Commentary on: “an appraisal of behavioral price research (Part I)”

Keith S. Coulter

Received: 3 February 2013 / Accepted: 1 March 2013 / Published online: 16 March 2013
© Academy of Marketing Science 2013

In their article, Cheng and Monroe (2013) undertake a comprehensive review of the major historical, theoretical and empirical developments in the field of behavioral price research. They reveal that theoretical principles underlying work in this area are derived from centuries-old observations in the fields of mathematics (Bernoulli 1954) and psychophysics (Weber 1834; Fechner 1860). Based on these early studies, as well as more recent work by Scitovsky (1944); Adam (1958); Emery (1962) and others, Cheng and Monroe (2013) demonstrate that behavioral price research is grounded in the premise that price is a physical stimulus. As such, it is subject to perceptual bias, distortion, and processing interpretation just as any other physical stimulus. An important implication is that demand for products changes relative to *perceived* (rather than actual) differences in prices. Further, buyers' judgments of price reflect a logarithmic relationship between price and value. Using these principles and observations as background, Monroe (1968, 1973) identified the four fundamental concepts of behavioral price research. These are: (1) reference price, (2) differential price threshold, (3) absolute price threshold, and (4) acceptable price range.

The four fundamental concepts

Reference price Regarding the first of these concepts, a substantial body of literature has evolved to address the importance of reference price (see also Biswas et al. 1993 for a discussion) and the theories on which it is based (e.g., adaptation-level theory, assimilation-contrast theory, prospect theory, and range-frequency theory). Cheng and Monroe (2013) make the important point that reference price is an *internal*, dynamic, and ever-changing construct. It is also important to note that consumers might formulate

reference prices relative to both individual brands, as well as to product categories (Kalyanaram and Winer 1995).

This latter distinction becomes particularly important when studying the effects of comparative price advertising, where a higher “regular” price is often contrasted with the lower “sale” price. By utilizing a fictitious brand in their stimulus advertisement, researchers might presume that such an externally supplied comparative standard (i.e., the higher regular price) *becomes* the buyer's internal reference price, thereby serving as an anchor for buyers to make price evaluations. However, whereas the final selling price could potentially represent a “good” deal relative to the higher, externally-supplied regular price, nevertheless it might represent a “bad” deal relative to some internal reference price - particularly if that standard is below the current stated selling price. Thus, researchers must be particularly cognizant of the fact that reference prices are *internally*-driven and constantly changing.

Differential price threshold The second concept addressed by Cheng and Monroe (2013) is that of differential price threshold. This concept is defined as the minimum difference in price between: (a) the price in question and (b) a buyer's (internal) reference price that is necessary to induce a change in perceived relative expensiveness (Monroe 1968, 1973, 2003). Research demonstrates that the relationship between the change in price (ΔI) and the individual buyer's reference price (P_{ref}) is a constant (K) for any “just-noticeable difference” in price change (Gabor and Granger 1969; Monroe 1971). Further, studies in numerical cognition have confirmed that numerical magnitude comparisons typically follow the Weber-Fechner Law. That is, holding absolute difference constant, these numerical comparisons track a log-linear function such that the perceived difference between two numbers decreases as the magnitude of those numbers increases (Algom et al. 1996; Grewal and Marmorstein 1994; Dehaene et al. 1990). Consequently, when making quantitative comparisons, one's ability to distinguish between two numbers (i.e., determine which is

K. S. Coulter (✉)
Clark University, Worcester, MA, USA
e-mail: kcoulter@clarku.edu

larger or smaller) is directly related to the *relative* difference between them (Dehaene 1992a, b).

