studies, including the current one. The entire session took about 50 minutes to complete. To strengthen the reproducibility of this study, all measures, hypotheses, and the analysis strategy were preregistered at the Open Science Framework (https://osf.io/wn6kr/).

In the first part of the task, all participants were presented with income distribution A from study 1. All participants were asked to complete the same five items which measured perceived income inequality from study 1 and 2. In addition, participants were asked to indicate the extent to which this income distribution was fair ("How fair is this income distribution to you?" 1 = not fair at all - 7 = very fair). Also, participants were asked to indicate the extent to which they would feel benignly and maliciously envious towards other income groups when they would be in the lowest income group of this distribution (*benign envy*: "If you would be in the lowest income group, to what extent would you be benignly envious towards higher income groups?" 1 = totally not benignly envious - 7 = very benignly envious; malicious envy: "If you would be in the lowest income group, to what extent would you be maliciously envious towards higher income groups?" 1 = totally not maliciously envious - 7 = very maliciously envious).

Next, all participants were shown another distribution in which incomes were multiplied by a factor of 1.2. However, participants were randomly assigned to one of two between subjects condition in which we manipulated how the 20% income increase was framed. Half of the participants were told that all incomes were increased with 20% (see table 3 for the exact description). The other half was shown the absolute amount of money that was added to each income group (see table 3). As in study 1, we told all participants that buying power was held constant. Participants were asked to fill out the same items as for the first distribution. To be sure that the effects found were not caused by a difference in perceived buying power, we clearly mentioned that buying power did not differ between worlds. To check whether participants understood that buying power was held constant, we asked the same control questions as in study 1.

Table 3. Focus Manipulation: Study 3

	"+ 20% frame" condition	**"Absolute number frame" condition**
G1	Group 1 (the poorest group) gets **20%** of their wage added to their original wage (1175 euro).	Group 1 (the poorest group) gets **235 euro** added to their original wage (1175 euro).
G2	Group 2 gets **20%** of their wage added to their original wage (1520 euro).	Group 2 gets **304 euro** added to their original wage (1520 euro).

G3	Group 3 gets **20%** of their wage added to their original wage (1865 euro).	Group 3 gets **373 euro** added to their original wage (1865 euro).
G4	Group 4 gets **20%** of their wage added to their original wage (2210 euro).	Group 4 gets **442 euro** added to their original wage (2210 euro).
G5	Group 5 (the richest group) gets **20%** of their wage added to their original wage (2555 euro).	Group 5 (the richest group) gets **511 euro** added to their original wage (2555 euro).

5.2 Results

As in study 1 and study 2, the five items for each income distribution were averaged into a composite measure (α1 = .89; α2 = .86) of perceived income inequality. In total, 74% of the respondents (N = 97) correctly answered the two buying power questions, in other words, indicated that prices went up. Only these participants were included in the analysis reported here.

First, we conducted a mixed-design ANOVA on perceived income inequality ratings with income distribution as a within subjects factor and frame (percentage vs. absolute) as a between subject factor. This revealed a significant main effect of income distribution ($F(1,95) = 27.09$, $p < .001$), but no significant main effect of frame ($F(1,95) = 1.56$, $p = .215$), and, unexpectedly, no significant interaction ($F(1,95) = 1.60$, $p = .209$). More specifically, when all incomes were raised by 20%, participants judged this income distribution ($M = 3.89$, $SD = 1.25$) to be more unequal compared to the first income distribution ($M = 3.40$, $SD = 1.28$). This result replicates the findings of study 1 and 2.

Secondly, a mixed-design ANOVA was conducted on fairness ratings with income distribution as a within subjects factor and frame as a between subject factor. The results showed a significant main effect of income distribution ($F(1,95) = 32.16$, $p < .001$; $\eta_p^2 = .25$), a marginally significant main effect of frame ($F(1,95) = 3.88$, $p = .052$; $\eta_p^2 = .04$). As expected, the second income distribution ($M = 4.02$, $SD = 1.45$) was perceived to be less fair than the first one ($M = 4.64$, $SD = 1.37$). However, this main effect was qualified by a marginally significant interaction effect (*F*(1,95) = 3.00, *p* = .086; η_p^2 = .03). More specifically, when the income raise was specified in absolute terms (M_{diff} = .80, *SD* = 1.21), the effect on fairness was marginally stronger than when it was specified in relative terms (M_{diff} = .43, *SD* = .88). In addition, when all incomes were raised by 20 percent, participants judged this income distribution to be significantly fairer in the percentage condition (*M* = 4.38, *SD* = 1.41) than in the absolute condition (*M* = 3.68, *SD* = 1.42; *F*(1,95) = 5.99, *p* = .016).

Thirdly, we employ a mixed-design ANOVA on benign envy ratings with income distribution as a within subjects factor and frame as a between subject factor. In contrast with our expectations, this analysis revealed no significant main effect of income distribution (*F*(1,95) = 2.65, *p* = .107), no significant main effect of frame effect (*F*(1,95) = .004, *p* = .950) and no significant interaction effect (*F*(1,95) = .49, *p* = .486).

Fourth, we conducted a mixed-design ANOVA on malicious envy ratings with income distribution as a within subjects factor and frame as a between subject factor. This analysis revealed a significant main effect of income distribution (*F*(1,95) = 13.80, $p < .001$), but no significant main effect of frame effect (*F*(1,95) = .002, *p* = .967) and no significant interaction effect (*F*(1,95) = 0.07, *p* = .793). Irrespective of the frame in which incomes were specified, when all incomes were raised by 20%, people felt more malignly envious in this income distribution (*M* = 4.15, *SD* = 1.47) compared to the first income distribution (*M* = 3.90, *SD* = 1.41).

We also wanted to test whether the perceived inequality ratings mediated the relationship between type of income distribution (baseline vs. 20% increase) and the proposed consequences. Given that there were only significant effects for fairness and malicious envy ratings, we first test for mediation for these two constructs. A multilevel model (General Estimating Equations) accounted for the repeated-measures nature of the data. To get an estimate of the indirect effect, we use the Monte Carlo method for assessing mediation (Selig & Preacher, 2008). Consistent with our expectations, the effects of distribution on fairness (see figure 2) and malign envy ratings (see figure 3) were mediated by perceived inequality perceptions. Interestingly, we also found indirect only mediation by perceived inequality between distribution and benign envy (95% confidence interval based on 20,000 resamples [.015 to .15]).

Figure 2. Mediation Analysis Income Distribution – Fairness: Study 3

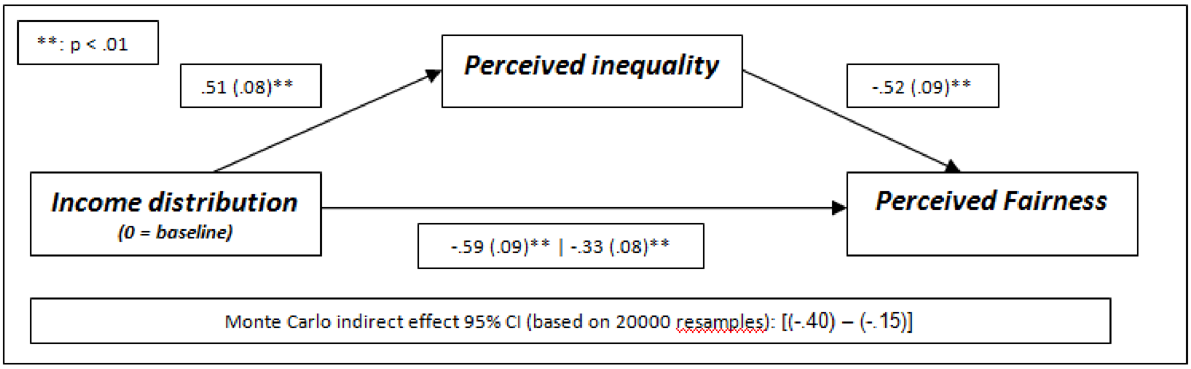
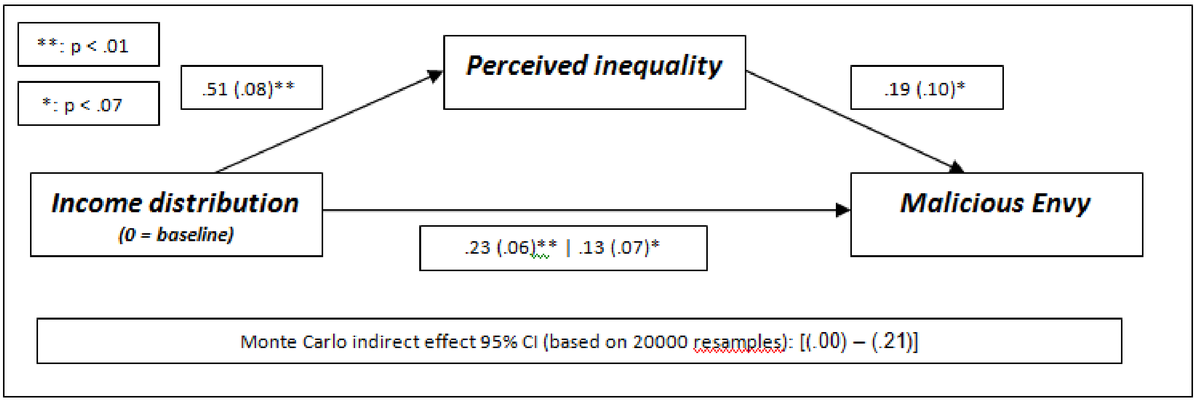


Figure 3. Mediation Analysis Income Distribution – Malicious Envy: Study 3



5.3 Discussion

The previous experiments showed that people's perceptions of inequality are affected when incomes are multiplied by a scalar. The present study demonstrates that the multiplication by a scalar may not only change the perceived inequality of a distribution, but also feelings of fairness and malign envy. More specifically, when all incomes are multiplied by the same scalar, perceived inequality in increased which, in turn, lowers feelings of fairness and increases feelings of malicious envy. One may wonder why we did not find an effect on benign envy ratings. One reason may be that people felt that higher income groups may not have deserved a larger income increase in absolute terms. Hence, this feeling then in turn led to an increase in malicious envy, but not in benign envy. This would be consistent with recent literature suggesting that people are more likely to experience malicious envy in situations in which other people do not deserve their rewards, while it is more likely that people experience benign envy when people think that other people deserved their rewards (Van de Ven et al., 2011).

In addition, the present study shows that this effect seems robust across framing manipulations. More specifically, whether a 20% fixed percentage increase is presented in a percentage frame (e.g., 20% for group 1, 20% increase for group 2, …) or as a absolute number frame (e.g., an increase of 200 euro for 1000 euro income group; 300 euro increase for 1500 euro income group;…) seems not to affect our proposed effect. Although we hypothesized that a percentage frame would attenuate the effect, we believe that the current results speak to the robustness of the effect. Only for the fairness ratings, we found that specifying an income increase in a percentage format somewhat diminishes the strength of the effect.

6. **CONCLUSIONS**

Recent research on income inequality has shown that widening income gaps may have many negative consequences (Pickett et al., 2005; Wilkinson & Pickett, 2009; Wilkinson, 2004). Until now, this research stream has implicitly assumed that income inequality is a relative phenomenon. However, our research provides a more nuanced view on this implicit assumption.

Across three studies, using different manipulations, we show that people also attend to absolute differences when judging income inequality. That is, an income distribution consisting of incomes with higher face values (i.e. fixed percentage increase) was judged to be more unequal than an income distribution consisting of incomes with lower face values, despite having an identical income inequality in relative terms. In a first study, we offered evidence for this proposition by employing a mixed design. In addition, we found that perceived inequality not only increases in a within subject design, but also in a between subject design. That is, participants rated an income distribution as more unequal when its values were doubled, despite keeping the GINI coefficient constant. In study 2, we extended these findings using a fictitious currency, thereby eliminating effects of using a familiar currency. In study 3, we showed that the effect was robust across different frames (percentage vs. absolute increase). Further, we demonstrate the downstream consequences in terms of envy and fairness. More specifically, we found that when incomes are multiplied by a scalar, fairness ratings drop whereas levels of malicious envy increase.

By looking at feelings of envy and fairness, we showed that perceived income inequality may elicit effects that are not anticipated from a relative point of view of income inequality. Possibly, other effects found in the literature on income inequality may also emerge when face values change. For example, research suggests that people are less trusting when income differences are large (Gold, Kennedy, Connell, & Kawachi, 2002; Rothstein & Uslaner, 2005). In a similar vein, merely perceiving income differences as larger may also lead to decreasing trust. Other research has demonstrated that subjective well-being may be negatively related to increasing income gaps (Easterlin, 2001; Frey & Stutzer, 2002). One may wonder whether a mere change in face value of a currency may affect subjective well-being in a similar fashion.

In addition, people may attempt to reduce this dissatisfaction generated by the higher perceived income inequality by buying more status-related goods (i.e., conspicuous consumption; Frank, 1985). This way lower tier consumers may try “keeping up with the Joneses”. This increased spending on conspicuous consumption may lead to reduced saving rates and reduced consumption of necessary goods (Frank, 1985). Future research may investigate whether increased *perceived* income differences may have similar consequences as *actual* income inequality.

In our studies, we made use of an experimental set up in order to control for potential confounds. It may be interesting to look for support of these effects in a more natural setting. For example, in 2005, a Turkish monetary reform introduced the New Turkish Lira, thereby reducing the face value of the currency by a factor of 1,000,000 (Amado et al., 2007). Applying our findings to this particular case, perceived income differences may have decreased. Similarly, in countries having a high face value currency people may also perceive wider income gaps. For example, in South Korea, a 500 euro income gap becomes a gap of approximately 707,000 Korean Won. In sum, our results suggest that South Koreans may perceive a higher income inequality given the high face value of their home currency.

Our findings may also have important implications for policymakers and managers. More specifically, when restructuring an organization, managers sometimes may cut wages for every worker by a fixed percentage. Aside from other effects, our results imply that this operation may instigate a feeling of smaller income differences. Conversely, policy makers may introduce a general tax cut for each income group, raising each income with a fixed percentage. As such, people may perceive income inequality as increasing by such an intervention. Our results suggest that a well-intentioned tax cut may therefore have unanticipated consequences.

One may argue that our studies present people with a rather artificial situation in which people consider income distributions in its entirety. Research on social comparison suggests that, in real life, people probably attend several reference incomes (Festinger, 1954).

While this may be the case, this does not alter the implications of our results. For example, consider the case of a person A making an income of 1500 euro a month and his/her neighbor making an income of 1600 euro. An income raise of 10% (e.g., due to correction for inflation) would then change incomes to respectively 1650 euro and 1760 euro. In relative terms, the difference between incomes is still 6,66%; in absolute terms, however, the difference between incomes is increased with 10 euro. If this income increase is generated by inflation, buying power is kept constant, which should lead people to discount this increase.

However, there is strong evidence suggesting that people do not account for inflation. For example, research on the money illusion has shown that people often think about monetary values in nominal rather than in real terms (Shafir, Diamond, & Tversky, 1997; Svedsäter, Gamble, & Gärling, 2007). Consequently, instead of opting for the best alternative in economic terms, they prefer the option that dominates in nominal terms. For example, Shafir and colleagues (1997) showed that people thought that they would be happier receiving a 5% raise in salary when there was 4% inflation over a 2% raise in salary with no inflation.

Our research adds to this research stream by suggesting seemingly irrelevant factors (e.g., face value of a currency) may affect how people think about income inequality. It may be interesting for future research to test whether the face value of the currency may also affect support for redistributive policies. Particularly, higher perceived income inequality generated by higher monetary face values may induce greater support for redistributive policies.

One may also wonder how phenomena like hyperinflation may be even more devastating than previously assumed in terms of perceived income inequality. Under hyperinflation, the face value of a currency may inflate so rapidly that people exaggerate income gaps. Also, with hindsight, due to inflation (assuming that incomes also increase), income inequality may appear to be less pronounced in the past.

CHAPTER 3

ARE ALL UNITS CREATED EQUAL? THE EFFECT OF DEFAULT UNITS ON PRODUCT EVALUATIONS[2]

[2] Chapter III is published as “Lembregts, C., & Pandelaere, M. (2013). Are All Units Created Equal? The Effect of Default Units on Product Evaluations. *Journal of Consumer Research, 39*(6), 1275-89.”

CHAPTER III: ARE ALL UNITS CREATED EQUAL? THE EFFECT OF DEFAULT UNITS ON PRODUCT EVALUATIONS

Consumers often confront quantitative product information during their purchase decisions and may even consider it more informative than their own direct experience with the product (Hsee, Yang, Gu, & Chen, 2009). Despite the clear importance of quantitative information in consumer decisions, relatively little research investigates the potential influence of the unit in which such information is specified. For example, do consumers' evaluations of a cell phone vary if its warranty is expressed in years or days? Normatively, specifying an attribute in an alternative unit should not influence product evaluations, but an emerging research stream suggests that consumers show different preferences when quantitative information is expressed in alternative units (Burson et al., 2009; Monga & Bagchi, 2012; Pandelaere et al., 2011; Zhang & Schwarz, 2012). Specifically, when an attribute description uses a contracted scale (e.g., quality rating on a 10-point scale) rather than an expanded one (e.g., quality rating on a 1000-point scale), consumers perceive the difference between two options as greater in the latter situation (Pandelaere et al., 2011). Research on medium maximization and loyalty programs further shows that consumers prefer rewards expressed in larger numbers, even if the outcomes are identical (Bagchi & Li, 2011; Hsee, Yu, Zhang, & Zhang, 2003), mainly because people rely too much on the sheer number and ignore the unit that specifies the attribute.

Although this converging evidence indicates that consumers infer bigger quantities from bigger numbers, prior research seems to assume that the units for conveying information do not differ in evoked meaning, such that the choice of specific unit to express attribute levels may seem arbitrary. In contrast, we argue that for many attribute levels, default units exist that represent the units most people would use to express information on a particular attribute. For example, consumers probably are more accustomed to see warranty information expressed in years rather than in days; years constitutes their default unit for a warranty. This possibility raises the question of whether consumers still infer a longer warranty if it is specified in days (i.e., larger numbers) rather than years (i.e., smaller numbers). We argue and show that they do not. In general, positive attributes (i.e., higher values are preferred) expressed in default units generate more favorable product evaluations, due to enhanced ease of processing (i.e. processing fluency; Schwarz, 2004), despite its lower numerosity. For our theorizing, we draw on research into categorization, numerical cognition, and metacognitive feelings.

This research thus contributes to emerging literature on numerosity effects in product evaluations (Burson et al., 2009; Monga & Bagchi, 2012; Pandelaere et al., 2011) in three ways. First, this research adds to current literature by showing that choice of specific unit to express attribute levels is not arbitrary. Second, we offer a more nuanced understanding of when numerosity effects occur and specify the conditions in which they are reversed. Third, by drawing on literature on categorization, numerical cognition, and fluency, we offer a new perspective to recent research that suggests quantitative information can generate inferences beyond the numbers involved (Monga & Bagchi, 2012; Zhang & Schwarz, 2012).

In addition, this research extends literature on fluency by identifying a hitherto ignored source. Research on fluency typically employs manipulations that make information either easy or difficult to perceive, by changing the font or varying the contrast between statements and background (e.g., Novemsky, Dhar, Schwarz, & Simonson, 2007; Reber, Winkielman, & Schwarz, 1998). But considering the importance of clearly communicating product information, it is rather unlikely that one would find real-world advertisements written in unclear fonts or shady backgrounds. Still, sellers may make choices about the units used to communicate product information in an arbitrary fashion. For example, Amazon.com advertises the battery life of cell phones in hours, whereas Wirefly.com employs days. Our research shows that this choice is not without consequences.

1. THEORETICAL BACKGROUND

1.1 Numerical Framing and the Unit Effect

Emerging literature indicates that consumers evaluate options differently when attribute information is expressed in alternative units (Burson et al., 2009; Monga & Bagchi, 2012; Pandelaere et al., 2011; Zhang & Schwarz, 2012). For example, Zhang and Schwarz (2012) find that consumers infer higher accuracy for attributes specified in smaller units. Pandelaere and colleagues (2011) asked participants to evaluate the difference between two television sets, for which participants received quality information with the unit manipulated: on a 10-point scale or a 1000-point scale. The results indicate that an attribute difference looms larger when it is expressed in large numbers (i.e., small units) rather than small numbers (i.e., large units). A possible explanation for this so-called unit effect is that consumers associate bigger numbers with bigger quantities (i.e., numerosity heuristic; Josephs, Giesler, & Silvera, 1994; Pelham, Sumarta, & Myaskovsky, 1994). Despite the potential usefulness of this heuristic, it can lead to misestimated outcomes, because people fail to take the *type of unit* into account when evaluating numerical information. Instead, they rely only on the *number of units*.