These findings have important implications for research in comparative price advertising. More specifically, if consumers *perceive* the difference between two prices in relative terms, does that mean that when presented with a high (“regular”)¹ and low (“sale”) price, they will “automatically” transcribe, process, and encode that difference as a relative proportion? For example, assume that a consumer is exposed to a high price of \$120 and a low price of \$80, and that this difference exceeds his/her differential threshold (e.g., −6 %) for a price reduction. Does the consumer then process and encode the discount as 33 %...or as \$40? Further, assume that a second consumer is exposed to a high price of \$1200 and a low price of \$1160 in a different product category. The second consumer’s differential price threshold is −2 %. Would that second consumer process and encode the discount as 3 %... or as \$40? These questions are important because form of processing (i.e., in absolute or relative terms) could impact perceived discount magnitude (Chen et al. 1998).

Some studies have demonstrated that whether consumers evaluate the difference between two prices in absolute vs. relative terms may depend upon the manner in which the information is presented (Bonini and Rumiati 2002; Bartels 2006; Peters et al. 2006; Choi and Coulter 2012) or how the specific task is framed (Thomas and Morwitz 2009). For example, consider a high (regular) price of \$12.00, and a low (sale) price of \$8.99. One could argue that asking people to evaluate a “price difference” would imply calculating an absolute dollar amount (\$3.01), whereas asking subjects to evaluate a “price discount” might typically imply the need to calculate (or assess) a relative difference (approximately 25 %). Thus, the framing of the task in prior studies could impact relative versus absolute discount assessment, which might account for some of the significant findings reported in the literature (e.g., Thomas and Morwitz 2009).

Once a differential price threshold has been crossed, whether consumers then evaluate the difference between prices in absolute vs. relative terms may also be predicated upon the degree of conscious versus non-conscious processing involved (Adaval and Monroe 2002), as well as the degree to which formal “calculation” actually occurs in the price comparison process. As noted by Cheng and Monroe (2013), a decrease in price may be *perceived* if $[\Delta D/P_{\text{ref}} - \Delta D]$ exceeds K . Once perceived, a relative decrease (i.e., discount) could subsequently be *calculated* as $[(\text{higher price} - \text{lower price}) / \text{higher price}]$ (Dehaene and Akhavein 1995; Heath et al. 1995). This calculation involves the process of division and, because prior research has indicated that multiplication and

division operations may typically require more cognitive effort than addition or subtraction (Morwitz et al. 1998), one could conclude that relative discount assessment is cognitively more demanding (i.e., and therefore less likely to occur) than absolute discount assessment (Chen and Rao 2007).

Yet, when presented with high and low prices, research also demonstrates that consumers can be quite accurate in their relative discount perceptions, even when not consciously engaged or involved in the price comparison process (Monroe 1973; Mazumdar and Jun 1993; Monroe and Lee 1999; Coulter and Norberg 2009; Coulter and Coulter 2010). These findings indicate that consumers are capable of arriving at relative (i.e., percent) discount assessments without expending significant cognitive effort. Further, a recent number comparison study using reaction time manipulations demonstrated that consumers are able to accurately *estimate* (if not “compute”) relative differences with minimal cognitive effort, and in a matter of milliseconds (Choi and Coulter 2012). Finally, research has demonstrated that consumers may be more likely to estimate discounts in relative terms as computational difficulty increases (Thomas and Morwitz 2009). In summary, relative discount assessment may indeed be the predominant (“default”) processing and encoding mode. However if that is the case, this processing may involve estimation rather than a formal calculation procedure.

Absolute price threshold and acceptable price range As acceptable price range is defined by the lower and upper price thresholds (i.e., points where a buyer finds the prices to be too low and too high, respectively), the two concepts are inexorably linked. The notion of upper and lower price thresholds and an acceptable price range in between has been widely accepted and integrated into most theoretical accounts in pricing research (e.g., Kalwani and Yim 1992; Kalyanaram and Winer 1995; Lichtenstein et al. 1988; Mazumdar and Jun 1992). Studies have found that relatively low prices tend to be less acceptable because they are perceived as reflecting low product quality, whereas relatively high prices tend to be less acceptable because they are judged as too expensive. These results led to the postulation of an inverted U-shaped priced acceptability function linking subjective price acceptability with actual prices (Kalyanaram and Winer 1995).

Importantly, and as pointed out by Cheng and Monroe (2013), more recent evidence suggests that consumers may *prefer* very low prices and exhibit a decreasing price acceptability function without a lower price threshold (Ofir 2004). Further, variables such as price consciousness, price-quality relations, need for cognition, and product involvement may moderate the shape of the price acceptability function (Suri and Monroe 2001; Ofir 2004). Because certain segments of demand can be linked to each of these variables, further examination of their effects is warranted.

¹ Assume for purposes of this discussion that the high regular price is identical to the consumer’s reference price.

Processing price information

In the second half of their paper, Cheng and Monroe delve into the numerical cognition literature to formally address the manner in which price information is processed. Research in the field of numerical cognition seems to suggest that the human cognitive system deals with numerical information (and hence prices) through a dedicated cognitive subsystem (Ashcraft 1992; Dehaene 1992a, b, 1997; Vanhuele et al. 2006). McCloskey (1992) has proposed that this subsystem consists of unitary representations of quantity (termed “number-semantic representations”), which are independent of the code in which the input is presented (e.g., Arabic or verbal number forms). According to his “modular theory,” the abstract quantity (number-semantic) representation serves as a mental platform upon which all numerical operations such as arithmetic fact retrieval, mental calculation, etc. are performed (McCloskey and Macaruso 1995).

Dehaene (1992a, b) and colleagues, in contrast, developed a Triple-Code Model of the cognitive numerical subsystem, in which it is proposed that numbers can be mentally represented and manipulated in three different forms: visual, auditory, and semantic (or “analog”). Importantly, this model is in complete agreement with theories of “grounded cognition” (Barsalou 2008), which argue that perceptual experiences are encoded as *bimodal* representations or “simulations,” incorporating various related elements of sensory stimuli and multiple memory traces.

In the case of numbers, the first modal representation involves the visual (Arabic) code. This code represents numbers on a spatial visual medium on the basis of their written form in Arabic numerals (e.g., 72). Arabic number forms can be processed or generated in each of the cerebral hemispheres in the occipital-temporal regions of the ventral-visual pathway (Dehaene and Cohen 1995). Second, the auditory verbal code is generated through a phonological representation in which each number is represented by a sequence of phonemes (e.g., “seventy” and “two”). This type of processing is only present in the left hemisphere within the perisylvian language areas (Dehaene and Cohen 1995, 1997). Third, the semantic/analog magnitude code represents numbers as judgments of relative “size” arrayed in parallel-format along a left-to-right-oriented mental number line (Dehaene et al. 1990, 1993). Both hemispheres possess an analog magnitude representation of numbers in the vicinity of the parieto-occipito-temporal junction (Dehaene and Cohen 1995; Pinel et al. 1999).

Importantly, analog magnitude representations may be encoded in terms of either an exact value (e.g., seventy-two), an approximation of the exact value (e.g., “between seventy and seventy-five), or a more global assessment of a number (i.e., “large” or “expensive”) (Dehaene et al. 1990). Studies within the numerical cognition literature typically

involve single-digit number processing without reference to scalar dimensions (e.g., pounds, degrees). Therefore, the findings reported in these studies may reflect the encoding and processing of analog magnitude representations involving exact, absolute amounts.

Studies within the marketing literature, however, often involve exposing consumers to either (a) single prices associated with familiar product categories or (b) multiple prices associated with the same (unfamiliar) brand (e.g., in the case of comparative price advertising). In such instances, consumers are likely to compare those prices to either externally-provided or internally-generated reference values (Compeau and Grewal 1998; Compeau et al. 2002). Thus, analog magnitude representations are more likely to reflect relative estimates rather than exact absolute amounts (cf. Coulter and Coulter 2007; see Monroe and Lee 1999 for a discussion). This “implicit price knowledge” may drive purchase decisions in the absence of more precise empirical information (Roediger and McDermott 1993; Krishnan and Chakravarti 1999).