Although this research suggests that people infer larger quantities from larger numbers, it also implicitly assumes that units do not differ in elicited meaning and can be used interchangeably to express a given score on an attribute. In some situations, this assumption is true; Burson and colleagues (2009) manipulate the number of movies (per week vs. per year) of a movie rental plan, and Pandelaere and colleagues (2011) employ quality ratings and probability judgments (10- or 1000-point scales). In these studies, the units probably do not differ in evoked meaning, and respondents should not have considered switching between units. Other researchers have used attribute scores that are equally easy to process such as one month or 31 days, and people probably have no preference for either expression. However, in other cases, some units may be markedly preferred over others to express attribution information. We propose that expressing information in these default units may affect product judgments.

1.2 The Origins of Default Units

Linguistics studies show that people prefer to use certain expressions over others, without any specific reason (Greenberg, 1966). In asymmetric relationships between linguistic elements, so-called marked elements are dominant and more frequently used, so when asking about a person's age, people tend to use the adjective "old" ("How old are you?") instead of "young" ("How young are you?"). Extending this line of reasoning, we propose that people might have dominant expressions for quantitative information and prefer to use convenient numbers to express attributes.

What makes a number convenient? Research on numerical cognition suggests that numbers are mapped onto an approximate mental number line (Cantlon, Platt, & Brannon, 2009; Cohen Kadosh, Tzelgov, & Henik, 2008; Dehaene, 2011; Izard & Dehaene, 2008), which exhibits a magnitude effect (Dehaene et al., 1998; Dehaene, 2003; Parkman, 1971; Shepard et al., 1975). That is, people have a harder time discriminating between two large numbers than two small ones, because the mental number line follows Weber's law, which posits that the threshold of discrimination between two stimuli increases linearly with stimulus intensity. The mental representation of numbers thus becomes less precise when they convey larger magnitudes. For example, people decide more quickly that 7 is larger than 5 than they can decide that 107 is larger than 105 (Parkman, 1971) and rate 8 and 9 as more similar than 2 and 3 (Shepard et al., 1975). This decreasing accuracy prompts people to prefer to use smaller numbers(Banks & Coleman, 1981; Banks & Hill, 1974; Viarouge et al., 2010).

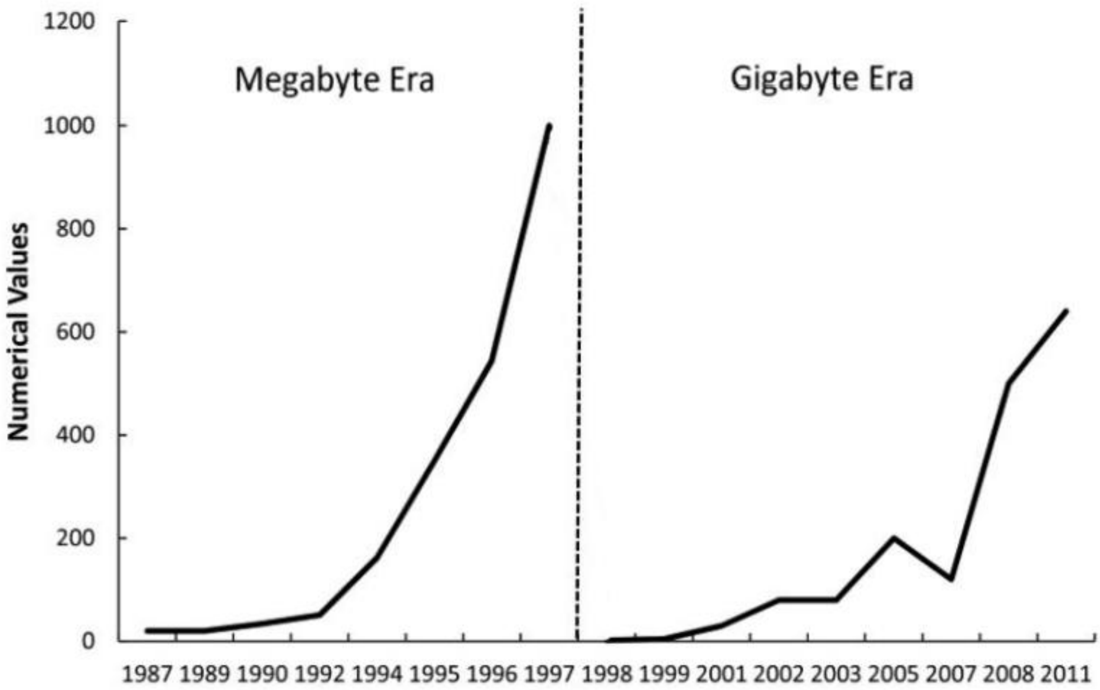
Also from a computational point of view, smaller numbers appear preferred. Research has repeatedly shown that for mental computations, a problem-size effect occurs (Ashcraft, 1992), such that computations with large numbers induce typically longer response times than computations with small numbers (Ashcraft, 1992; Groen & Parkman, 1972). In addition, linguistic analyses of number frequencies reveal that small numbers appear more frequently in written texts in many languages (Dehaene & Mehler, 1992; Dorogovtsev, Mendes, & Oliveira, 2006; Jansen & Pollmann, 2001). Words take numerical prefixes, such as bi- or tri-, only for small numerosities; no prefixes exist for 57 or 26 (Dehaene, 2011). From a rational perspective, it would make more sense to categorize a journal issue as number 564, but most people seem to prefer to classify it by volume and then issue within the volume, which reduces numerosity.

Our system of units also clearly reflects this preference. When humans quantify objects, at a certain threshold, large numerosities tend to be grouped into smaller numbers. Thus, people represent an increasing quantity in the same unit until the point at which the numerals representing this quantity become too large (e.g., 1024 megabytes). After this point, they regroup the large quantity in one larger unit (e.g., 1 gigabyte). Through this mechanism, people adapt the environment to the constraints imposed by their brain structure (Dehaene, 2009). Normatively, there is no reason to change the unit in which a quantity is specified, but contrary to this rational perspective, the human brain's preference for small natural numbers leads people to employ relatively large units (and thus small numbers).

Numerical units are basically categories of measurement (Stevens, 1946; Wiese, 2003). Research on categorization has demonstrated that some categorization levels are more dominant than others (Mervis & Rosch, 1981; Rosch, 1975). Objects are mostly categorized at basic levels (e.g., tree) rather than at superordinate (e.g., plant) or subordinate (e.g., Red Maple) levels, though this categorization is not simply a matter of expressing information as cognitively efficiently as possible. For example, categorizing a tree as a plant is very cognitively efficient but also insufficient to distinguish the object from other plants, resulting in low accuracy. Likewise, expressing quantitative information exclusively in small numbers is very cognitively efficient but not very accurate for discriminating among objects. A measurement system that would use a limited range of small numbers would be too imprecise to be practically useful in most cases; a measurement system that consisted exclusively of 1, 2, and 3 would make differentiating 20 attribute levels impossible. We argue that people trade off some level of cognitive efficiency to achieve higher accuracy and prefer the units that best achieve both aims (need for accuracy and need for cognitive efficiency). Decision making theory (e.g. Bettman, Luce, & Payne, 1998) supports such an argument. In general, decisions are often characterized by some compromise between the desire to make an accurate decision and the desire to minimize cognitive effort.

The tension between the need for cognitive efficiency and the need for accuracy is best illustrated by the way technological innovations can change the preferred unit. As a demonstration, we conducted a pilot study, in which we examined the numbers and units used to specify computers' hard disk capacity in multiple issues of the Belgian equivalent of *Consumer Reports*. Figure 1 shows the changing numbers that refer to the lowest disk capacity from 1987 to 2011. In 1987, the unit was megabytes; considering the limited memory capacity available, this unit provided consumers with a relatively small, convenient number. The numbers also were sufficiently precise to discriminate among attribute levels of that time. As hard disk capacity increased though, the numbers grew quickly, and in the trade-off, accuracy began to dominate cognitive efficiency. Around 1997, an increase of 1 megabyte seemed too precise, considering the low level of cognitive efficiency it then implied. To regain cognitive efficiency, a less precise unit came into use (i.e., gigabyte). With further technological improvements, the terabyte seems likely to replace the gigabyte as the preferred unit for hard disk capacity (Kryder & Kim, 2009).

Figure 1. Evolution of Units Describing Hard Disk Capacity (1987-2011): Pilot Study



In general, the choice of specific unit to express attribute levels might not be arbitrary. We propose that for many attribute levels, "basic units" arise from people's need to represent a range of attribute scores cognitively efficiently while still allowing for a sufficient level of accuracy. Basic units optimally achieve both aims.

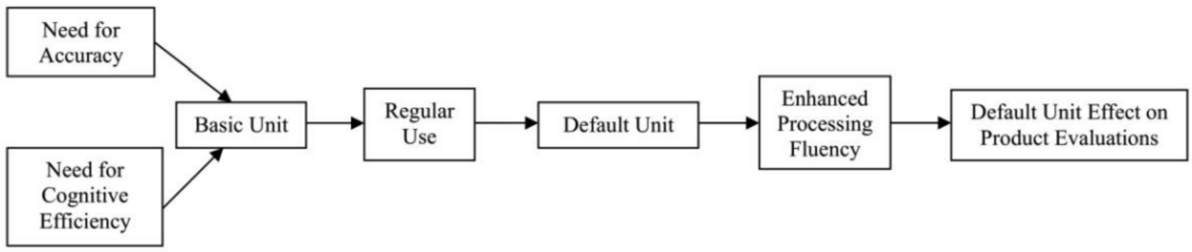
1.3 Default Units, Processing Fluency, and Product Evaluation

Because basic units strike the most optimal trade-off for a particular attribute range, consumers might employ them more regularly than other units. As a consequence, a basic unit might become the default unit for a specific range of attribute scores. Default units are thus the units that consumers are most accustomed to for describing certain attributes. Given that people are more familiar with default units, consumers should be able to process attribute information more easily when it appears in default units rather than nondefault units. Thus, specifying attribute information in an alternative unit might change the metacognitive experience of fluency that consumers experience during processing.

Vast research has documented that experienced ease or difficulty of processing provides a basis for a wide array of judgments, such as liking (Reber et al., 1998; Winkielman & Cacioppo, 2001), aesthetic appreciation (Pandelaere, Millet, & Van den Bergh, 2010; Reber, Schwarz, & Winkielman, 2004), product evaluations (Cho & Schwarz, 2010; Pocheptsova, Labroo, & Dhar, 2010), goal pursuit (Labroo & Kim, 2009; Labroo & Lee, 2006), importance ratings (Labroo, Lambotte, & Zhang, 2009; Shah & Oppenheimer, 2007), risk assessments (Song & Schwarz, 2009), and choice (Garbarino & Edell, 1997; Novemsky et al., 2007). Fluency can be generated through various instantiations, including font manipulations (e.g., Novemsky et al., 2007; Reber et al., 1998), rhyming words (McGlone & Tofighbakhsh, 2000), and even facial expressions (Stepper & Strack, 1993; Strack & Neumann, 2000).

Adding to this stream of research, we suggest that specifying attribute information in an alternative unit might change the fluency that consumers experience during processing. Because consumers have default units in which they prefer attribute information to be expressed, specifying information in nondefault units might lead to some metacognitive difficulty. Metacognitive difficulty likely generates negative product evaluations (Labroo, Dhar, & Schwarz, 2008; Reber et al., 1998), so we propose that, relative to default units, attribute information specified in nondefault units leads to less favorable product evaluations (see figure 2).

Figure 2. Overview Default Unit Effect



1.4 Default Unit vs. Numerosity Effect

In potential contrast with a numerosity account, we theorize that expressing positive attributes in *smaller* units (i.e., *larger* numbers) will not always lead to more positive product evaluations. However, the default unit account is not an alternative explanation of extant numerosity findings; rather, we argue that numerosity guides the judgment of products described in alternative units under a different set of circumstances. Consistent with previous research (Monga & Bagchi, 2012; Zhang & Schwarz, 2012), we argue that quantitative information can generate inferences beyond the numbers involved. For example, changing the consumers' focus to units could reduce the accessibility of numerosity as a decision criterion

(Monga & Bagchi, 2012). Similarly, when metacognitive difficulty is the most accessible decision input, it may reverse the effect of numerosity, thereby resulting in a default unit effect. However, when numerosity is the most accessible decision input, a numerosity effect may dominate the default unit effect.

One factor that might affect the accessibility of different judgment cues is evaluation mode (Hsee, 1996). Research on the effects of specifying attributes in an alternative unit (e.g. Burson et al., 2009; Pandelaere et al,. 2011) typically involved joint evaluation modes in which attribute values were explicitly juxtaposed. Consequently, attribute differences and numerosity may become very salient, resulting in a numerosity effect. Moreover, in comparative situations, the alternative options are all expressed in the same unit, as a result of which the type of unit (default vs. nondefault) could become nondiagnostic. During single evaluations though, the attribute difference cue disappears, and metacognitive feelings may emerge as the most accessible decision criterion.

We do not claim that numerosity effects cannot occur in separate evaluation contexts. Srivastava and Raghubir (2002) demonstrated a face value effect: Relative to a less numerous foreign currency, consumers tend to underspend when prices are specified in a more numerous foreign currency. Gourville (1998) demonstrated that, relative to a year frame (US$300 per year), representing a donation request in a day frame (US¢85 per day) leads to higher donations. These results seem inconsistent with the hypothesized default unit effect in separate evaluation mode. However, in these studies, metacognitive experiences may be similar across conditions. In the face value effect studies, an American participant would consider both Malaysian ringgit and the Bahraini dinar nondefault units, and equally difficult to process. Similarly, in the Gourville studies, US$300 per *year* versus US¢85 per *day* are presumably equally easy or difficult to process.

Some experiments compared a (default) home currency to a higher numerosity foreign currency and obtained a numerosity effect (e.g., exp. 2 and 4 in Srivastava & Raghubir 2002). However, there are two major differences with our work. First and most importantly, in Srivasta and Raghubir (2002), participants were not presented with any product attribute values at all. Rather, participants were asked to *generate* a maximum price for a particular product (e.g. a scarf) in either a foreign or familiar currency. In our theorizing, we expect the default unit effect to occur when attributes are simultaneously *presented* with the product. Second, given that metacognitive experiences between the familiar (default) and unfamiliar (nondefault) currency presumably differ, one could argue that the default unit account should predict that consumers should be willing to spend more in a familiar currency, irrespective of face value. However, consumers seem to be *less* inclined to spend more fluent forms of money (e.g., Mishra, Mishra, & Nayakankuppam, 2006). The default unit account would therefore make similar predictions as the numerosity account.

2. **STUDY OVERVIEW**

We test our predictions in six experiments. In study 1a, we offer evidence for our contention that the choice of units is not arbitrary. Particularly, units that most optimally satisfy the need for cognitive efficiency and the need for accuracy are preferred. In study 1b, we provide evidence that for a wide range of product attributes, a default unit exists that is considered the most suitable and most regularly used. In study 2, we demonstrate the default unit effect on product evaluations. Specifying attribute information in default units, relative to nondefault units, leads consumers to pay more, irrespective of the face value of the attribute.

In study 3, we provide evidence for our premise that fluency drives the default unit effect by employing a misattribution paradigm (Schwarz et al., 1991), in which the fluency generated by the default unit effect can be misattributed to an irrelevant source (i.e., background music). In study 4, we provide process evidence for the default unit effect. Specifically, the enhanced processing fluency associated with the default unit leads to enhanced product evaluations. In addition, we exclude the possibility that this effect is generated by the fluency associated with the numbers used in information specified in default units. In study 5, we show that evaluation mode (Hsee, 1996) determines whether a default unit or a numerosity effect arises. In a separate evaluation, we replicate the default unit effect; in the joint evaluation though, numerosity may overrule the fluency generated by default units as a decision input.

3. **STUDY 1A**

We strive to find support for our premise that that the choice of units is not arbitrary; instead, units differ in the extent to which they satisfy the need for cognitive efficiency and the need for accuracy. This implies that people should prefer a measurement system that makes use of a parsimonious number of categories, but nevertheless achieves a sufficient level of accuracy. In addition, we aim to show that consumers prefer a unit that represents the most balanced trade-off between accuracy and parsimony. We anticipate that a unit consisting of a limited range of small numbers (e.g., 1–10) will appear very parsimonious but not very precise. Conversely, a unit containing a very wide range of numbers (e.g., 1–1000) will be considered very precise but not parsimonious. Alternatively, a unit containing a moderate range of relatively small numbers should be regarded as precise *and* parsimonious (e.g., 1–100). This unit maximizes accuracy at the smallest cost possible, so we predict it will be preferred.

3.1 Method

In total, 33 participants (M_{age} = 22 years, 26 women) were recruited from an online panel. In the first part of the study, participants were told that a couple of companies had decided to introduce a new product. In addition, this product had a new feature for which no measurement unit existed. Three attribute scales were considered: numbers from 1 to 10, from 1 to 100, and from 1 to 1000 range. Participants were informed that they would rate each scale on two dimensions: accuracy and parsimony. Both accuracy and parsimony were concisely described before rating (Accuracy: “the extent to which a scale allows people to make very precise distinctions” – Parsimony: “the extent to which a scale allows people to express information in a simple way by completely minimizing complexity”). Next, for each scale, participants rated the extent to which it was accurate in specifying attribute information (1 = “not accurate at all”; 7 = “very accurate”) and parsimonious in conveying attribute information (1 = “not parsimonious at all”; 7 = “very parsimonious”). After completing these measures, participants indicated for each scale its suitability for specifying the new attribute (1 = “totally not suitable”; 7 = “very suitable”).

3.2 Results

We first subjected the accuracy ratings to a repeated measures analysis of variance (ANOVA) with scale type (1–10; 1–100; 1–1000) as within-subjects factors. This analysis yielded the expected main effect of scale type ($F(2,64) = 37.73$, $p < .05$). Planned contrasts revealed that the wide range unit was rated as more accurate than the narrow ($M_{\text{wide}} = 5.85$ vs. $M_{\text{narrow}} = 3.64$; $t(32)= 6.58$, $p < .05$) or moderate ($M_{\text{wide}} = 5.85$ vs. $M_{\text{moderate}} = 5.27$; $t(32)= 2.17$, $p < .05$) range units. As expected, an analysis of the parsimony ratings also revealed a significant main effect ($F(2,64) = 34.12$, $p < .05$). The narrow range unit was considered more parsimonious than the moderate (M_{narrow} = 5.73 vs. $M_{moderate}$ = 5.18; $t(32)= 2.18$, $p < .05$) and wide (M_{narrow} = 5.73 vs. M_{wide} = 3.33; $t(32)= 7.29$, $p < .05$) versions.

An analysis of the suitability ratings demonstrated significant differences across the three units ($F(2,64) = 10.35$, $p < .05$), in further support of our conjecture that the units are not arbitrary. Confirming our hypothesis, participants rated the moderate range unit as more suitable than the narrow ($M_{moderate}$= 5.64 vs. M_{narrow} = 4.67; $t(32) = 2.67$, $p < .05$) or wide ($M_{moderate}$= 5.64 vs. M_{wide} = 3.88; $t(32) = 4.86$, $p < .05$) range units. The difference in suitability between the narrow and wide range units was marginally significant ($t(32) = 1.82$, $p = .078$), which suggests that people may consider parsimony more important than accuracy.

We next regressed evaluations of suitability on accuracy and parsimony ratings. A multilevel model accounted for the repeated-measures nature of the data. To test whether people trade off accuracy and parsimony, we included the interaction between accuracy and parsimony ratings. The analysis reveals main effects of both parsimony ($F(1,38.51) = 22.21$, $p < .001$) and accuracy ratings ($F(1,26.69) = 5.19$, $p < .05$). As expected, a significant interaction ($F(1,38.89) = 19.29$, $p < .001$) indicates that people trade off accuracy for parsimony.