In agreement with the literature involving grounded cognition, research has demonstrated that the verbal, visual, and analog representations are neurologically connected with one another; there are paths linking the different representations within each of the hemispheres and paths connecting (through the corpus callosum) the left and right analog magnitude representations and the left and right Arabic visual systems (Noel 2001). However, each of the three codes is differentially involved in various kinds of arithmetic operations and number processing, with no need to rely on a unitary number representation as in the McCloskey (1992) model (Cohen and Dehaene 1996; Dehaene et al. 1998). A specific number could be coded as an exact, absolute numerical amount in terms of the Arabic visual system (e.g., “78”) but as a relative estimation in terms of the analog magnitude system (e.g., “large”). Further, the various internal codes and processing routes appear to be unrelated to verbal versus Arabic stimulus input format (Gallistel and Gelman 1992), but research has demonstrated that the applicable number code may be task-dependent (Dehaene 1992a, b). Thus, for example, a consumer in a typical online comparative shopping environment might read prices to him or herself (without speaking out loud) and rehearse those prices internally to keep them in memory. In such a situation, the auditory code could become particularly important when the final purchase decision is made (Vanhuele et al. 2006; Luna and Kim 2006, 2009).

Importantly, while evidence indicates that an auditory stimulus may be linked to an encoded auditory representation and a visual stimulus may be linked to a visually encoded representation (Brysbaert et al. 1998, 2000; Vanhuele et al. 2006; Coulter and Coulter 2010; Coulter et al. 2012), research suggests that a numeric value-related

representation in the analogue magnitude code is encoded (and subsequently retrieved) *automatically*, effortlessly, and non-consciously whenever a number is represented in the verbal or visual code (Dehaene et al. 1990; Pavese and Umiltà 1998; Dehaene 1992a, b; Tzelgov et al. 1992; Coulter and Norberg 2009). The fact that analog codes are automatically evoked is particularly important because recent studies have shown that the magnitude representation that sustains the processing of numeric value may be highly related to the underlying magnitude code that sustains the processing of physical stimuli (Dehaene 1989). These studies have demonstrated close behavioral parallels between the processing of quantitative information associated with the numerical difference between numbers (e.g., large or small), and that associated with the physical distance between numbers or other sets of stimuli (e.g., close or far) (Seron and Fias 2006). Such parallels have led researchers to posit that there exists a common cerebral representation of magnitude or quantity (Dehaene et al. 1998). Evidence of this common representation is provided by Fias et al. (2003), who in comparing angles, lines, and numbers found that the processing of various forms of quantitative information had a common neural basis. Several studies utilizing brain-imaging technology (e.g., fMRI scanning) have demonstrated that this common processing substrate occurs around the intraparietal sulcus (IPS) (Pesenti et al. 2000; Pinel et al. 2004; Seron and Fias 2006).

Such commonality implies that magnitude representations related to *both* relevant (i.e., numeric value) and non-relevant (e.g., physical font size) visual and verbal stimulus dimensions may be automatically evoked upon visual/verbal stimulus exposure (Dehaene and Akhavein 1995), and each can have an impact upon how the other is encoded. The effect occurs because (as noted earlier) magnitude may be processed at an abstract level (e.g., depending on context, 50 in. and 50 lb could both be encoded as “large” or “small” amounts), and therefore different analog representations of quantity, regardless of the symbolic or non-symbolic nature of the representations, are comparable (c.f. Campbell and Clark 1988; McCloskey 1992; Noel and Seron 1993, 1997; Adaval and Monroe 2002). What this means is that just about any relevant or non-relevant visual or verbal stimulus evoking perceptions of “size,” distance, volume, or magnitude – when linked to price encoding – could potentially impact numerical magnitude perceptions (Adaval and Monroe 2002; Coulter and Coulter 2010; Thomas et al. 2010).