A closer inspection of this interaction reveals that accuracy is not related to suitability when parsimony is low (-1SD) (simple slope = .013, $z = .93$, $p = .35$). As parsimony increases, accuracy becomes related to suitability. For instance, for moderate (i.e. mean) parsimony, accuracy influences suitability (simple slope = .41, $z = 4.71$, $p < .001$). Likewise, parsimony is not related to suitability when accuracy ratings is low (-1SD) (simple slope = -.12, $z = .89$, $p = .37$). As accuracy increases, parsimony becomes related to suitability. For instance, for moderate (i.e. mean) accuracy, parsimony influences suitability (simple slope = .24, $z = 2.27$, $p < .05$). This pattern of results suggests that people indeed prefer units that maximally satisfy both the need for cognitive efficiency and the need for accuracy.

3.3 Discussion

This study demonstrates that choice of units is not arbitrary; people try to achieve both accuracy and cognitive efficiency. Our results suggest that units that most optimally satisfy both the need for cognitive efficiency and the need for accuracy seem more suitable than units that overemphasize either one. Admittedly, due to the within subjects design, the current study suffers from a demand effects explanation. Future research may therefore investigate the tension between accuracy and parsimony in a between-subjects design. Still, our study offers preliminary evidence for the existence of optimal units. Our theorizing suggests that such optimal units are likely to be used more often and consequently become default units.

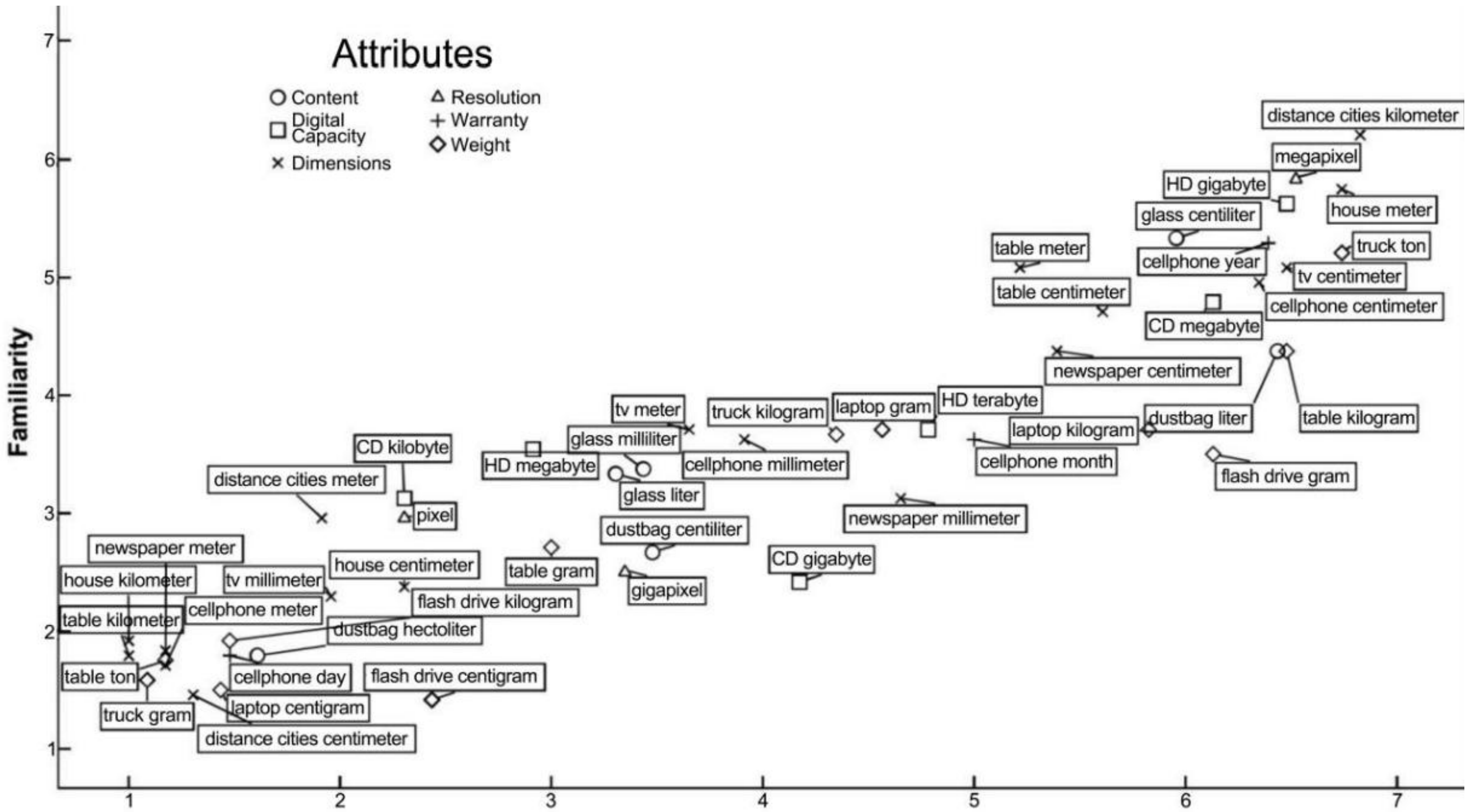
4. **STUDY 1B**

In study 1a, we demonstrated that units that most optimally balance between the need for cognitive efficiency and accuracy are preferred. In this study, we aim to show that for a wide range of attributes, such a preferred unit exists and is used commonly. That is, we argue that these initially preferred units become default for particular attributes. We test the regular use of a unit indirectly by assessing its familiarity. If a unit is used more frequently, it should be more familiar than other units. We expect that unit suitability (i.e., extent to which it represents an optimal balance between small number preferences and need for precision) should be highly correlated with unit familiarity.

4.1 Method

In total, 47 undergraduates (M_{age} = 21 years, 18 women) from Ghent University participated in exchange for course credit. To avoid false inflation of the relations between unit suitability and unit familiarity, we opted for a between-subjects design. Half the participants rated the suitability of a unit for a particular attribute (1 = “totally not suitable”; 7 = “very suitable”), and the other half indicated the extent to which a unit was familiar (1 = “totally not familiar”; 7 = “very familiar”). We included six attributes: weight (laptop, USB flash drive, table, truck), spatial dimensions (cell phone, table, television, distance between cities, newspaper, house), digital capacity (computer hard disk, CD), warranty (cell phone), camera resolution (digital camera), and content (glass, dustbag of a vacuum cleaner). For each attribute, participants rated three alternative units on their familiarity or suitability. For example, for hard disk capacity, they rated kilobyte, megabyte, and terabyte; for the dimensions of a television, they considered meter, millimeter and centimeter. The order of presentation was random. For each combination of attribute and unit, we calculated a mean score across participants for both familiarity and suitability (see figure 3).

Figure 3. Familiarity Ratings as a Function of Suitability Ratings and Product Attributes: Study 1b



4.2 Results and discussion

We observed a strong positive correlation between mean unit suitability and mean unit familiarity ($r = .92$, $p < .001$); more suitable units were more familiar. Visual inspection of figure 3 clearly shows that for most attributes, people have a default unit: The warranty of a cell phone in years appears more familiar and suitable than one expressed in days, and for camera resolution, megapixels is the default unit, whereas gigapixels and pixels are nondefault units. Megapixels probably most optimally meet the need for both accuracy and cognitive efficiency, whereas the two latter units insufficiently satisfy the need for accuracy and the need for cognitive efficiency, respectively.

Consistent with our theory, a default unit for product A might be a nondefault unit for product B. For example, a centimeter is the default unit for describing the spatial dimensions of a television, but not for measuring the spatial dimensions of a house. For the latter purpose, centimeters clearly insufficiently meet the need for cognitive efficiency. Extending this reasoning, the same attribute (e.g., weight) can have multiple default units (e.g., grams or kilograms), depending on the attribute level. The default unit for the weight of light objects (e.g., USB stick) is grams; that for heavy objects (e.g., truck) is kilograms or tons. The kilogram is lacking accuracy for light objects, but a gram insufficiently satisfies the need for cognitive efficiency for heavy objects. Consistent with our pretest, a gigabyte is currently the default unit for hard disk capacity, but technological improvements are already making the terabyte a fairly suitable alternative.

Thus, we provide support for the premise that default units exist for a wide range of attributes. In addition, we show that these default units are preferred over other units and used more regularly than nondefault units. In the following studies, we investigate how attribute information in default units affects product evaluations.

5. **STUDY 2**

In study 2, we want to examine the proposed default unit effect; we predict that a product with attributes expressed in default units generates a higher willingness to pay, despite its lower numerosity.

5.1 Method

In total, 158 students (M_{age} = 21 years, 68 women) were recruited in exchange for a course credit for a series of unrelated studies, including the current one. Five outliers were excluded (more than 3SD's from the mean), leaving the final sample size at 153 participants. The entire session took about 50 minutes to complete. The participants were randomly assigned to one of two conditions and presented with an advertisement for a cell phone and a vacuum cleaner. Both products were described on the basis of one attribute: battery life for the cell phone and capacity of the dust bag for the vacuum cleaner. In the *high numbers, nondefault* condition, battery life was expressed in hours and dust bag capacity in centiliters (i.e., large numbers). In the *low numbers, default* condition, attributes were described in default units of information, or days and liters, respectively. An open-ended question assessed willingness to pay (WTP) for both products.

To ensure that the framing of the attributes corresponded with our conceptualization of default and nondefault units, we conducted a pretest with 31 adults from the same population as the main study. All participants reviewed the attribute information of a cell phone, specified in the varying units, and indicated the extent to which these units were familiar to them in describing the attribute (1 = "totally not familiar"; 7 = "very familiar"). For battery life, participants rated 6 days as more familiar than 144 hours (M_{days} = 5.65 vs. M_{hours} = 4.45; $t(30) = 2.52$, $p < .05$). Likewise, 2.6 liters was rated as more familiar than 260 centiliters (M_{liters} = 5.35 vs. $M_{centiliters}$ = 1.68; $t(30) = 10.96$, $p < .001$).

5.2 Results and discussion

A one-way between-subjects MANOVA conducted on WTP ratings yielded a significant difference ($F(2,150) = 4.87$, $p < .05$). Consistent with our hypothesis, two separate t-tests showed that participants were willing to pay more when information was in *low numbers, default* units than in *high numbers, nondefault* units. Similar difference arose for both the cell phone ($M_{default}$ = €126 vs. $M_{nondefault}$ = €102; $t(151) = 2.52$, $p < .05$) and the vacuum cleaner ($M_{default}$ = €98 vs. $M_{nondefault}$ = €80; $t(151) = 2.16$, $p < .05$).

This study supports the hypothesis that a product described in default units generates a higher WTP, despite the lower numerosity of the attribute score. In the next study, we search for evidence of the proposed mechanism.

6. **STUDY 3**

Study 3 aims to support the proposed fluency mechanism for the default unit effect. In particular, we examine the role of metacognitive feelings in the default unit effect. To do so, we use a misattribution paradigm, such that we provided respondents with an alternative, salient source to which they could attribute the metacognitive feelings they experience (Schwarz & Clore, 1983). With this alternative source, their experienced metacognitive feelings are no longer attributed to the product they are evaluating, and no affective transfer to the product occurs. For example, Schwarz and colleagues (1991) told participants that their affective reactions to forthcoming stimuli might be influenced by background music; this manipulation undermined the informational value of their affective reactions, because participants attributed them instead to the background music, and fluency effects on judgments no longer arose.

Similarly, the metacognitive difficulty that participants experience when processing information in nondefault units should not lead to negative product evaluations when they believe that these feelings have been caused by background music. The mere presence of background music does not suffice to establish misattribution, because participants normally do not regard it as a valid source of their experienced feelings. Instead, participants must be informed that music can influence their feelings, which makes that background music salient as a source of metacognitive feelings. We expect that the default unit effect will be attenuated by the presence of background music, if it is perceived as a source of experienced metacognitive difficulty. If background music is not regarded as a source, the default unit should persist.

6.1 Method

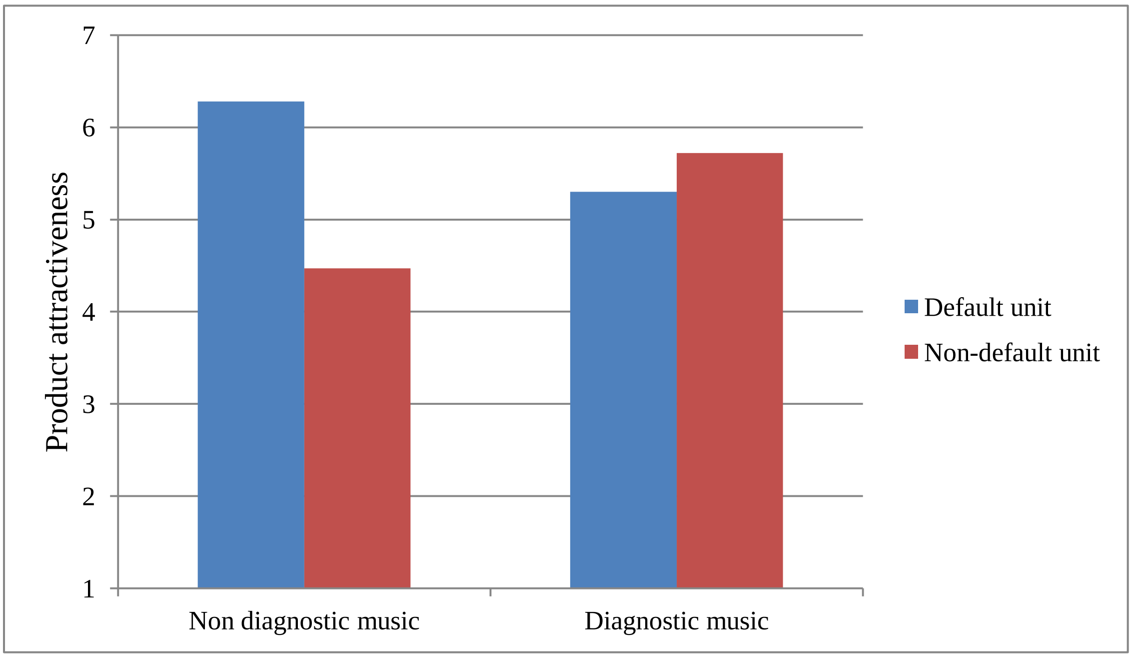
Participants were 89 undergraduates (M_{age} = 20 years, 35 women) who participated in exchange for course credit. The experiment employed a 2 (unit: low numbers, default vs. high numbers, nondefault) x 2 (background music: nondiagnostic vs. diagnostic) design. When participants entered the laboratory, they were seated in a cubicle in front of a computer. Background music started playing at that moment. In the *nondiagnostic music* conditions, participants were informed only that they were to evaluate a cell phone and answer some questions afterward, without any specific information about the background music. In the *diagnostic music conditions*, we told participants that the experiment dealt with the influence of music on product evaluations and that previous research had shown that music has an influence on experienced feelings. Participants also were informed that every feeling they experienced probably could be attributed to the background music.

Next, all participants reviewed a cell phone and its warranty information. In the *low numbers, default unit* condition, the warranty was expressed in years, whereas in the *high numbers, nondefault* condition, it was specified in days. The face value of the latter condition thus was substantially higher. A pretest showed that “2 years” appeared more familiar than “731 days” for warranty length (M_{years} = 6.37 vs. M_{days} = 1.68; $t(70) = 20.78$, $p < .05$). Participants then rated the attractiveness of the product offer on a 10-point scale (1 = “totally not attractive”; 10 = “very attractive”).

6.2 Results and discussion

The 2 (unit: low numbers, default vs. high numbers, nondefault) □ 2 (background music: nondiagnostic vs. diagnostic) ANOVA conducted on participants’ product attractiveness ratings yielded the expected interaction ($F(1,85) = 6.51$, $p < .05$). In the nondiagnostic music conditions, a significant difference in attractiveness ratings emerged: The cell phone was rated as more attractive when the warranty was specified in years than in days (M_{default} = 6.28 vs. $M_{\text{nondefault}}$ = 4.47; $F(1,85) = 8.17$, $p < .05$). This pattern replicates the key finding of study 2. Consistent with our hypothesis, in the diagnostic music conditions, the difference in attractiveness was not significant (M_{default} = 5.30 vs. $M_{\text{nondefault}}$ = 5.72; $F(1,85) = .10$, $p = .75$). That is, participants discounted the metacognitive cues generated by the attribute information.

Figure 4. Product Attractiveness Ratings as a Function of Music Diagnosticity and (Non)Default Units: Study 3



This experiment provided evidence of the role of processing fluency in specifying attributes in default versus nondefault units. Giving participants the possibility to misattribute metacognitive feelings generated from processing the attribute information to background music playing during their product evaluation eliminated the default unit effect. In these conditions, participants' product attractiveness ratings did not differ across alternative attribute frames. When background music was not identified as a source to which feelings could be attributed, a product described in default units was rated as more attractive than one described in nondefault units, despite the lower face value of the former.

7. **STUDY 4**

Study 4 had two main goals. First, we wanted to provide process evidence for how default units influence product evaluations. Specifically, we predicted that the processing fluency associated with the unit mediates the effects of default units on product evaluations. Second, we aimed to eliminate an alternative explanation for our effects based on a numerical fluency account (King & Janiszewski, 2011). King and Janizewski (2011) demonstrate that numerical stimuli can enhance fluent experiences. Because default units often use fluent numbers, the default effect could be explained by the fluency generated by the numbers used (e.g., 2 is probably more numerically fluent than 731). From our theorizing, we expect default unit effects to emerge because this type of unit is deemed more appropriate to describe a range of attribute scores, irrespective of number fluency. To distinguish these explanations, we set up an experiment in which the numbers in both the default and the nondefault unit condition were equally fluent to process.

7.1 Method

In total, 74 participants (M_{age} = 22 years, 48 women) were randomly assigned to one of two conditions, and all were presented an advertisement for a smartphone. The smartphone was described on one attribute: warranty. In the *high numbers, nondefault* condition, warranty was specified in weeks (80 weeks), such that the attribute was specified in small units and large numbers. In the *low numbers, default* condition, information was presented in years (1.5 years), that is, rather large units and small numbers. We asked a separate group of participants from the same population (N = 40) to rate the extent to which they found the numbers 1.5 and 80 difficult to process (1 = "totally not difficult to process"; 7 = "very difficult to process"). The numbers did not differ significantly in processing difficulty ($M_{1.5}$ = 2.48 vs. M_{80} = 2.15; $t(39) = 1.29$, $p = .20$), though if anything, participants considered 1.5 somewhat more difficult to process than 80. In addition, we conducted a pretest (N = 31) showing that a warranty of 1.5 years was more familiar than 80 weeks (M_{years} = 6.42 vs. M_{weeks} = 2.42; $t(30) = 12.72$, $p < .001$). An open-ended question assessed WTP for the phone.

To test for mediation, we included three measures of the fluency associated with the unit: How "right" does it feel to express warranty for smartphones in years (weeks)? (1 = "totally not right"; 7 = "very right"); How suitable do you think it is to express warranty for smartphones in years (weeks)? (1 = "totally not suitable"; 7 = "very suitable"); and How appropriate is it to express warranty for smartphones in years (weeks)? (1 = "totally not appropriate"; 7 = "very appropriate"). These measures were summed into a composite measure ($\alpha = .95$) of the fluency associated with the unit.

7.2 Results

Fluency associated with the unit. An independent samples t-test revealed that participants rated default units as eliciting more fluent attribute information processing than nondefault units ($M_{default}$ = 6.07 vs. $M_{nonefault}$ = 2.14; $t(72) = 19.26$, $p < .001$).

Willingness to pay. In line with our hypothesis, an independent samples t-test revealed that a smartphone described in low numbers and default units generated a higher WTP than when it was specified in high numbers and nondefault units (M_{default} = €161 vs. $M_{\text{nondefault}}$ = € 129; $t(72) = 2.04$, $p < .05$).