As suggested by research in grounded cognition (Decety and Grezes 2006; Goldman 2006), it is possible that other embodied and/or grounded metaphors linked to visual/verbal aspects of a price stimulus could also impact price evaluations. For example, assuming a left-to-right reading perspective, the alpha-numeric digit characters used in a price could be said to exhibit a “forward” orientation (i.e., 5, 6), a “neutral”

orientation (i.e., 0, 8), or appear to “face backward” (i.e., 1, 2, 3, 4, 7, 9) (Coulter 2007). Further, some prices (e.g., \$810,018) exhibit vertical mirror symmetry and therefore appear “balanced,” whereas others (e.g., \$805,099) do not (Dobson et al. 2010). Also in regard to prices appearing on a printed page, mental metaphors such as “up is good, down is bad” (Casasanto and Chrysikou 2011) and “up is north, down is south” (Nelson and Simmons 2009) might be expected to impact how a price is perceived. Finally, the angle at which a price is viewed (i.e., “head-on is powerful”) could impact how that price is evaluated (Schuldt et al. 2012). It is suggested that future research efforts be directed toward investigating the effects of other visual or verbal stimulus dimensions on price perceptions. Future research might also investigate the impact of other sensual stimuli (e.g., those involving touch, taste, or smell) on price evaluations.

References

- Adam, D. (1958). *Les reactions du consommateur devant le prix*. Paris: Sedes.
- Adaval, R., & Monroe, K. B. (2002). Automatic construction and use of contextual information for product and price evaluations. *Journal of Consumer Research*, 28, 572–588.
- Algom, D., Dekel, A., & Pansky, A. (1996). The perception of number from the separability of the stimulus: the Stroop Effect revisited. *Memory and Cognition*, 24, 557–572.
- Ashcraft, M. H. (1992). Cognitive arithmetic: a review of data and theory. *Cognition*, 44(1–2), 75–106.
- Barsalou, L. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617–645.
- Bartels, D. M. (2006). Proportion dominance: the generality and variability of favoring relative savings over absolute savings. *Organizational Behavior and Human Decision Processes*, 100(1), 76–95.
- Bernoulli, D. (1954). Exposition of a new theory on the measurement of risk. *Econometrica*, 22, 23–36. translated from original Latin by Sommer, L. in 1954.
- Biswas, A., Wilson, E. J., & Licata, J. W. (1993). Reference pricing studies in marketing: a synthesis of research results. *Journal of Business Research*, 27, 239–256.
- Bonini, N., & Rumati, R. (2002). Acceptance of a price discount: the role of the semantic relatedness between purchases and the comparative price format. *Journal of Behavioral Decision Making*, 15(3), 203–220.
- Brysbaert, M., Fias, W., & Noel, M.-P. (1998). The Whorfian hypothesis and numerical cognition: is “twenty-four” processed in the same way as “four-and-twenty”? *Cognition*, 66, 51–77.
- Brysbaert, M., Fias, W., & Reynvoet, B. (2000). The issue of semantic mediation in word and number naming. In F. Columbus (Ed.), *Advances in psychology research*, vol. 1 (pp. 181–200). Huntington: Nova.
- Campbell, J., & Clark, J. (1988). An encoding complex view of cognitive number processing: comment on McCloskey, Sokol, & Goodman (1986). *Journal of Experimental Psychology: General*, 117, 204–214.
- Casasanto, D., & Chrysikou, E. (2011). When left is “right”: motor fluency shapes abstract concepts. *Psychological Science*, 22(4), 419–422.