Mediation analysis. Following Zhao, Lynch, and Chen (2010), we tested whether unit fluency mediated the relation between condition (default unit = 1) and WTP ($\beta = 32.06$, $t(72) = 2.04$, $p < .05$) using a bootstrap resampling method based on 5,000 resamples (Preacher & Hayes, 2004, 2008). The results revealed an indirect effect (a × b = 70.72, $SE = 39.32$), with a 95% confidence interval excluding 0 (.09 to 148.38). Compared with the nondefault unit, being in the default unit condition enhanced processing fluency ($\beta = 3.94$, $t(72) = 19.26$, $p < .001$); holding constant condition (default vs. nondefault), unit fluency increased WTP ($\beta = 19.09$, $t(71) = 2.17$, $p < .05$). The direct effect of condition on WTP turned insignificant ($t(72) = -1.14$, $p = .26$), so this mediation was classified as complementary (Zhao, Lynch, & Chen 2010). Because our mediation analysis suffered from multicollinearity, we drew on the logic of ridge regression (Hoerl & Kennard, 1970; Mahajan & Jain, 1977) to reduce it. This analysis yielded similar results, showing that the mediation result is robust.

7.3 Discussion

This experiment provides clear evidence of the proposed mechanism driving the default unit effect. The default unit effect emerges because default units are more fluently processed than nondefault units. Furthermore, in contrast with a numerical fluency account, attribute information specified in default units generates a larger willingness to pay, even if the numbers involved do not differ in their number fluency.

8. **STUDY 5**

Study 5 aims to position the default unit effect relative to the numerosity effect. People often employ the most accessible decision criterion (Chaiken, 1987; Wyer, 2011), so we predict that the relative strength of numerosity and default unit effects depends on the respective accessibility of numerosity and metacognitive feelings as decision inputs. Particularly, evaluation mode (Hsee, 1996) might affect accessibility. In joint evaluation mode, the numerosity associated with attribute differences may become very salient, such that it could override the fluency associated with processing default versus nondefault units. When consumers evaluate differences between larger numbers, the differences may still seem greater than equivalent differences between smaller numbers, even if the product information is described in nondefault units. During single evaluations though, the salient attribute difference numerosity cue disappears, so metacognitive feelings may emerge as the most accessible decision criterion for consumers' judgments.

In addition, prior research has mainly employed relative judgments (e.g., choice) that ask participants to compare two products. Specifically, participants must indicate the offer they consider best. Because the type of unit is identical (i.e., both default or both nondefault), no difference can surface in metacognitive experiences between options, thereby excluding the possibility of the default unit effect. To detect a possible default unit effect, we employed absolute judgments (e.g., attractiveness of product offer) in a comparative context (e.g., multiple products).

8.1 Method

In total, 175 students (M_{age} = 21 years, 132 women) participated in an online study. The experiment employed a 2 (unit: low numbers, default vs. high numbers, nondefault) $\times$ 2 (evaluation mode: separate vs. joint) design.

All participants reviewed at least one digital camera and its warranty information. In the *low numbers, default unit* conditions, the warranty was expressed in years, whereas in the *high numbers, nondefault unit* conditions, it was specified in days. In the separate evaluation conditions, participants evaluated only one digital camera. Warranty was either presented in years (2 years) or in days (730 days). In the joint evaluation conditions, participants rated two digital cameras. One of them (superior one) was identical to the one presented in the separate evaluation conditions. The other camera had a warranty of 1.5 years (550 days). A pretest (N = 31) confirmed that a warranty of 1.5 years was rated as more familiar than 550 days (M_{years} = 6.42 vs. M_{days} = 2.03; $t(30) = 15.21$, $p < .05$). Thus, in all conditions, participants rated the attractiveness of the offer involving the camera with a warranty of 2 years (or 730 days) on a 10-point scale (1 = "totally not attractive"; 10 = "very attractive").

8.2 Results

A 2 (unit: low numbers, default vs. high numbers, nondefault) x 2 (evaluation mode: separate vs. joint) ANOVA conducted on participants' product offer attractiveness ratings yielded the expected interaction ($F(1,171) = 10.91$, $p < .05$). In the separate evaluation mode, planned contrasts showed a significant difference in attractiveness ratings between default and nondefault unit conditions: The digital camera offer was rated as more attractive when the warranty was specified in years (low numbers, default unit) than when it was specified in days (high numbers, nondefault unit) ($M_{default} = 6.73$ vs. $M_{nondefault} = 5.67$; $F(1,171) = 8.47$, $p < .01$). This result replicates the default unit effect.

Consistent with prior research on numerosity effects, in joint evaluation mode, this difference in attractiveness was marginally significantly reversed ($F(1,171) = 3.35$, $p = .07$): Contrary to the single evaluation mode, the digital camera was rated as marginally significantly *less* attractive when the warranty was specified in years (low numbers, default unit) than when it was specified in days (high numbers, nondefault unit) ($M_{default} = 6.46$ vs. $M_{nondefault} = 7.21$). Of note is that the attractiveness of the offer in the nondefault conditions differs across evaluation modes: In joint evaluation modes, attractiveness is higher than in single evaluation modes ($M_{joint} = 7.21$ vs. $M_{single} = 5.67$; $F(1,171) = 16.51$, $p < .001$). For default units, no difference emerged between single and joint evaluation modes ($F(1,171) = .45$, $p = .50$).

8.3 Discussion

Whereas the previous experiments used situations in which the metacognitive ease associated with processing default versus nondefault units probably was a more salient decision input than attribute numerosity, this study examined a situation in which it was not the case. When a digital camera was evaluated by itself, the default unit effect emerged. When the same digital camera was juxtaposed to another a marginally significant numerosity effect emerged. The latter result is consistent with previous studies (Burson et al., 2009; Monga & Bagchi, 2012; Pandelaere et al., 2011).

In addition, this result does not necessarily imply that no default unit effect can occur in a comparison of several products. Research on evaluability (Hsee, Loewenstein, Blount, & Bazerman, 1999) instead emphasizes that the distinction between joint and separate evaluation should be regarded as a continuum. In this study, products in joint evaluation mode were explicitly juxtaposed, and the numerosity associated with the attribute difference was thus very salient. However, when consumers evaluate multiple options more sequentially, the numerosity of the difference may become less salient. Instead, the ease versus difficulty of processing may serve as a more accessible cue in this situation, giving rise to a default unit effect.

Finally, in this context it is interesting to note that research on knowledge accessibility suggests that once a target has been evaluated, the evaluation is likely to affect future judgments (Kardes, 1986; Pocheptsova & Novemsky, 2010; Yeung & Wyer, 2004). For example, Pocheptsova and Novemsky (2010) examine how incidental mood during real-time judgments affects subsequent judgments. In one study, they show that participants who evaluated a painting based on incidental affect continued to employ this biased evaluation criterion five days later. If consumers evaluated a product described in default units in single evaluation mode (e.g., an advertisement), the favorable representation might persist and affect subsequent judgments, even if they involve comparison with other products. This prior evaluation then may attenuate or even reverse numerosity effects in a subsequent joint evaluation. Similarly, numerosity effects that occur during a joint evaluation may attenuate or reverse the default effect in subsequent single evaluations.

9. **CONCLUSIONS**

Research on attribute framing increasingly considers the possible role of specifying attributes in alternative units (Burson et al., 2009; Monga & Bagchi, 2012; Pandelaere et al., 2011; Zhang & Schwarz, 2012). This research has shown that describing product attributes in smaller units and larger numbers, relative to those specified in larger units and smaller numbers, inflates the perceived attribute difference between products. The proposed mechanism is that consumers infer higher quantities from larger numbers. However, the extent to which judgments exhibit numerosity effects, and whether the numerosity heuristic is the only mechanism influencing such judgments, has remained unclear. In a series of studies, we identify a different, complementary mechanism and examine the circumstances in which it operates.

In this work, we find that positive product attributes specified in small units do not unequivocally lead to more favorable product evaluations. In contrast with the assumption that attribute levels are specified in arbitrary units, we find that in many cases, consumers maintain a default unit for the expression of product attribute levels and experience greater difficulty judging a product when the attributes are expressed in nondefault units. This metacognitive cue leads them to evaluate products described in nondefault units less favorably.

With study 1a, we offer evidence for the premise that preferred units represent the most optimal trade-off between accuracy and parsimony (or cognitive efficiency). Study 1b shows that for a wide range of attributes, a default unit exists. Study 2 provides preliminary evidence of the proposed default unit effect, because products with positive attributes specified in default units generate a higher WTP than products described in nondefault units, despite a lower face value of the former. With study 3 we demonstrate that these effects are generated by the enhanced fluency of processing product information expressed in default units. If participants misattribute the experienced affect to background music, the default unit effect disappears. Study 4 provides process evidence about how default units affect product evaluation and excludes an alternative account based on numerical fluency. Finally, study 5 reveals the role of evaluation mode in guiding cue selection for judgment (numerosity or ease versus difficulty of attribute processing). In the separate evaluation mode, we replicate the default unit effect, but in the joint evaluation mode, a marginally significant numerosity effect emerges. This study extends previous research by showing when numerosity effects may be reversed.

It also offers a more nuanced understanding of how specifying attributes in an alternative unit influences consumers' evaluations. Particularly, this article offers a new perspective on recent research that suggests that quantitative information can generate inferences beyond the numbers involved (Monga & Bagchi, 2012; Zhang & Schwarz, 2012). In addition, we offer a more nuanced understanding of when numerosity effects occur and specify the conditions in which they are reversed. Finally, this research adds to current literature by recognizing that default units exist for many attributes.

Given that the current paper only employs positive attributes (i.e. higher values are preferred to lower values), one may wonder whether the effects found also apply to negative attributes (i.e. lower values are preferred to higher values). Extant theorizing on fluency (e.g. Novemsky et al., 2007; Reber, Winkielman, & Schwarz, 1998) suggests there seems little reason to expect that the default effect would not hold for negative attributes. So, we would expect that default units always increase product evaluations. At the same time, however, we believe that it may be very challenging to disentangle numerosity and default unit effects for negative attributes. This would require specifying attribute information in default units in *larger* numbers. Our theorizing on the origin of default units implies that low attribute values would usually correspond to default unit specification. Any nondefault unit specification that uses even lower numbers implies the use of decimal fractions below 1 (e.g. numbers like 0.71). The use of decimal fractions may elicit additional processes that may attenuate the default unit effect (e.g. left digit effect; Manning & Sprott, 2009; Thomas & Morwitz, 2005).

We have demonstrated that evaluation mode may determine whether a numerosity or a default unit effect arises. Specifically, in joint evaluations, the options compared differ in their attribute levels but not their type of unit, so processing fluency is similar for both options, and the numbers for specifying the attribute levels primarily affect evaluations, resulting in a numerosity effect. In single evaluation, though, attribute-level differences are less salient, and processing fluency appears more likely to affect evaluations, resulting in a default unit effect. Alternatively, a joint evaluation context might also communicate new defaults. Specifically, the default effect might be attenuated if two products are described using nondefault units because consumers begin to perceive the new unit as a standard. Given that the current experiment cannot distinguish between these two explanations, future research may address this.

Our research expands research findings by Maglio and Trope (2011) that show that people tend to adopt an abstract focus when presented with larger units. In their study, participants estimated the length of a line representing a road trip in small or large units and revealed when they expected the road trip to occur. The larger units induced an abstract (i.e., more distant) mindset; participants in this condition expected the trip to happen later (i.e., more temporally distant) than those in the smaller unit condition. Some core assumptions of their study fit nicely with our framework: They argue that more distant objects are associated with larger units and more proximate ones with smaller units, so for distant objects, a larger unit is default, whereas for more proximate objects, a smaller unit is the primary unit. For example, the default unit for the distance from a front door to a mailbox is probably in feet or yards; the default unit for the distance from a front door to the nearest beach may be miles or hundreds of miles. Recent research on construal-level theory confirms that more distant objects get segmented in larger segments (Henderson, Fujita, Trope, & Liberman, 2006). Moreover, people with an abstract construal level are less affected by metacognitive feelings (Tsai & Thomas, 2011). Further research should investigate whether they are also less likely to exhibit a default unit effect.

The processing fluency associated with default units is likely to stem from two different sources of processing fluency, one stemming from frequency of usage and one stemming from the tradeoff between cognitive efficiency and accuracy. Usually, these two sources go hand in hand: That is, the unit that most optimally satisfies both needs (cognitive efficiency and accuracy) also is most frequently used. However, default units likely change through technological advance. During a short period of ‘turbulent change’, both the old and the new default unit may be considered default. For example, around 1997, the then frequently used and familiar unit “megabyte” no longer struck an optimal balance between accuracy and cognitive efficiency while the less familiar unit “gigabyte” did (see Figure 1). Investigating default unit effects in such transition periods may yield additional insights in the default unit effect.

Factors beyond technological innovation might also change default units. Research on categorization has shown that basic categories shift in specific conditions, including individual differences in domain-specific knowledge that affect the extent to which the basic level is central to categorization (Dougherty, 1978; Johnson & Mervis, 1997). For example, when bird experts were asked to perform a free naming task on birds, they used more subordinate-level names (e.g., jay) for identifying objects (e.g., bird). In a similar vein, Johnson and Mervis (1997) find that fish experts are more inclined to generate new features of a fish at a subordinate level. In the consumer domain, increased familiarity with a product category results in an increased ability to categorize objects at a finer level (Alba & Hutchinson, 1987).

In light of these findings, consumers with prior knowledge or expertise might prefer attribute information specified in precise units. Even if the majority of consumers consider more precise units nondefault, knowledgeable consumers might cite the more precise unit as the default unit. From the perspective of our discussion about how default units emerge, this possibility makes perfect sense: Default units offer satisfactory levels of both accuracy and parsimony. Increased familiarity with a product and its attributes might lead to an enhanced capacity to process information, thereby allowing for additional precision without trading off some level of parsimony (Alba & Hutchinson, 1987). Consequently, increased product familiarity may nudge consumers to prefer a higher level of accuracy and consider more precise units the default.

Our research also contributes to work regarding fluency effects in consumer evaluations. We identify a hitherto ignored source of fluency effects: the default unit. Although we have focused specifically on product evaluations, default units might influence judgments through indirect pathways (Oppenheimer, 2008). People often weight information according to the ease with which they can process it (Shah & Oppenheimer, 2007). When comparing products on a range of attributes, the weight of a specific attribute might be influenced by its frame, such that an attribute specified in default units might seem more important. Specifying an attribute on which a target product performs badly in nondefault units might reduce the damaging effect of this attribute on judgments. In addition, nondefault units are associated with decreased processing fluency, so specifying an attribute in nondefault units probably increases choice deferral and strengthens the compromise effect (Novemsky et al., 2007).

Although we find that a product described in nondefault units generates less favorable product evaluations, recent evidence shows that the effect of metacognitive cues depends on the inferences drawn from these experiences (Briñol, Petty, & Tormala, 2006; Unkelbach, 2006). For example, in one experiment, some participants read a short text arguing that unintelligent people often experience a feeling of difficulty when thinking, and intelligent people mainly experience a feeling of ease, while the other half read a paragraph containing the opposite information and reversing the traditional easy-is-good association. The interpretation of metacognitive experience emerged as malleable in this study; sometimes metacognitive difficulty can enhance evaluations (Labroo & Kim, 2009; Pocheptsova et al., 2010).

For special occasion products, the inference that a product feels unusual, out of the ordinary, or more difficult to process likely has positive connotations (Pocheptsova et al., 2010), so these products might even benefit from the difficulty associated with processing nondefault units. For example, a limited edition MP3 player could best be described in nondefault units. Pursuing a goal requires an assessment of the extent to which an object is instrumental to its fulfillment. During evaluations, people often predict that a good indicator of the instrumentality of an object is its experienced difficulty. According to this naïve theory, metacognitive difficulty actually might improve efficacy evaluations of the means to attain the goal (Labroo & Kim, 2009), and our findings would suggest that a product described in nondefault units may be perceived as more instrumental. Consider a fitness goal: Specifying a bicycle warranty in nondefault units, such as days, increases processing difficulty, which may cause that bicycle to appear more instrumental for the fitness goal and generate more favorable product evaluations.

Further research should address how other factors might attenuate default unit effects. For example, motivational context can moderate the positive effects of fluency (Freitas, Azizian, Travers, & Berry, 2005). Because fluency often signals safety, prevention-focused people experience positive affect when presented with fluent stimuli. In contrast, promotion-focused people are less focused on security, so for them, fluency effects may be eliminated. Similarly, information in default units may be more appealing when induced in a prevention focus rather than a promotion focus. With the assumption that happiness signals a safe environment, De Vries and colleagues (2010) demonstrate that happiness moderates fluency effects, because familiarity is less valued in benign environments. Thus default unit effects may be less pronounced for people in a happy mood.

Specifying attribute information in alternative units can alter metacognitive experiences and affect product evaluations. This research is among the first to integrate research streams on fluency, attribute framing, and numerical cognition. Furthermore, we add to growing literature that describes the circumstances for numerosity effects (Bagchi & Davis, 2012; Monga & Bagchi, 2012) by showing that units have differential effects on product evaluations. In five studies, we have demonstrated that products described in default units (i.e., basic-level categories of measurement) generate more positive product evaluations, despite their lower numerosity.

CHAPTER 4

WHEN PRECISION PROTECTS: PRECISE PRODUCT INFORMATION AS A SOURCE OF CONTROL

CHAPTER IV: WHEN PRECISION PROTECTS: PRECISE PRODUCT INFORMATION AS A SOURCE OF CONTROL

Imagine arriving at a store after having been stuck in a long and frustrating traffic jam. Would the experience of being stuck in traffic affect your unrelated purchase choices?

Consumers regularly encounter situations in which they lack personal control, whether due to traffic jams, financial crises, terrorist threats, unexpected weather conditions, or out-of-stock events. When their daily lives get interrupted by episodes of unpredictability, people temporarily sense a loss of personal control. Yet despite the frequency of such personal control threats, knowledge of how consumer's decisions differ after experiencing a personal control threat remains limited (Cutright, Bettman, & Fitzsimons, 2013; Cutright & Samper, 2014; Cutright, 2012).

To investigate how experiencing a control threat might influence consumer decisions, we consider the type of product information consumers prefer, with the prediction that people who sense a lack of control have a stronger need for more precise product information (e.g., three-year warranty, 14-hour battery life), which in turn affects their product choices. Consumers whose control has been threatened then may be more inclined to pay attention to precise product information, so they become more likely to choose a product that is superior on certain attributes specified in a precise format, compared with consumers who have not experienced a recent control threat.

In testing these predictions, this study extends several research streams. First, consumers regularly confront situations that threaten their personal control (e.g., traffic jam) in close temporal proximity to purchase decisions (e.g., shopping after escaping the traffic jam). By showing that a control threat may lead them to search for more precise product information, we extend recent consumer behavior literature on the effect of personal control losses on reactions to brand logos (Cutright, 2012), brand extensions (Cutright et al., 2013) and high-effort products (Cutright & Samper, 2014). Second, prior research on the effects of personal control threats generally focuses on how structure can help restore a sense of predictability (Kay, Whitson, Gaucher, & Galinsky, 2009; Rutjens, van Harreveld, van der Pligt, Kreemers, & Noordewier, 2012; Whitson & Galinsky, 2008); we instead address the similar effects of precision. Third, we extend research into how precise product information can affect product preferences (Bagchi & Li, 2011; Monga & Bagchi, 2012; Pandelaere et al., 2011; van Dijk &

Zeelenberg, 2003; Zhang & Schwarz, 2012) by identifying a situation that shifts consumers' attention toward an attribute, merely because it has been specified precisely.

1. **THEORETICAL BACKGROUND**

1.1 Control Threats and Need for Predictability

People prefer to feel as if they have personal control, defined as the perceived ability to exert force and to alter an environment (Thompson & Schlehofer, 2008). This motivation seemingly stems from the more fundamental desire to guard against the existential anxiety evoked by perceptions that the world is an unpredictable place (Kay, Gaucher, & Napier, 2008; Lerner, 1980). Specifically, an individual that has personal control over the environment essentially determines the predictability of the environment since it is the individual who decides what can be expected in the future (Averill, 1973; Mineka & Hendersen, 1985). For example, having personal control over a car implies that you decide where the car will go and when it will stop. In contrast, when an individual perceives a lack of personal control, his or her personal responses may not seem to have a consistent impact on future events and may instigate feelings of unpredictability. For example, when your car is stuck in a huge traffic jam, personal control levels may drop because it is the environment that determines what happens next.

Personal control over the environment invokes various positive consequences (Rutjens, 2012). For example, Glass and colleagues (1973) demonstrate that perceptions of control over an aversive stimulus significantly reduce stress reactions: If participants in their experiment believed that the duration of an electrical shock was contingent on their reaction speed, they showed less severe stress reactions than participants who received no such information. Conversely, a lack of personal control provokes stress and anxiety (Janoff-Bulman, 1992). Anxiety disorders such as obsessive–compulsive disorder relate to a perceived lack of personal control (Moulding & Kyrios, 2006, 2007).

To avoid the unpleasant feelings associated with control losses, people employ strategies that help them maintain a sense of personal control, even if they actually lack such control (Converse, Risen, & Carter, 2012; Langer, 1975; Thompson, 1999). Langer (1975) shows that people prefer to keep a lottery ticket they have picked, rather than switch to an assigned ticket, even if the latter has higher odds of winning. In addition, when waiting for a desired outcome, people exhibit a greater tendency to help others, as if they could change their "fate" by performing good deeds (Converse et al., 2012).

When people cannot see no immediate possibility to restore personal control, they search instead for alternative ways to protect themselves from the threatening realization that the world is unpredictable (Kay et al., 2008, 2009). That is, even though people cannot restore predictability through personal control, they may search for external sources that can provide predictability. For example, after being confronted with a threat to their personal control, people report stronger beliefs in the existence of a God that is responsible for events (Kay et al. 2008), express more support for benevolent governmental and societal institutions (Kay et al. 2008) and prefer to have a structured environment (Cutright 2012; Rutjens et al. 2013; Whitson and Galinsky 2008). For example, when getting stuck in a traffic jam people may search for traffic information that tells them how long they will be stuck.

Taken together, these results indicate that after experiencing a lack of personal control, people are looking for signs of a predictable environment. We propose that this increased need for predictability may guide consumer's decision processes by increasing the focus on aspects that help achieve feelings of predictability. In this manuscript, we highlight how the desire for increased predictability may affect the type of information consumers prefer. That is, consumers may appreciate product information that gives them a sense of knowing what to expect from the environment. We advance the idea that one particular characteristic of product information, its precision, may sometimes speak to this need for predictability. Specifically, we propose that precise information may help restoring feelings of predictability and thus lead to a stronger preference for precise product information among people who lack control, compared with those who feel in control.

1.2 Preference for Precise Product Information

When evaluating products, consumers try to predict how products will perform and which benefits the products will provide (Hsee et al., 2009; van Osselaer & Janiszewski, 2012b). The reason why consumers frequently resort to predicting benefits instead of experiencing actual benefits may be because it might take too long to actually test every option directly or because some benefits can only be experienced after some time. As a result, consumers mostly rely on proxies such as product information to predict actual benefits. In other words, consumers attempt to predict fundamentals such as performance and benefits by relying on proxies such as measured product attributes (Hsee et al., 2009). For example, measured battery life and measured weight may be regarded as valid proxies for true battery life and true weight respectively.

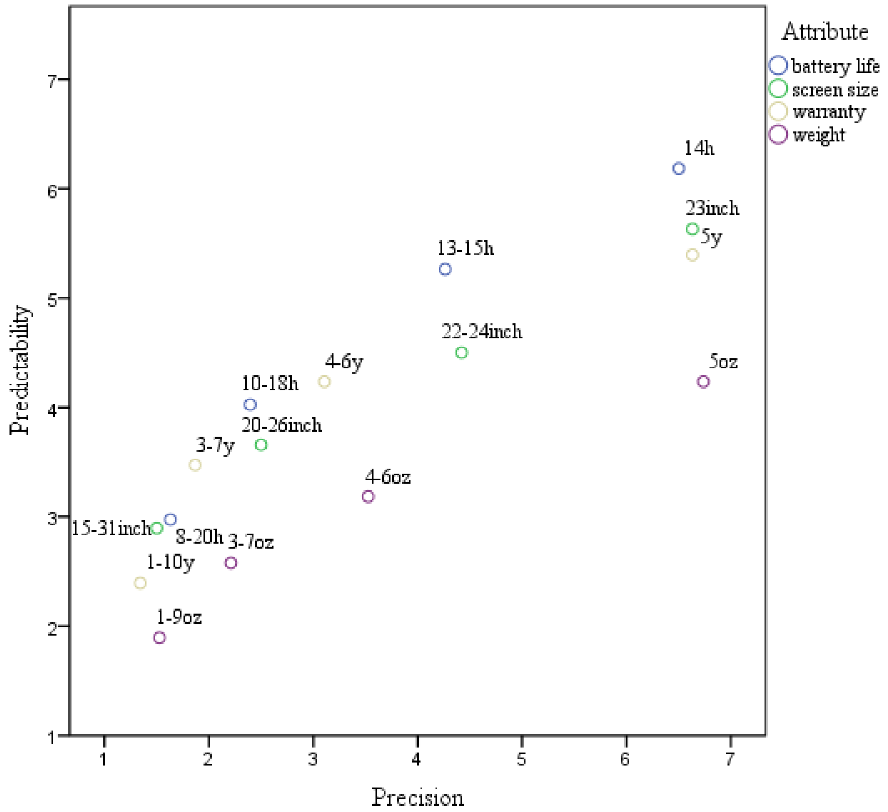
In this respect, it is important to note that product information descriptions differ in its precision. For example, the description “intuitive user interface” is less precise than “15-hour battery life.” Even quantitative product information varies in its precision, such that battery life might be specified as “long,” “15 hours,” or “15–17 hours.” Companies sometimes have good reasons to use relatively imprecise information, especially considering that such imprecise information, presented in verbal formats, often appeals to consumers (Wallsten, Budescu, Zwick, & Kemp, 1993). Calling a product “lightweight” likely feels more natural to consumers than specifying its “5.3 oz. weight.” In addition, relatively imprecise information can better represent reality; describing a battery’s life as “13 hours” is overly accurate, because battery life varies depending on the consumer’s usage habits, whereas citing “12–14 hours” is more representative of reality. However, if information is too imprecise, it becomes useless to consumers (Bagchi and Li 2011; Van Dijk and Zeelenberg 2003).

The precision with which product information is communicated has implications for how consumers interpret this information. In general, people typically expect that speakers only say things they know to be accurate (Grice, 1975). As such, precisely describing product attribute indicates that one knows the characteristics of that particular object to such an extent that an exact format can be used. For example, if Sara declares that an apple weighs 121 grams, recipients will infer that this is the exact weight and assume that it will not weigh 116 or 123 grams precisely because she uses this exact format. If she would have been less sure about the weight, recipients would have expected that she would have communicated weight as “between 115 and 125 grams”.

In light of this discussion, one may assume that the precision with which product attributes is described speaks to the extent to which true product performance is perceived to be predictable. Specifically, precisely specified product attributes may give the impression that true product performance can be predicted very well. For example, specifying battery life as “14 hours” assures consumers that true battery life can be predicted to be 14 hours. By contrast, specifying battery life as 13-16 hours evokes the perception that the true battery life cannot be fully predicted. In sum, precise product information may also increase feelings of predictability.

We tested this assumption in a small pilot study (N = 76) in which participants rated four product attributes (battery life, weight, screen size and warranty) specified in four different formats (very wide range, wide range, tight range and point value). Half of the participants rated the *precision* of these 16 (i.e. four product attributes x four formats) product attribute descriptions ("How precise is the following description?") while the other half rated them on feelings of predictability ("Please rate the extent to which a particular product information description gives you the feeling that the benefits and performance of a product can be predicted. In other words, to what extent do you feel that having this product information allows you to predict the actual performance of the product?"). Consistent with our expectations, results showed that ratings of precision and feelings of predictability were strongly positively related (r = .85, p < .001). As shown in figure 1, when attribute descriptions were rated as more precise, they were considered to be more predictive of product's benefits and performance.

Figure 1. Level of Predictability as a function of Precision: Pilot Study 1



Given that increased levels of precision may elicit higher levels of predictability, it follows that people who have a stronger need for predictability may also feel stronger need for precision. A second pilot study (N = 138), in which we preliminary tested this premise by having participants fill out the need for precision scale (Crombach's α = .86; Viswanathan

1997) and desire for predictability scale (Crombach's α = .90; subscale of Need for Closure Scale; Webster & Kruglanski, 1994), confirms a positive relationship between both constructs ($r = .28$, $p < .001$).

Taken together, it seems that precise product information may instigate feelings of increased predictability. As such, a desire for increased predictability seems to be positively related with a need for precision. Given that experiencing a lack of personal control leads to a desire for increased predictability, we hypothesize that when they experience a control threat, consumers will search for more precise product information, such as descriptions of the Kindle Fire that highlight its "16 gigabyte storage," "345 grams weight," and "10 hours of battery life." In this manuscript, we use quantitative information that features a single number and a familiar measurement unit (e.g., "345 grams weight," "12 hours battery life") to operationalize precise information. Hereafter, we refer to this information presentation as precise information.

Importantly, we do not claim that all precise information provides predictability; for example, a particular piece of information may be very precise but still lack predictability because consumers believe the manufacturer should have specified the information using a more familiar unit (Lembregts & Pandelaere, 2013). For the purposes of this study, we focus only on metrics (and attributes) that are frequently used in the marketplace, and we predict specifically that, compared with those who have control, consumers who lack personal control have stronger needs for more precise product information, which in turn leads them to choose products that are superior on attributes that happen to be specified in a more precise format. Also, relative to those who have control, consumers who lack personal control may value a product more if it is specified in precise terms.

2. STUDY OVERVIEW

We test our predictions in nine experiments. In study 1, we offer preliminary evidence for our basic contention that, relative to those who have control, people who lack personal control display a stronger need for more precise information. In study 2, we provide behavioral evidence by showing that when they make product decisions, consumers who lack personal control are more motivated to search for more precise information; specifically, when they gain access to more precise information during decision making, they make more use of it. In addition, we exclude alternative explanations based on a difference in general motivation or decision difficulty. In study 3, we conceptually replicate the findings of study 1 and study 2 by demonstrating that consumers who experienced a control threat have a stronger preference for precise product description. With study 4a, we demonstrate that, relative to having control, lacking personal control leads to a stronger preference for an alternative that is superior on attributes described precisely. Then in study 4b and a follow-up study, we exclude a mood explanation and confirm the robustness of the effect across stimuli and manipulations. We replicate the effect in study 5a and reveal that the preference for specific attributes is attenuated when attributes are specified in less precise, verbal terms. Study 5b also shows that, relative to consumers who do not, those who experience a control threat are even willing to pay more for a product merely because its attributes are specified in precise specifications. Finally, with study 6 we detail how the effect of a control threat on preferences for attributes specified in a precise format (e.g., 13 hours) dissipates if the same attributes are specified in a tight range (e.g., 12–14 hours), with the same expected value.

3. **STUDY 1**

We test our basic premise that consumers who experience a control threat have a stronger need for more precise information than those who have control.

3.1 Method

We recruited 106 participants from Amazon's Mechanical Turk (AMT; M_{age} = 34 years, 56 women) to complete a recall task, in which they described an incident in which they either did not have any control or were in complete control (Whitson & Galinsky, 2008). This manipulation has appeared frequently in prior research on control threats; we also tested its effectiveness in a pretest with participants from the same population (N = 75). Relative to participants who recalled a situation in which they had control, those who recalled an incident in which they lacked personal control were more likely to believe that they lacked control over their lives ($M_{\text{low control}}$ = 4.52; $M_{\text{high control}}$ = 5.19; $t(73)$ = 2.47, p < .05). Two coders checked whether the reports entered in the recall task were appropriate (intercoder reliability = 97.2%; disagreements resolved by discussion); we dropped six participants who failed to recall a relevant situation.

Next, participants completed the Need for Precision Scale (Viswanathan, 1997; e.g., "I am satisfied with information as long as it is more or less close to the facts" (R); "Vague descriptions leave me with the need for more information."). Twelve participants who failed to pass two attention checks (“Please do not rate this statement” and “Please indicate strongly agree”) were excluded from the analysis.

3.2 Results and discussion

Participants who recalled a personal control threat had a stronger need for more precise information than did those who recalled an episode in which they had personal control ($M_{\text{low control}}$ = 4.79; $M_{\text{high control}}$ = 4.41; $t(86) = 2.36$, $p < .05$). This result provides initial evidence that people who lack control are more likely to need more precise information than those who have control.

4. **STUDY 2**

In study 2, we seek behavioral evidence that people who lack personal control have a higher need for more precise information, so we test if people who have experienced a control threat are more motivated to look for more precise information than those who have not experienced it. If they search for and receive more precise product information, these consumers also should make more use of the precise information. We added two new conditions to the study 2 design, in which participants could not look for more precise information, so that we could test for several alternative explanations. In general, people who experience a control threat may be more motivated to process information (Cutright & Samper, 2014), which would create latency differences (i.e., time spent looking at product information). In addition, people who experience a control threat could experience more decision difficulty and therefore spend more time looking at the attributes. If either of these explanations holds, control would exert only a main effect on latencies, regardless of whether precise product information is available. However, if those in the control threat conditions are interested in more precise product information, we expect to find no differences only in conditions in which more precise information is not available.

4.1 Method

In total, 157 undergraduates (M_{age} = 21 years, 65 women) received course credit to participate in a series of unrelated lab studies, including the current one. The entire session took about 50 minutes to complete. We manipulated the sense of control with the autobiographical recall task from study 1. Two coders checked whether the reports were appropriate (intercoder reliability = 95.6%; disagreements resolved by discussion); none were excluded. Next, participants completed a seemingly unrelated task in which they considered two smartphones, each of which was described on six attributes (see appendix A). The instructions for half of the participants asked them to look closely at the attributes and indicate their final choice on the next page. The other half of the participants received the same instructions but also could click on each of the attribute values, which would reveal a more precise value for 1 second. For example, if participants clicked on "Large hard disk capacity," they saw the attribute value "30 gigabytes." To minimize the impact of random experiments with this feature on target choices, we gave participants the opportunity to engage in a short test trial, during which they could learn how the feature worked, before proceeding to the target choice.

For all conditions, we measured the time that participants spent looking at the attributes. In the condition that provided access to precise information, we also collected the number of times participants clicked on an attribute. Then we recorded which alternative the participants preferred, using a seven-point scale (1 = "strongly prefer product A"; 7 = "strongly prefer product B"). Although we added this preference measure to make the experimental task seem more realistic, we did not expect to find any differences as a function of the experimental manipulation, as was confirmed by the results (all ps > .61). Three participants who experienced problems with the task were excluded from the analysis, as was one outlier (more than three standard deviations from the mean number of clicks), leaving a final sample of 153 participants.

4.2 Results

For the analysis of the number of times participants clicked on attribute values, we logically included only the half of the sample that could click to find more precise information. To account for the count nature of these data, we conducted a Freeman-Tukey transformation (Freeman and Tukey 1950; see also Atalay, Bodur, and Rasolofoarison 2012). An independent t-test showed that when their control was threatened, participants clicked significantly more than if their control was not threatened ($M_{\text{low control}}$ = 9.17; $M_{\text{high control}}$ = 7.61; $t(75) = 2.78$, $p < .01$). The count also included multiple clicks on the same attribute value, but an analysis of how many *different* attribute values participants clicked (Freeman-

Tukey transformed) revealed a similar pattern ($M_{\text{low control}}$ = 6.88; $M_{\text{high control}}$ = 5.96; $t(75)$ = 3.29, $p < .01$).

To correct for skewness, we subjected the latencies (i.e., time spent looking at the attributes) to a log transformation, then conducted a 2 (control: present vs. absent) × 2 (access to precise information: yes vs. no) analysis of variance (ANOVA) with the transformed latencies (milliseconds) as the dependent variable. This analysis revealed a main effect of access to precise information ($F(1,149)$ = 19.91, $p < .001$): When participants had such access, they spent more time looking at the product information (M = 10.41) than did participants who had no access (M = 10.10). Although we found no significant main effect of the level of control ($F(1,149)$ = .79, p = .37), a marginally significant interaction arose between access to precise information and control ($F(1,149)$ = 2.93, p = .09). For participants who had no access to precise information, we found no significant difference in the time spent across the high and low control conditions ($F(1,149)$ = .33, p = .57), but for those participants with such access, those who experienced a control threat spent more time looking at the attribute information (M = 10.51) than those who had control (M = 10.32; $F(1,149)$ = 3.41, p = .07; see figure 2).

In the conditions in which participants could search for more precise product information, we also aimed to investigate whether the difference in latencies between the high and low control conditions resulted from a difference in the number of clicks, so we conducted a mediation analysis. Following Zhao, Lynch, and Chen (2010), we tested whether the number of clicks mediated the relationship between control (high control = 1) and latencies (β = -.18, $t(75)$ = 2.01, $p < .05$), using a bootstrap resampling method based on 5,000 resamples (Preacher & Hayes, 2004, 2008). The results revealed an indirect effect (a × b = -.08, SE = .04), with a 95% confidence interval excluding 0 (-.20 to -.02). Compared with high control, a lack of control increased the number of clicks (β = -1.56, $t(75)$ = 2.78, $p < .01$), whereas if we held that condition to be constant, the number of clicks increased latencies (β = .05, $t(74)$ = 3.00, $p < .01$). The direct effect of condition on latencies became non-significant ($t(74)$ = -.10, p = .28), indicating complementary mediation (Zhao et al. Chen 2010). Thus we found evidence that the difference between low and high control in latencies can be explained by the number of clicks on attributes, not by an overall difference in processing speed.

4.3 Discussion

People who lack personal control are more motivated to search for precise product information than those who have personal control. Specifically, participants lacking control make more use of the possibility to gather more precise information than do those who feel in control. In addition, they spend more time inspecting product information when given the opportunity. However, when only relatively imprecise information is available, we find no difference in the time spent across control conditions which implies that the effect can be attributed to differences in general motivation or decision difficulty.

One may argue that this finding may still be open to alternative interpretations. One possibility is that experiencing a loss of personal control may simply increase participants' propensity to click the attributes (in the precise-information-accessible condition, when they could do that), not because they wanted more precise information but because the action of clicking (the action under their control) provided them with a sense of control. To at least take partly care of this alternative account we tested whether providing participants with range information (e.g., warranty is between 3 years and 5 years) instead of point value information would still yield the same results. If lacking control leads to a tendency to click, one would also expect that to find an increase in click rates when information is specified in ranges. However, when lacking control leads to a search for precise information, one would expect no difference between high and low control conditions because range information does not provide precise information. A short posttest (N = 75; two conditions: high control – low control) in the lab with participants from the same population revealed no significant difference between high and low control when the information that appeared when clicking on product information was specified in a range format ($t(73) = .67$, $p = .51$).

5. **STUDY 3**

Study 3 had two aims. First, we wanted to conceptually replicate the effects found in study 2 by using a different set-up. Second, we aimed to exclude an alternative account based on mood. That is, the manipulation used in study 1 and 2 may have inadvertently manipulated participants' moods, such that those in the low control conditions may have experienced a more negative mood than those in high control conditions. In the current study, we looked whether the effect still persists after we statistically control for mood.

5.1 Method

We recruited 164 participants (M_{age} = 22 years, 97 women), in exchange for a small payment, to participate in a series of unrelated lab studies, including the current one. The entire session took about 50 minutes to complete. We manipulated the sense of control with the autobiographical recall task from study 1. One coder checked whether the reports were appropriate, and as a result, one participant was excluded; one additional participant was excluded because response on the dependent variable was more than three standard deviations from the group mean, leaving a final sample of 162 participants. After this manipulation, participants completed the brief PANAS scale (Tellegen, Watson, & Clark, 1988).

Next, participants were introduced to a seemingly unrelated task in which they were asked to evaluate the way a particular product attribute is described ("We are interested how people evaluate descriptions of product attributes. For example, information can be described very precisely or less precisely. We simply want to know to what extent you like to receive the following description of a product attribute when you are evaluating a product."). One half of the participants was shown a precise description of weight ("The product weighs exactly 150 grams"), whereas the other half was presented with a less precise description of weight ("The product weighs between 140 and 160 grams"). Participants were asked to rate the extent to which they would like to receive such a description of weight when making product evaluations (1 = would not like to receive this description at all; 7 = would very much like to receive this description).

5.2 Results and discussion

The 2 (control: present vs. absent) × 2 (description weight: precise vs. imprecise) ANOVA yielded a significant interaction ($F(1,158) = 8.83$, $p < .01$). When weight was described precisely, a significant difference in preferences emerged: Participants expressed stronger preferences for the precise weight specification if they lacked control rather than when they had control ($M_{low\ control} = 5.78$; $M_{high\ control} = 5.08$; $F(1,158) = 3.87$, $p = .05$). However, when weight was described imprecisely, preference dropped for both conditions, but the drop was steeper for the conditions who lacked personal control ($F(1,158) = 8.83$, $p < .01$). Somewhat unexpectedly, we found that for the imprecise conditions, lacking personal control led to a lower evaluation of the description compared to having personal control ($M_{low\ control} = 3.27$; $M_{high\ control} = 4.02$; $F(1,158) = 5.04$, $p < .05$). To test whether the effect held when we controlled for mood, we averaged the positive mood states as a positive mood index and the negative mood states as a negative mood index. Adding positive or negative mood scores as a covariate also did not change the results (interaction term with negative mood as a covariate $F(1,157) = 8.39$, $p < .01$; interaction term with positive mood as a covariate: $F(1,157) = 8.13$, $p < .01$).

In this study, we demonstrate that a control threat increases consumers' desire for precise product description. In addition, results show that when information is specified in a imprecise range format, consumers who experienced a control threat prefer it even less than those who experienced no control threat. Also, results provide a preliminary indication that these effects are not driven by general mood differences.

6. **STUDY 4A**

Our theorizing further predicts that when product information is specified precisely, it evokes high levels of predictability. As such, it may appear functional to people lacking control. Therefore, with the present study, we test whether experiencing a control threat leads consumers to rely more on precise information when they make product choices.

6.1 Method

We recruited 135 participants (M_{age} = 23 years, 68 women), in exchange for a small payment, to participate in a series of unrelated lab studies, including the current one. The entire session took about 50 minutes to complete. We manipulated their feelings of control with a concept identification task (Pittman & Pittman, 1980; Zhou, He, & Yang, 2012), in which participants had to guess a concept in a choice task with feedback. Participants considered a pair of pictures, one that correctly represented the concept and another that did not, and had to choose the correct one, then received feedback after each trial. In total, they completed four blocks of ten trials (including one practice trial). In the control-threatened condition, the feedback was random. In the baseline condition, participants were told that the experimenters needed to get a base rate, so they would answer without receiving computer feedback and simply make their best guess about which concept the computer had selected. We told them that their performance did not matter and that we simply wanted their instinctive responses. A pretest (N = 47) using this manipulation showed that participants in the control-threatened condition felt they had less control over their lives than those in the baseline condition ($M_{low\ control} = 2.61$; $M_{baseline} = 4.11$; $t(45) = 2.17$, $p < .05$).

After this manipulation, participants received a choice task, in which they selected between two MP3 players on a seven-point scale (1 = "strongly prefer product A"; 7 = "strongly prefer product B"). Each MP3 player was described on several attributes; we identified them on the basis of a pretest (N = 15) that confirmed MP3 player A was superior in its battery life and weight. These two attributes were described precisely (MP3 A "weighs 140 grams and battery lasts up to 16 hours"; MP3 B "weighs 165 grams and battery lasts up to 14 hours"). To ensure that at least some participants would choose MP3 player B, we also confirmed in a pretest that it was superior on other (less precise) attributes (MP3 A "intuitive interface and carrying case"; MP3 B "supports MP3 and WMA files and ultrabright color display"). A complete description of the pretest and stimuli is in appendix B.

6.2 Results and discussion

Confirming our hypothesis, an independent sample t-test showed that participants whose control was threatened favored product A, which was superior on the precisely specified attributes, over product B, which was superior on imprecisely specified attributes, more so than did participants whose control was not threatened ($M_{\text{low control}} = 2.85$; $M_{\text{baseline}} = 3.38$; $t(133) = 2.01$, $p < .05$). This result indicates that lack of personal control leads consumers to choose on the basis of precise information.

7. **STUDY 4B**

Although it provides some preliminary evidence, study 4a has several limitations. First, the manipulation helped simulate an unpredictable environment, but it may also have manipulated participants' moods. Second, the study included an additional confound, in that the differences in the precisely described attributes referred to the same dimension, whereas the other differentiating attributes reflected different dimensions (S. Zhang & Markman, 1998). Because of this confounding factor, our finding might imply that a threat to a sense of control increases the weight of alignable (vs. nonalignable) attributes. To address this confound, in study 4b we test the effect when all differentiating attributes are alignable.

7.1 Method

We recruited 150 participants (M_{age} = 23 years, 103 women), in exchange for a small payment, to complete a series of unrelated lab studies, including the current one. The entire session took about 50 minutes to complete. We manipulated their sense of control with the autobiographical recall task from study 1. Two coders checked the appropriateness of the reports (intercoder reliability = 92.7%; disagreements resolved by discussion); we dropped six participants who failed to recall a relevant situation. After this manipulation, participants completed the brief PANAS scale (Tellegen et al., 1988).

Next, participants chose between two smartphones. Smartphone A was superior on memory capacity and talk time, whereas smartphone B was superior in its battery life and warranty. The first two attributes were specified precisely (Smartphone A "6 gigabyte memory and 7.5 hours talk time"; Smartphone B "4 gigabyte memory and 6 hours talk time"), whereas the latter two were expressed in a less precise format (Smartphone A "Long warranty and medium battery life"; Smartphone B "Extra long warranty and long battery life"). Appendix C contains the full description of the stimuli. Finally, as in study 3a, participants chose between the two smartphones (1 = "strongly prefer product A"; 7 = "strongly prefer product B"). The spatial location of each offer (left vs. right) was counterbalanced.

7.2 Results

An independent sample t-test showed that participants who experienced threats to their control favored product A more than participants whose control was not threatened ($M_{\text{low control}}$ = 4.33; $M_{\text{high control}}$ = 4.97; $t(140.22) = 2.14$, $p < .05$; because the equality of variances was violated, we corrected for it). To test whether the effect held when we controlled for mood, we averaged the positive mood states as a positive mood index and the negative mood states as a negative mood index; the manipulation did not affect either positive ($t(143) = -.70$, p = .49) or negative ($t(143) = .39$, $p = .70$) moods. Adding positive or negative mood scores as a covariate also did not change the results (control manipulation with positive mood as a covariate $F(1,142) = 4.79$, $p < .05$; control manipulation with negative mood as a covariate: $F(1,142) = 4.60$, $p < .05$). We also conducted additional analyses of the control manipulation for each PANAS item. Participants in the low control conditions appeared more distressed ($M_{\text{low control}}$ = 1.68; $M_{\text{high control}}$ = 1.28; $t(143) = 2.48$, $p < .05$), marginally more upset ($M_{\text{low control}}$ = 1.58; $M_{\text{high control}}$ = 1.26; $t(143) = 1.94$, $p = .06$), less guilty ($M_{\text{low control}}$ = 1.26,; $M_{\text{high control}}$ = 1.60; $t(143) = -2.36$, $p < .05$), and marginally less proud ($M_{\text{low control}}$ = 1.93; $M_{\text{high control}}$ = 2.28; $t(143) = 1.81$, $p = .07$). However, including each item as a covariate separately did not change the findings regarding the effect of control threats (distressed $F(1,142) = 4.69$, $p < .05$; upset $F(1,142) = 4.86$, $p < .05$; guilty $F(1,142) = 4.90$, $p < .05$; proud $F(1,142) = 5.74$, $p < .05$), nor did their combination ($F(1,139) = 6.44$, $p < .05$).

7.3 Discussion

This study provides additional support for the assertion that people who lack personal control prefer products that are superior on attributes that are precisely described. In addition, we exclude an explanation based on mood (or specific emotions). To confirm the exclusion, we also conducted a study on AMT (N = 124), in which we manipulated feelings of personal control without affecting general mood states (Cutright, 2012; Kay et al., 2008). If mood were the key mechanism, this manipulation should attenuate the effect we have found. Thus, in the low personal control condition, participants wrote about "something positive that happened to you in the past few months that was NOT because of something that you did." In the high personal control condition, participants wrote about "something positive that happened to you in the past few months that was because of something that you did." Next, they completed the brief PANAS scale (Tellegen et al., 1988). As in study 3a (appendix B), participants chose between two MP3 players (1 = "strongly prefer product A"; 7 = "strongly prefer product B"). The analysis by two coders (intercoder reliability = 100%) led us to exclude ten participants, and two additional participants failed to finish the survey.

Consistent with previous research, we found that the manipulation did not affect positive ($t(110) = .48$, $p = .63$) or negative ($t(110) = .18$, $p = .86$) moods. Participants in the low control conditions were marginally more likely to choose the MP3 player that was superior on the precisely described attributes ($M_{\text{low control}} = 3.21$; $M_{\text{high control}} = 3.89$; $t(110) = 1.75$, $p = .08$). Adding positive or negative mood scores as a covariate did not change the results (positive $F(1,109) = 2.91$, $p = .09$; negative $F(1,109) = 3.04$, $p = .08$). These results offer additional support that our results are independent of mood.

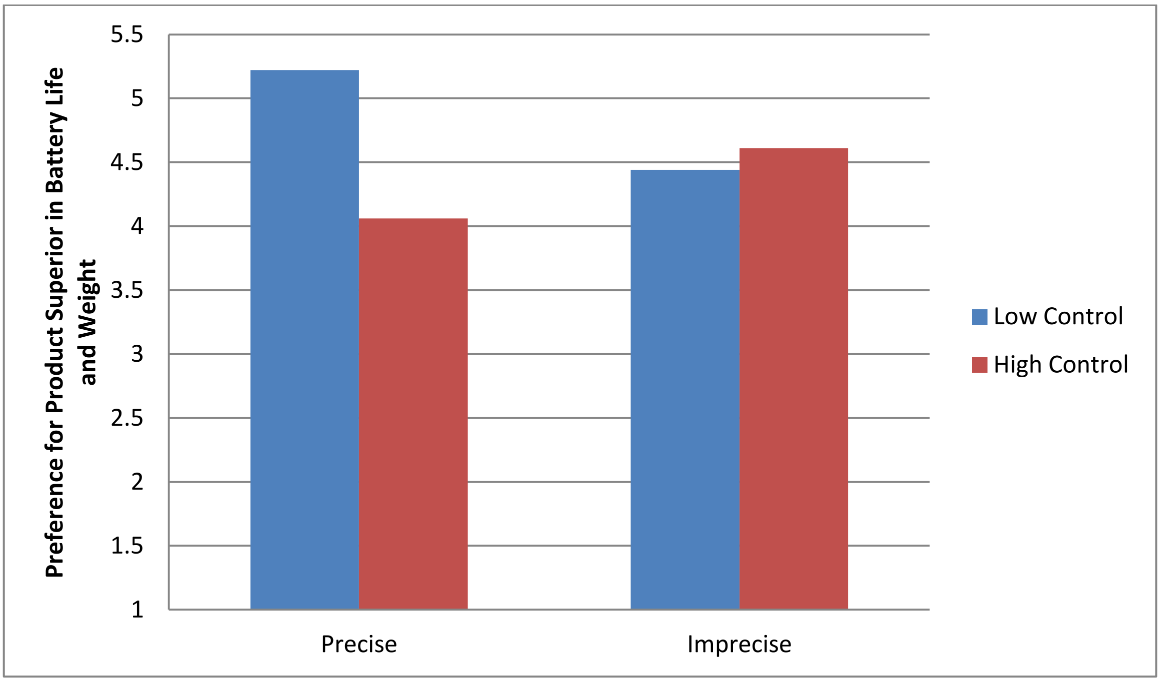
8. **STUDY 5A**

If all attributes are specified in a relatively imprecise format, such that they evoke little predictability, people who lack control should no longer rely on specific attribute dimensions (e.g., battery life, weight), because doing so does not help them restore control. When no precise information is available, the preference difference between high and low control conditions also should be eliminated. With study 5a, we seek to exclude the possibility that the effect we found in studies 4a and 4b could be attributed to the greater importance of specific attribute dimensions, such as battery life or weight. To eliminate this possibility, we include conditions that specify battery life and weight in a less precise format (e.g., “rather long battery life,” “lightweight”). If the effect we have found previously is due to the increased importance of specific attribute dimensions, it should persist when the attributes are specified relatively imprecisely.

8.1 Method

In total, 156 people (M = 36 years, 78 women) participated in an online study, through AMT. We manipulated their sense of control with the autobiographical recall task from study 1. Two coders checked the reports (intercoder reliability = 97.4%; disagreements resolved by discussion), leading us to drop 14 participants who failed to recall a relevant situation. Another participant was excluded for not completing the task. Half of the participants chose between the two MP3 players, as in study 4a (see appendix A), while the other half reviewed a different pair of MP3 players, whose battery life and weight (i.e., the two precisely described attributes) were described in less precise terms (MP3 A “Lightweight and battery lasts long”; MP3 B “Rather lightweight and battery lasts fairly long”; see appendix D). In these conditions, we expected to find no preference differences between high and low control, because they do not offer any precise information. We counterbalanced the spatial location of each offer (left vs. right). Participants indicated their preferences on a seven-point scale (1 = “strongly prefer product A”; 7 = “strongly prefer product B”).

Figure 2. Preference as a Function of Level of Control and Type of Specifications: Study 5A



8.2 Results

The 2 (control: present vs. absent) × 2 (description battery life and weight: precise vs. imprecise) ANOVA yielded a marginally significant interaction ($F(1,137) = 4.05$, $p = .06$), as we show in figure 2 (Please note that we reversed the scale in the figure). When battery life and weight were described precisely, a significant difference in preferences emerged: Participants expressed stronger preferences for the offer with better battery life and weight attributes if they lacked control rather than when they had control ($M_{\text{low control}} = 2.78$; $M_{\text{high control}} = 3.94$; $F(1,137) = 5.34$, $p < .05$). This pattern replicated a key finding from study 4. When the battery life and weight descriptions were relatively imprecise, preferences did not differ significantly as function of the absence or presence of control ($M_{\text{low control}} = 3.56$; $M_{\text{high control}} = 3.39$; $F(1,137) = .13$, $p = .72$). Furthermore, participants in the control-threatened conditions displayed a marginally higher preference for MP3 player A, which scored best on battery life and weight, when those attributes were described precisely rather than imprecisely ($F(1,137) = 2.75$, $p = .10$). We found no significant preference difference in the conditions marked by no control threat ($F(1,137) = 1.12$, $p = .29$).

8.3 Discussion

We offer further evidence that experiencing a control threat leads consumers to gravitate toward precise information. Specifically, study 5a documents that consumers who experience a control threat prefer a product that is superior on precisely described attributes, compared with consumers who have not experienced such a threat. However, without access to precisely described attributes, the difference in preference between those who have personal control and those who lack it disappears. Thus, it appears unlikely that this effect results from an increased preference for a superior value on a specified attribute, such as battery life or weight.

9. **STUDY 5B**

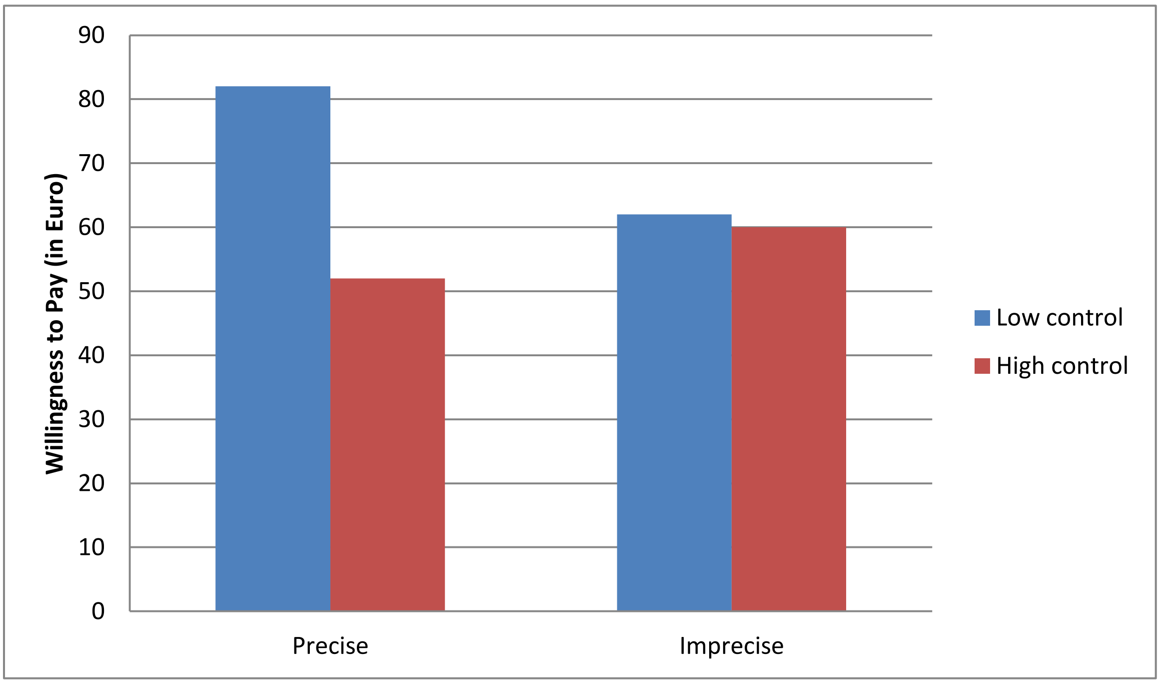
To extend our prior findings, in study 5b, we investigate whether a control threat affects the valuation of an individual product consistently. Consumers who temporarily lack personal control may rate products described using precise information more positively than do consumers who have control. However, if a product description uses less precise product information, we predict no difference in valuations across the control threat versus no control threat conditions.

9.1 Method

For study 4b, we recruited 125 people (M_{age} = 22 years, 78 women) for a series of unrelated lab experiments, including this one. Participants completed a recall task: They described an incident in which they either had no control or were in complete control (Whitson & Galinsky 2008). After this manipulation, they considered an offer for an MP3 player, described by five attributes: hard disk capacity, screen size, weight, battery life, and size. For participants in the precise information conditions, the attribute specifications used quantitative terms (see appendix E).

An open-ended question assessed all participants' willingness to pay (WTP). In addition, two coders confirmed that all reports entered in the recall task described a situation in which participants had control or no control (intercoder reliability = 94.4%; disagreements resolved by discussion). Three participants whose recollections were not congruent with the instructions were dropped.

Figure 3. Willingness to Pay as a Function of Level of Control and Type of Specifications: Study 5B



9.2 Results

A 2 (control: present vs. absent) × 2 (information: precise vs. imprecise) ANOVA of the WTP ratings yielded a significant main effect of control ($F(1,118) = 4.24$, $p < .05$). Relative to having control, experiencing a control threat increased WTP ratings ($M_{\text{low control}}$ = €72; $M_{\text{high control}}$ = €56); this main effect also was qualified by a marginally significant interaction ($F(1,118) = 3.12$, $p = .08$), as we show in figure 3. When the product information was precise, participants were willing to pay more for the MP3 player if they experienced a control threat ($M_{\text{low control}}$ = €82; $M_{\text{high control}}$ = €52; $F(1,118) = 7.32$, $p < .01$). However, this effect disappeared if the attribute descriptions used less precise information ($M_{\text{high control}}$ = €62; $M_{\text{low control}}$ = €60; $F(1,118) = .04$, $p = .84$). When control was threatened, participants also were willing to pay more for a product described precisely rather than imprecisely ($F(1,118) = 3.32$, $p = .07$). Without a control threat, the type of information did not affect WTP ($F(1,118) = .46$, $p = .50$).

A close inspection of the data also revealed four participants who entered a WTP value of 0. Because these null values could seriously affect the results, we conducted an additional analysis without these four cases. The effect size decreased, but we replicated our finding that participants in the low control conditions would pay more for an MP3 player described in precise terms than would those in the high control conditions ($M_{\text{low control}}$ = €82; $M_{\text{high control}}$ = €58; $F(1,114) = 4.69$, $p < .05$).

9.3 Discussion

This study supports our prediction that consumers who lack control, relative to those who do not, are willing to pay more for a product described in precise terms, whereas imprecise descriptions eliminated this effect. The results further indicate that consumers who experience a control threat are those most likely to be influenced by whether the attribute information is specified in a precise format. Although the precise and imprecise product descriptions might not have been equally attractive, we find several indications that both descriptions led to similar evaluations. A further analysis showed no significant difference between the imprecisely and precisely described product offers in the high control conditions ($M_{\text{imprecise}}$ = €60; M_{precise} = €52; $F(1,118) = .46$, $p = .50$). Furthermore, no significant differences arose among the imprecisely described product offer in the low control condition (M = €62) or the imprecisely (M = €60; $F(1,118) = .04$, $p = .84$) and precisely (M = €52; $F(1,118) = .80$, $p = .37$) described product offers of the high control conditions. That is, participants had similar product evaluations across descriptions.

10. **STUDY 6**

For studies 5a and 5b, we manipulated precision and the corresponding levels of precision by using qualitative versus quantitative attribute descriptions. However, the imprecision associated with verbal labels such as “lightweight” and “rather lightweight” renders it difficult to construct equally attractive stimuli. For example, it is difficult to argue that a .5 oz. difference corresponds exactly to the difference between “rather lightweight” and “lightweight.” With study 5, we address this issue by changing the precision manipulation and using range information (e.g., 14–16 hours battery life) instead of verbal information. Thus we can manipulate precision but maintain the same expected value across conditions. For example, the specification “5.5 oz.” is slightly more precise than “5.4–5.6 oz.” but has the identical expected value.

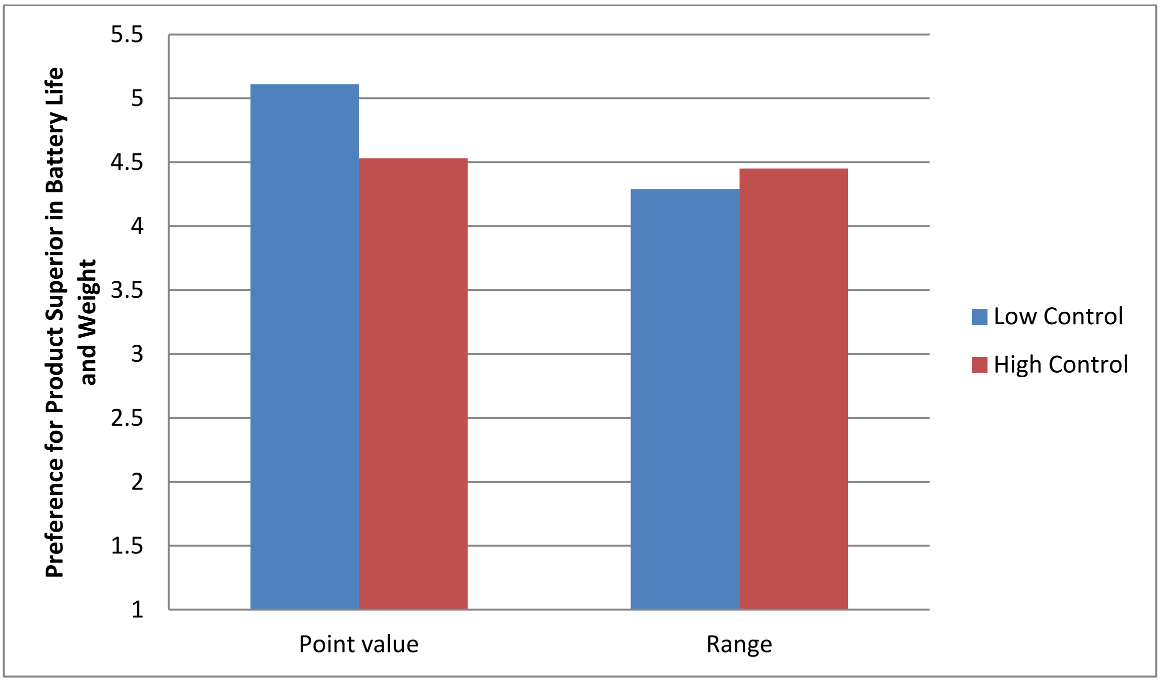
Range information can vary in the level precision. A wide (and thus more imprecise) interval such as “3.0–6.0 oz.” should evoke a weaker feeling of predictability than a more precise range such as “5.4–5.6 oz.” As a stringent test of our prediction that consumers who lack personal control pay more attention only to product information that is exact, we use tight ranges (e.g., “5.4–5.6 oz.”). Even a slight hint of imprecision should be sufficient to attenuate the effect. Specifically, if battery life and weight are specified precisely (e.g., “13 hours,” “5.3 oz.”), consumers who lack control should be more likely to pick the alternative that rates best on these two attributes than are consumers who are in control. However, when battery life and weight are specified in a slightly less precise format (e.g., “12–14 hours”), we expect no preference differences across control conditions.

In addition, we note that there is no overlap between the attribute values of battery life and weight (MP3 A “15–17 hours battery life and 5.1–5.3 oz. weight”; MP3 B “12–14 hours battery life and 5.4–5.6 oz. weight”). Thus the products are clearly ordered according to battery life and weight, because it is evident which product is superior on both attributes. If control threats led solely to an increased search for order or structure, consumers’ preference should not be affected by a slight increase in precision. In contrast, our proposed explanation suggests that the slight increase in precision still causes consumers who have experienced a control threat to be more likely to attend to these attributes.

10.1 Method

We recruited 280 people (M_{age} = 29 years, 83 women) from AMT and manipulated their sense of control with the autobiographical recall task from study 1. Two coders checked whether the reports entered in the recall task were appropriate (intercoder reliability = 98.3%; disagreements resolved by discussion); we dropped two participants. Participants in the precise information conditions chose between two MP3 players that were very similar to those from study 2a (see appendix G), namely, MP3 player A, which was superior on two attributes (battery life and weight) specified in a precise format, and MP3 player B, which was superior on two relatively less precise attributes. In the imprecise information conditions, participants considered an alternative pair of MP3 players, whose battery life and weights were specified in a very tight range (MP3 A “15–17 hours battery life and 5.1–5.3 oz. weight”; MP3 B “12–14 hours battery life and 5.4-5.6 oz. weight”; see appendix H). Thus the expected values of both attributes were identical; we introduced only a slight degree of imprecision.

Figure 4. Preference as a Function of Level of Control and Type of Specifications: Study 6.



10.2 Results

The 2 (control: present vs. absent) × 2 (information: point vs. range) ANOVA of participants' preferences yielded a marginally significant interaction (F(1,274) = 2.69, p = .10), as we show in figure 4 (Please again note that we reversed the scale). Information specified in exact point values led to marginally higher preferences for the alternative that was superior in weight and battery life among those who recalled a loss of control situation compared with those who recalled a situation in which they had control ($M_{\text{low control}}$ = 2.89; $M_{\text{high control}}$ = 3.47; F(1,274) = 3.27, p = .07). Consistent with our expectations, this effect disappeared when the information was specified as a range ($M_{\text{low control}}$ = 3.71; $M_{\text{high control}}$ = 3.53; F(1,274) = .28, p = .60). The preferences of those in the control threat conditions shifted, depending on the information format (F(1,274) = 6.08, p < .05). For participants in the low control conditions, the preference for the alternative superior in weight and battery life decreased when it was described by a tight range (M = 3.71) rather than by an exact point value (M = 2.89). For those in the high control conditions, we found no such difference (M_{range} = 3.53; M_{point} = 3.47; F(1,274) = .05, p = .82).

10.3 Discussion

This study has provided evidence that, relative to those who have control, consumers who lack personal control attend more to attribute descriptions only if they are specified precisely. Even relatively precise range information attenuates the effect of very precise information. However, no such preference shift occurs among people who have control, suggesting that they do not discount information as long as it does not evoke much imprecision. That is, for people who enjoy a sense of control, very tight ranges (e.g., “12–14 hours”) contain are still sufficiently that they have the same informational value as their more precise counterparts (e.g., “13 hours”).

An interesting implication of these findings is that people who lack control may attend disproportionally to precise information, even though it is actually not very representative of reality. A battery life description of “13 hours” is overly precise, because battery life varies by use patterns. Instead, “12 – 14 hours” is more representative of reality, in that it accounts for this uncertainty. This result lends support to our argument that people who lack personal control are fixated on accessing precise information, even if it is less accurate.

11. **CONCLUSIONS**

Despite the ubiquity of situations in which consumers experience a loss of control, our knowledge of how these control threats influence consumer decisions is limited (cf. Cutright, 2012; Cutright et al., 2013). With this study, we tested whether consumers who experience less personal control prefer more precise product information, relative to those who possess control, and then rely more on precisely specified attributes to make decisions. With study 1, we demonstrate that, relative to those who do not, people who experience a control threat have a stronger need for more precise information. In study 2, we show that consumers who lack personal control are more motivated to search for precise information than those who have personal control. Thus, when consumers lack control but also have access to more precise information, they exploit this access and spend more time looking at product information, relative to those who have control. However, if only relatively imprecise information is available, consumers do not act differently, regardless of their perceived level of personal control. Study 3 shows that a control threat leads consumers to have a stronger preference for precise product descriptions. Study 4a also provides support for our argument that lacking personal control leads to a stronger preference for a product alternative that is superior on attributes specified in a precise format; study 4b and a follow-up study affirm the robustness of this effect across stimuli and manipulations and exclude a mood explanation.

With study 5a, we replicate this effect and demonstrate that the preference for specific attributes is attenuated when the attributes are specified in less precise, verbal terms. Study 5b extends these findings by demonstrating that the effect of a control threat on the preference for precise information is such that consumers who experience a control threat are even willing to pay more for a product, merely because its attributes are precisely described. Finally, in study 6 we show that the effect of a control threat on preference for precisely specified attributes does not extend to attributes specified in a tight range. Even the slightest hint of imprecision seems to turn off consumers who have experienced a control threat.

This study focuses specifically on how consumers rely on product information to restore their sense of personal control; the results might speak to other domains as well. For example, firm managers frequently confront control threats (e.g., unexpected software errors, stock market fluctuations) and potentially respond to these threats in ways similar to those we have described. That is, managers who experience control threats may be more likely to attend to precise, quantitative indices of performance, instead of less precise performance assessments, even if the former are less representative of reality. Experiencing a control threat also might lead hiring managers to judge job candidates on more precise criteria (e.g., number of publications, number of awards), instead of more qualitative indicators.

Our research findings complement recent research that suggests that quantitative value representations offer greater self-esteem certainty than comparable qualitative representations (Rothschild, Landau, & Sullivan, 2011). People who are particularly sensitive to self-esteem certainty threats prefer quantitative self-representations. Thus participants with a high need for structure who feel threatened in one domain (e.g., visual intelligence) prefer a quantitative value representation in another domain (e.g., verbal intelligence). The quantitative self-representations in these studies were precise, so they might also have helped participants eliminate unpredictability about themselves. Rothschild and colleagues (2011) denote the effect of self-esteem certainty on self-representations, whereas we examine whether a threat to personal control affects the type of product information consumers prefer. Despite these clear differences though, our studies share the basic premise that people who experience uncertainty gravitate toward more precise types of information.

Furthermore, our research may relate to work on the granularity of measurement units (Zhang & Schwarz, 2012). For example, studies show that consumers infer greater credibility from information specified in smaller units (e.g., 31 days) rather than larger units (e.g., 1 month). We then might reason that, compared with very fine-grained descriptions (e.g., 840 minutes, 50,400 seconds), specifying battery life in hours does not, strictly speaking, not the most precise way of specifying information. However, our pilot study confirmed that most participants perceived already high levels of predictability when they received information that used a single number and a familiar measurement (e.g., 12 grams, 3 years), even if more fine-grained units would be possible. Perhaps when they judge attribute values, consumers simply do not consider the possibility that the information could be specified in an even more fine-grained unit. This argument is consistent with research that shows that consumers include granularity considerations in their judgments of quantitative information only if they have been reminded explicitly of alternative units (Pandelaere et al., 2011).

Another potential link involves literature on evaluability, or the extent to which a person has relevant reference information to gauge the desirability of target values and use them in evaluations (Hsee & Zhang, 2010). That is, precise information may be more evaluable than imprecise information, in which case our findings would suggest that people who lack personal control are more likely to attend to more evaluable information. However, increasing precision does not unequivocally increase evaluability; a rather imprecise statement such as "lightweight" might offer more relevant reference information than "5 oz." because even though it does not specify the exact weight, "lightweight" provides comparative information.

We also consider whether, instead of a lack of control *increasing* people's reliance on precise information, greater control *reduces* their reliance. However, the data suggest otherwise. In study 3a, we compared control-threatened participants with a baseline group, and the expected differences still emerged. It appears that high perceptions of personal control represent the baseline state (Cutright, 2012), and deviations from this state trigger compensatory processes. Also, in studies 4a, 4b, and 5 we observed no significant difference between the precise and imprecise information conditions when participants possessed control, whereas a marginally significant difference emerged in the control threat conditions, so control threats appear to drive these results, instead of control possession.

One may wonder why exactly precise product information is more attractive for consumers who experience a lack of control. In the current manuscript, we propose that a lack of control leads consumers to look for information that enhances predictability of the environment. As such, we propose that precise information may function as a sort of external source of control which helps people to restore control. However, an alternative perspective may suggest that precision gives consumers a feeling of confidence after the negative experience of control loss. The current data makes it difficult to disentangle between both mechanisms. One way would be to measure feelings of confidence after making an evaluation or choice. If these ratings mediate the effect between control loss and product choice (but only in the precise information conditions), this might be evidence that precision might boost confidence. However, one may wonder to what extent both mechanisms may actually be complementary. In general, precise information may enhance the predictability of the environment and can be considered as an external source of control. But even though precise information is an external source of control, it still requires people to actively rely on it. As such, despite being an external source of control, people may still experience effects of using precise information (e.g., increased consumer's confidence). In a sense, increased confidence may be seen as a consequence of relying on an external source of control.

Variables other than precision could affect the level of predictability consumers experience, which prompts us to speculate about the breadth and implications of our findings. Particularly, we see no reason the effects would be limited to preferences for precise product information. For example, people who lack control may have stronger preferences for detailed pictures or paintings; does a control threat thus generate a preference for more realistic art over impressionistic art? On a more abstract level, a control threat could prompt people to prefer consistency in judgments, because such consistency provides more predictability. Further investigations of these speculations might yield interesting results.

Additional research also could investigate the relation between control and power. Power traditionally has been defined as asymmetric control over valued resources in social relations (Magee & Galinsky, 2008; Rucker, Galinsky, & Dubois, 2012), but the links of personal control to power are not totally transparent (Fast, Gruenfeld, Sivanathan, & Galinsky, 2009; Inesi, Botti, & Dubois, 2011). When people are deprived of power, they may feel motivated to satisfy their desire for control (Inesi et al, 2011), in which sense power functions as a source of personal control, and a lack of power may induce a preference for quantitative information. Instead of seeing power as an alternative explanation, we suggest that power differences generate similar effects, which may be mediated by a more fundamental desire for control.

However, our results should not be taken to imply that consumers who lack personal control prefer more precise information in every situation. In particular, people do not strive to maximize their sense of personal control; rather, they seek an optimal level of control (Gino, Sharek, & Moore, 2011; Inesi et al., 2011). In support of this notion, Kay and colleagues (2010) reveal that support for governments and religious beliefs represent substitutable sources of control, so people who gain restored control through one external source (e.g., affirming belief in God) do not find added value from the alternative source. Likewise, people may be reluctant to restore their sense of control by relying more on precisely specified information, if they instead can regain it through some alternative source.

12. **APPENDICES**

APPENDIX A

Smartphone A	Smartphone B
Large storage capacity	Rather large storage capacity
Average screen size	Average screen size
Rather lightweight	Lightweight
Rather long battery life	Long battery life
Compact Size	Rather compact size
Long warranty	Rather long warranty

APPENDIX B:

Pretest study 3a

We conducted a pretest (N = 15) to develop our final stimuli. Participants made two choices between MP3 players A and B. In the second choice, MP3 player B was superior on two imprecise attributes, and 12 participants chose B. For the main study, we collapsed the precisely and less precisely specified attributes of each MP3 player, such that MP3 player A had the precisely specified (superior) attributes of the first choice and the less precisely specified (inferior) attributes of the second choice; it was quantitatively better than product B but qualitatively worse. Following a similar procedure, product B was superior to product A in qualitative terms but worse in quantitative terms. The two products then entered the target choice task in the main study.

Brand A	Brand B
30 GB internal storage	30 GB internal storage
Rechargeable battery lasts 16 hours	Rechargeable battery lasts 14 hours
Intuitive interface	Supports MP3 and WMA files
Weighs 140 grams	Weighs 165 grams
Comes with a carrying case	Ultra bright color display
Voice recorder	Voice recorder

APPENDIX C

Smartphone A	**Smartphone B**
Android phone	Android phone
6 gigabyte memory	4 gigabyte memory
Long warranty	Extra long warranty
7.5 hours talking time	6 hours talking time
Medium battery life	Long battery life
4G network	4G network

APPENDIX D

Brand A	**Brand B**
30 GB internal storage	30 GB internal storage
Rechargeable battery lasts long	Rechargeable battery lasts fairly long
Intuitive interface	Supports MP3 and WMA files
Lightweight	Rather lightweight
Comes with a carrying case	Ultra bright color display
Voice recorder	Voice recorder

APPENDIX E

MP3 Player
30 GB Storage Capacity
6.3 cm Screen Size
Weighs 120 grams
Battery life = 16 hours
Size = 7.6 x 3.9 x 0.5 cm

APPENDIX F

MP3 Player
Large Storage Capacity
Average Screen Size
Rather Lightweight
Fairly long battery life
Rather compact size

APPENDIX G

Brand A	**Brand B**
30 GB internal storage	30 GB internal storage
Rechargeable battery lasts 16 hours	Rechargeable battery lasts 13 hours
Intuitive interface	Supports MP3 and WMA files
Weighs 5.2 oz.	Weighs 5.5 oz.
Comes with a carrying case	Ultra bright color display
Voice recorder	Voice recorder

APPENDIX H

Brand A	**Brand B**
30 GB internal storage	30 GB internal storage
Rechargeable battery lasts between 15 - 17 hours	Rechargeable battery lasts between 12 - 14 hours
Intuitive interface	Supports MP3 and WMA files
Weighs between 5.1 – 5.3 oz.	Weighs between 5.4 – 5.6 oz.
Comes with a carrying case	Ultra bright color display
Voice recorder	Voice recorder

CHAPTER

5

CONCLUSIONS, CONTRIBUTIONS, AND FUTURE RESEARCH

CHAPTER V: CONCLUSIONS, CONTRIBUTIONS, AND FUTURE RESEARCH

The aim of the current dissertation is to gain better insight in the role of numerical information in evaluations and decisions. While prior research on numerical cognition and judgment and decision making has generated an impressive body of work, relatively little research has looked at how both fields may benefit from leveraging each other's concepts and results (but see Cai, Shen, & Hui, 2012; Coulter & Coulter, 2005, 2010; Coulter & Norberg, 2009; Thomas & Morwitz, 2005). Using insights of both fields, the current dissertation aims to provide a clearer picture of how numerical cognition may affect evaluations of incomes, product attributes and products in general. In three essays, we aim to advance knowledge of how people make evaluations based on numerical information by identifying how numerical information might activate specific procedures, thoughts and subjective feelings which may ultimately affect decisions. In the following sections, we provide a final overview of the findings of this dissertation and discuss both theoretical and practical implications. We end by identifying the major limitations of this research and provide directions for future research.

1. RECAPITULATION OF THE FINDINGS

In chapter II "A 20% Income Increase for Everyone?": The Effect of Relative Increases in Income on Perceived Income Inequality", we focus on how income distributions are evaluated. While the dominant measurement of income inequality assumes that people are insensitive to fixed percentage increases, we document that such increases in income evoke stronger feelings of income inequality. Across three studies, we demonstrate show that people are also sensitive to absolute differences when evaluating income distributions. In a first study, we found that participants rated an income distribution as more unequal when its values were doubled, despite keeping the GINI coefficient constant. These results were not only found in a within subjects design, but also in a between subjects design. In study 2, we replicated these results and eliminate any effect of using a familiar currency. In a final study, we demonstrated that the effect was robust across different frames (percentage vs. absolute increase) and showed some consequences in terms of envy and fairness. More specifically, we found that when incomes are multiplied by a scalar, fairness ratings drop whereas levels of malign envy increase.

In chapter III, "Are all Units Created Equal?: The Effect of Default Units on Product Evaluation", we examine how the units in which numerical information is specified may affect decisions. While prior research on this topic has implicitly assumed that the units used to specify this information elicit the same meanings, we show that consumers often have preset units for attribute levels. These units strike an optimal balance between a preference for small numbers and the need for accuracy (study 1a). As such, these default units are rated the most suitable and familiar units for specific attribute levels (study 1b). In a next study, we demonstrate the downstream consequences of specifying product information in default units. That is, when a product attribute is specified in a default unit, relative to nondefault units, consumers are willing to pay more for that product. In study 3, we provide evidence for our premise that subjective feelings of fluency drive the default unit effect by employing a misattribution paradigm (Schwarz et al., 1991), in which the fluency generated by the default unit effect can be misattributed to an irrelevant source (i.e., background music). In study 4, we provide additional process evidence by showing mediation. At the same time, we excluded an alternative account based on fluency associated with the specific numbers used when information is described in default units. In study 5, we more clearly delineate the factors that determine whether the number or the unit may dominate evaluations by showing that evaluation mode (Hsee, 1996) determines whether a default unit or a numerosity effect arises. In a separate evaluation, we replicate the default unit effect; when alternatives are evaluated jointly, numerosity dominates evaluations.

In chapter IV, "When Precision Protects: Precise Product Information as a Source of Control", we examine how depriving consumers from personal control may affect the importance of numerical information (number + unit) in decision making. We test our predictions in nine experiments. In study 1, we offer preliminary evidence for our basic contention that, relative to those who have control, people who lack personal control display a stronger need for more precise information. In study 2, we provide behavioral evidence by showing that when they make product decisions, consumers who lack personal control are more motivated to search for more precise information; specifically, when they gain access to more precise information during decision making, they make more use of it. In addition, we exclude alternative explanations based on a difference in general motivation or decision difficulty. Study 3 shows that a control threat leads consumers to have a stronger preference for precise product descriptions. With study 4a, we demonstrate that, relative to having control, lacking personal control leads to a stronger preference for an alternative that is superior on attributes described precisely. Then in study 4b and a follow-up study, we exclude a mood explanation and confirm the robustness of the effect across stimuli and manipulations. We replicate the effect in study 5a and reveal that the preference for specific attributes is attenuated when attributes are specified in less precise, verbal terms. Study 5b also shows that, relative to consumers who do not, those who experience a control threat are even willing to pay more for a product merely because its attributes are specified in precise specifications. Finally, with study 6 we detail how the effect of a control threat on preferences for attributes specified in a precise format (e.g., 13 hours) dissipates if the same attributes are specified in a tight range (e.g., 12–14 hours), with the same expected value.

2. THEORETICAL IMPLICATIONS

A large research stream has looked at how individuals make judgments and decisions. A key finding of this literature is that people seem to frequently violate normative assumptions such as calculating expected utility and weight costs and benefits (Ariely, 2008; Kahneman, 2011). For example, instead of performing extensive calculations based on full information, people have been shown to make decisions based on feelings (Avnet, Pham, & Stephen, 2012; Greifeneder, Bless, & Pham, 2010; Loewenstein, Weber, Hsee, & Welch, 2001; Pham, 1998; Pham, 2004), incomplete information (Hertwig, Barron, Weber, & Erev, 2004; Posavac, Sanbonmatsu, Kardes, & Fitzsimons, 2004; Sanbonmatsu, Posavac, Kardes, & Mantel, 1998) and even irrelevant information (Novemsky et al., 2007; Schwarz, 2004). In this dissertation, we contribute to this extensive literature by focusing specifically on how judgments involving numerical information are constructed. By using insights from work on numerical cognition and other literatures (e.g., fluency, personal control, and linguistic categorization,…), we were able to generate novel hypotheses and research questions that have implications for our understanding how people make judgments involving numerical information.

2.1 Numerical Cognition

We have documented how numerical cognition affects information processing (e.g., relative vs. absolute) and how it leads to a preference for specific types of numerical information (e.g. default vs. nondefault unit). In the first essay, we highlighted the role of how the representation of numbers in the brain may lead people to think relatively when comparing numbers. Our work on how people judge income distributions may point at a combination of both relative and absolute thinking (i.e. partial relative thinking; Azar, 2011). We will discuss the potential reasons for this result in the third section of this concluding chapter.

In the second essay of this dissertation, the role of numerical cognition in judgments was highlighted in an alternative way. Specifically, we documented that a preference for small numbers (Dehaene, 2011) may lead individuals to prefer situations in which product attributes is specified in small numbers (i.e. in a large unit). We proposed that this preference for small numbers may be rooted in how numbers are represented on an approximate mental number line (Cantlon, Platt, & Brannon, 2009; Cohen Kadosh, Tzelgov, & Henik, 2008; Dehaene, 2011; Izard & Dehaene, 2008). Particularly, small numbers tend to be more precisely represented than larger numbers (Dehaene et al., 1998; Dehaene, 2003; Parkman, 1971; Shepard et al., 1975). This decreasing accuracy prompts people to prefer to use smaller numbers (Banks & Coleman, 1981; Banks & Hill, 1974; Viarouge et al., 2010). In light of this small number preference, we inferred that most systems of units also clearly reflect this preference.

In the third essay, we focus on how using a symbolic number system allows individuals to make very precise distinctions between objects. For example, using grams as a measure for weight helps distinguishing an apple weighing 121 grams and one weighing 122 grams. Solely relying on a preverbal number sense would not allow for such fine-grained distinctions. While there are many good reasons to describe objects precisely, we document that one fundamental, psychological motivation may be grounded in people's need for having personal control over their environment.

2.2 Judgment and Decision Making

In this dissertation, we investigated how three core principles of judgment and decision making (Wyer, 2011) affect the procedures that individuals employ in making decisions involving numerical information: cognitive efficiency, knowledge accessibility and subjective experience. The first principle refers to the observation that people tend to put as minimal effort in cognitive processing as they think is necessary to achieve their goal (*cognitive* *efficiency*). For many decisions, this implies that individuals tend to exert rather little effort when making evaluations. Indeed, results of the second essay show that people may rely on relatively low level fluency experiences generated by quantitative product attributes. Specifically, when consumers are presented with a product of which attributes are specified in default units, they seem to experience more fluency than when attributes are specified in nondefault units. This discrepancy in fluency may subsequently lead to differences in evaluation of that product. Interestingly, research presented in the first essay may indicate that, in some circumstances, people may increase the level of effort they invest in processing information. Prior research has indicated that relative thinking seems to be stronger when people rely on low level intuitions such as feelings (Saini & Thota 2010). In the first chapter, we observe that, when individuals judge income distributions, they also likely to also consider absolute differences. As such, it might be that people shift to relying on more high level intuitions when judging incomes. Cognitive efficiency may also have played an important role in the findings of the third essay. In this essay, we find that the importance of precise, numerical information is increased by temporarily depriving people of personal control. In terms of cognitive efficiency, we are not necessarily suggesting that people exerted more effort per se but that they might have changed the criteria through which information was evaluated. That is, it could be that they judged the diagnosticity of information more in the light of the goal activated by the lack of personal control (i.e. need for precise information) at the expense of other possible criteria.

The second principle pertains to the finding that individuals tend to use the criteria that are most accessible in memory (*knowledge accessibility*). The three essays presented in this dissertation advance knowledge about which thoughts and procedures are rendered accessible when judging numerical information. In the first essay, we show that subjective income inequality is not only a matter of comparing relative differences, but also of comparing absolute differences. This is an important finding because several perspectives may have predicted no influence of absolute differences (Frank, 1985; Litchfield, 1999). For example, much research on income inequality implicitly assumes that increasing incomes by a fixed percentage increase does not change income inequality. Findings of the second essay also speak to which information may become accessible when judging numerical information. Specifically, we delineate the factors that determine whether the number or the unit are most accessible. While prior research has mainly documented an overreliance on the numerical component, we showed how the type of units (default vs. nondefault) may render specific subjective feelings accessible (fluency vs. disfluency). We further identify that a task specific factor such as evaluation mode may affect which of these accessible cues may dominate evaluation. In the third essay, we focus on which factors determine how the precision associated with numerical information may become more accessible. Compared to having high levels of personal control, experiencing low levels of control seems to render the extent to which information is precise to be more accessible. As a result, numerical information may be increasingly viewed as precise information, and subsequently become more important in evaluations when a loss of personal control is experienced.

A third principle relates to how people tend to misattribute irrelevant subjective reactions to objects they are judging regardless of the source of these experiences (s*ubjective experience*). Notably, the second essay of this dissertation identifies a novel instance of this general proposition. We show that subjective feelings evoked by a normatively irrelevant features as the unit in which information is specified actually affects the evaluation of a product. Consistent with prior research (Schwarz et al., 1991), when an alternative source for their subjective feelings was provided (i.e. music), the effect of the subjective feelings on product evaluation vanished. This result provides indirect evidence that individuals frequently have a difficult time to correctly attribute their feelings to the actual source of these feelings, unless they are explicitly provided with a diagnostic source such as background music. While the other essays in this dissertation might not directly point at how numerical information may evoke irrelevant subjective feelings, some results presented in this dissertation may hint at such a possibility. For example, it could be that the gratification of the need for precision by attending to numerical information may have evoked feelings of a fit experience (Avnet & Higgins, 2006; Schwarz, 2006). As such the positive feelings associated with having a fit between an activated goal and type of information might be considered to as irrelevant subjective feelings affecting judgments.

3. **PRACTICAL IMPLICATIONS**

The findings of the current dissertation also have several relevant practical implications. Given that income inequality has increased dramatically (e.g., Denavas-walt, Proctor, & Smith, 2012), some research shows that this may be a reason for concern because it may lead to diminishing levels of trust (Rothstein & Uslaner, 2005), increased feelings of envy (Ordabayeva & Chandon, 2011), increased obesity (Pickett et al., 2005) and increased levels of violence (Wilkinson & Pickett, 2009; Wilkinson, 2004). Although extant research shows that increasing income inequality has large consequences for people's lives, little is known about the factors that determine *subjective perceptions* of income inequality. In the first essay of this dissertation, we identify that a fixed percentage increase may affect perceptions of income inequality. At the same time, we provide preliminary evidence that these subjective perceptions of inequality may affect feelings of envy and fairness. These results may also have implications for policy. For example, policy makers may introduce a general tax cut for each income group, raising each income with a fixed percentage. As such, people may perceive income inequality as increasing by such an intervention. Our results suggest that a well-intentioned tax cut may therefore have unanticipated consequences.

Another important implication for practice involves how the simple intervention of merely specifying information in alternative units may have important consequences for judgment. Prior research on this topic has implied that specifying information in small units may evoke larger scores on a particular attribute. Applying this result to the real world, a policy maker or retailer may specify all positive quantitative information in smaller units, thereby inflating the perceived value of that attribute. In this dissertation, we provide a more nuanced understanding of this intervention by offering some clear and practical qualifications of prior research. First, as a marketer, it might be wise to check whether there are default units for this particular attribute. If yes, one might consider using the default unit for specifying product attributes instead of a smaller nondefault unit. A second qualification pertains to the evaluation mode in which a product is evaluated. When a retailer suspects that a product is typically evaluated in separate evaluation mode, it is more likely that there will be positive effects of specifying information in default units. For example, promoted products are typically presented in separate evaluation mode. While prior research might have suggested that, as a retailer, you best describe the positive attributes in small units, results of this dissertation suggest you preferably specify this information in default units.

Importantly, these suggestions are not limited to marketing practice but may also help policy makers to communicate information to citizens. Specifically, the insights presented in this dissertation may be used for improving choice architectures (Thaler & Sunstein, 2008). Choice architecture refers to the notion that the way a choice is set up always affects how decisions are made. Policy makers can use choice architecture to "nudge" individuals to make better decisions for themselves and others. One important application of the results reported in this dissertation can be found in Camilleri and Larrick (2014). In the context of vehicle fuel economy labels, the authors demonstrate that the purchase of fuel-efficient vehicles can be increased merely by manipulating the unit (100 miles vs. 15,000 miles vs. 100,000 miles) in which fuel economy information is expressed. Specifically, they find that specifying fuel economy information in cost of gas per 100,000 miles gives the largest increase in choice share for the fuel-efficient vehicle. Interestingly and somewhat consistent with a default unit account, the authors find that the default unit specification of "cost per 100 miles" more strongly affected the preference for the energy-efficient vehicle than a specification of "cost per 15,000 miles", despite the latter being more numerous. The authors suggest that one reason for this result may be that the familiarity of a specification in default units may increase its weight in decisions.

The results reported in this dissertation may also hint at how personal control may affect consumer's purchasing behavior and how this may be leveraged by companies and policy makers. Specifically, retailers may take into account the likelihood that people feel out of control around specific stores. For example, a store close to a road on which traffic congestions occur easily, might benefit from advertising more on quantitative attributes. Similarly, stores in locations where people are typically in a hurry (e.g., train stations) might also benefit from displaying quantified attributes. Another example relates to products that are typically used in situations in which people feel a lack of personal control. For example, life insurances or safety equipment such as helmets may benefit from emphasizing quantifiable benefits. Also, the unpredictability associated with some products might be mitigated when specified in precise quantitative terms because quantitative information might be associated with higher predictability. Examples include investing in stocks of an unknown company, but also very new products or seemingly dangerous experiences such as bungee jumps or rafting.

At the same time, it is important to note that our research may also help understanding why people sometimes value quantitative information disproportionately. While there can be many reasons why people prefer to rely on quantitative information, research presented in this dissertation shows that preferring quantitative information might be indicative of a lack of personal control. For example, in recent years, some people have become increasingly attracted to wearing devices which track all kinds of data such as their spending but also physical movements and heart rate. In essence, people's lives become increasingly quantified (e.g., "Quantified Self" movement; Wolf, 2010). Currently, little is known about what factors determine whether somebody is likely to engage in such self-quantification. One possibility can be that frequent episodes of lacking personal control may lead people to become more engaged in self-quantification. Also, it might be that people who rely most of the time on numerical information might be doing this because to keep grip on an unpredictable reality. For example, on the stock market, investors might be disproportionately relying on precise information which may give them a false sense of security. This overprecision (Mannes & Moore, 2013) may lead stock brokers and investors to take huge risks while failing to fully realize it. In a similar vein, human resource managers may be more likely to be influenced by quantitative criteria (e.g., number of publications, number of awards) when they recently experienced control losses (e.g., traffic jams, firing somebody).

4. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The research presented in this dissertation may have some important contributions and implications. At the same time, it has some limitations. We discuss some of the most important limitations below and provide some suggestions for future research.

While we present much empirical evidence for the effects proposed in this dissertation, we acknowledge that some of the explanations proposed for the findings may currently lack sufficient empirical support. In the first essay, we conclude that people are not only sensitive to relative differences, but also engage in absolute thinking when judging income distributions. It is not clear from our results *why* exactly this is the case. It might be that merely being presented with symbolic numbers might lead people to be more linear in their comparisons of numerical information. Given that symbolic numbers allow for finer distinctions, it may lead people to also become more fine-grained in their number discrimination. This intuition dovetails with findings in numerical cognition that people are better at discriminating symbolic numbers compared to the corresponding nonsymbolic numerosites (Buckley & Gillman, 1974; Roggeman, Verguts, & Fias, 2007). Another reason for this result may lie in the importance that people attach to income information. Incomes are crucially important for many people since they are essential having a decent life in modern society. As such, this increased importance attached to incomes may lead people have to judge income information, they may invest more effort in the evaluation of income information, thereby leading to decreasing relative thinking. We should also take into account the higher levels of numeracy that are probably present in our student samples compared a more representative samples (Henrich, Heine, & Norenzayan, 2010). Given that higher levels of education are accompanied by higher levels of numeracy and more precisely defined mental number line (Dehaene et al., 2008), it might be that this has inflated the level of absolute thinking. Future research may for example investigate the moderating role of numeracy in this effect. Alternatively, one may directly measure the precision of the mental number line by using a symbolic-number mapping task (Siegler & Opfer, 2003).

Likewise, in the third essay, we propose that need for predictability may drive the effects of control loss on preference for precise, numerical information. However, we admit that our current set of studies do not provide sufficient support for such an explanation. That is, in the current studies, we focus mainly on demonstrating the effect. While this approach may also have benefits in terms of showing robustness of the effect, it is insufficient to provide clinching evidence for the proposed mechanism. As such, it might be a good idea for future research to focus on providing empirical support for the exact process driving the proposed effect. In this respect, it might be important to note that much work on threat responses such as personal control threats has found it difficult to explicitly measure these responses, thereby rendering meditational approaches especially difficult (Banfield, 2011). When a process is difficult to measure, some scholars have suggested to resort to moderation to show process (Spencer, Zanna, & Fong, 2005). Applying these suggestions to research reported in the third essay, future research may investigate whether individual differences may moderate the precision protection effect. For example, prior research (Cutright, 2012) has found that people who have a sufficient buffer against control threats because of their religious beliefs may not display any effects of the manipulation of control. Alternatively, satisfying the need for precise information through an alternative task might also diffuse consumer desires for precision in subsequent product choices.

Most studies reported in this dissertation only focus on a limited set of stimuli or situations. As such, it would be fruitful to further investigate how the current findings would play out in very different circumstances. For instance, one may wonder whether the effects of the first essay may be replicated in organizational context. Would a fixed percentage wage cut be seen as more fair than cutting wages by the same absolute amount? Alternatively, one may test whether making fines dependent on income is considered to be fairer than giving absolute fines? In addition, the findings of the third essay may be very relevant in other contexts. For example, firm managers frequently confront control threats (e.g., unexpected software errors, stock market fluctuations) and potentially respond to these threats in ways similar to those we have described. That is, managers who experience control threats may be more likely to attend to precise, quantitative indices of performance, instead of less precise performance assessments, even if the former are less representative of reality.

It might also be worthwhile to investigate how default units influence judgments through indirect pathways (Oppenheimer, 2008). Future investigators may look at how specifying information in default units affect how information is weighted in decisions involving multiple attributes. Prior research has shown that people are more likely to consider fluent information (Shah & Oppenheimer, 2007). Another interesting avenue for research may be to look at how a product specified in nondefault units may evoke positive evaluations. For special occasion products, the inference that a product feels unusual, out of the ordinary, or more difficult to process likely has positive connotations (Pocheptsova et al., 2010), so these products might even benefit from the difficulty associated with processing nondefault units. For example, a limited edition MP3 player could best be described in nondefault units. In addition, pursuing a goal requires an assessment of the extent to which an object is instrumental to its fulfillment.

It is important to note that the vast majority of the findings presented in this manuscript are the result of experiments. While this method has many clear advantages such as testing effects in a highly controlled setting, we acknowledge that it may sometimes lead to somewhat artificial set-ups. In a sense, the findings reported in this dissertation may be viewed as a first, but necessary step to more ecologically valid tests of these effects by means of field studies. In addition, we acknowledge that we frequently rely on self-report measures which might be susceptible to demand effects. For example, in the first essay, the use of within subject designs might have encouraged participants to answer in a way that they believed fitted the experiment's goal. Although the use of between-subject set-up may have eliminated the chance of having demand effects, it might be interesting to replicate the results of the third study (with measures of envy and fairness) in a between subject set-up.

5. **CONCLUDING THOUGHTS**

To conclude, let us return to Sara, the woman who was introduced in the first paragraphs of this dissertation. The results reported in this dissertation may inform us on the questions that we initially asked ourselves about her:

- *When she arrives at work, Sara gets notified that everybody gets a wage cut of 20% due to an internal reorganization. Would she be happier if everybody had to give in €150?*

  Irrespective of whether she would be actually happier with one type of wage cut, we may guess that she would perceive the income distribution after a 20% wage cut to be more equal than after a €150 wage cut.

- *During lunch break, Sara eats lunch at her desk so she can surf the internet looking for a new smartphone. Sara wants to buy a new one to replace her old and slow one. She finds a promotion for a smartphone which specifies the warranty of the smartphone in days. While reading this promotion, she starts building up an evaluation of this smartphone. Would her evaluation be different when the exact same warranty was specified in years?*

  Yes, it is likely that her evaluations may depend on the type of unit in which information is specified. We would propose that her evaluation would be more positive when warranty was specified in years than in days because years is a default unit for warranty.

- *After a long day at work, Sara steps in her car. She still needs to get some groceries before finally going home. Five minutes later, she is stuck in a major traffic jam. For half an hour, she felt a sharp decrease in her level of personal control over her life. She just had to wait until she passed the traffic jam. Would this experience affect her grocery choices? Specifically, would she rely more on quantitative attributes in her choices?*

  Also in this case we would predict that it is likely that Sara's grocery choices may be affected by her traffic jam experience. Indeed, we would propose that she may attend more to quantitative attributes in her choices.

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