- Chen, H. A., & Rao, A. R. (2007). When two plus two is not equal to four: errors in processing multiple percentage changes. *Journal of Consumer Research*, 34(3), 327–340.
- Chen, S.-F., Monroe, K., & Lou, Y.-C. (1998). The effects of framing price promotion messages on consumers' perceptions and purchase intentions. *Journal of Retailing*, 74(3), 353–372.
- Cheng, L. L., & Monroe, K. B. (2013). An Appraisal of Behavioral Price Research (Part I): Core Concepts and Numerical Cognition. *AMS Review*. doi:10.1007/s13162-013-0041-1.
- Choi, P., & Coulter, K. S. (2012). "It's not all relative: the effects of frame of reference and price placement on absolute versus relative discount assessment." *Journal of Retailing*, 88(4), pp.
- Cohen, L., & Dehaene, S. (1996). Cerebral networks for number processing: evidence from a case of posterior callosal lesion. *Neurocase*, 2, 155–174.
- Compeau, L. D., & Grewal, D. (1998). Comparative price advertising: an integrative review. *Journal of Public Policy and Marketing*, 17, 257–273.
- Compeau, L. D., Grewal, D., & Chandrashekar, R. (2002). Comparative price advertising: believe it or not. *Journal of Consumer Affairs*, 36(2), 284–294.
- Coulter, K. S. (2007). The effects of digit-direction on eye-movement bias and price rounding behavior. *Journal of Product and Brand Management, special issue on Behavioral Pricing*, 16(7), 501–508.
- Coulter, K. S., & Coulter, R. A. (2007). Distortion of price discount perceptions: the right digit effect. *Journal of Consumer Research*, 34, 162–175.
- Coulter, K. S., & Coulter, R. A. (2010). Small sounds, big deals: phonetic symbolism effects in pricing. *Journal of Consumer Research*, 37(2), 315–328.
- Coulter, K. S., & Norberg, P. A. (2009). The effects of physical distance between regular and sale prices on numerical difference perceptions. *Journal of Consumer Psychology*, 19, 144–157.
- Coulter, K. S., Choi, P., & Monroe, K. B. (2012). Comma N' cents in pricing: the effects of auditory representation encoding on price magnitude perceptions. *Journal of Consumer Psychology*, 22, 395–407.
- Decety, J., & Grezes, J. (2006). The power of simulation: imagining one's own and other's behavior. *Brain Research*, 1079, 4–14.
- Dehaene, S. (1989). The psychophysics of numerical comparison: a reexamination of apparently incompatible data. *Perception and Psychophysics*, 45, 557–566.
- Dehaene, S. (1992a). Varieties of numerical abilities. *Cognition*, 44, 1–42.
- Dehaene, S. (1992b). Varieties of numerical abilities. In Dehaene S. (Ed.). *Numerical cognition*, Cambridge, MA: Blackwell (1993), 1–42.
- Dehaene, S. (1997). *The number sense*. Oxford: Oxford University Press.
- Dehaene, S., & Akhavein, R. (1995). Attention, automaticity, and levels of representation in number processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 314–326.
- Dehaene, S., & Cohen, L. (1995). Towards an anatomical and functional model of number processing. *Mathematical Cognition*, 1(1), 83–120.
- Dehaene, S., & Cohen, L. (1997). Cerebral pathways for calculation: double dissociation between rote verbal and quantitative knowledge of arithmetic. *Cortex*, 33(2), 219–250.
- Dehaene, S., Dupoux, E., & Mehler, J. (1990). Is numerical comparison digital? Analogical and symbolic effects in two-digit number comparison. *Journal of Experimental Psychology: Human Perception and Performance*, 16, 626–641.
- Dehaene, S., Bossini, S., & Giraux, P. (1993). The mental representation of parity and number magnitude. *Journal of Experimental Psychology: General*, 122, 371–396.
- Dehaene, S., Dehaene-Lambertz, G., & Cohen, L. (1998). Abstract representations of numbers in the animal and human brain. *Trends in Neurosciences*, 21, 355–361.
- Dobson, J., Gorman, L., & Moore, M. D. (2010). "Consumer choice bias due to number symmetry: evidence from real estate prices." *Journal of Research for Consumers*, 17(1).
- Emery, F. (1962). Some psychological aspects of price. Tavistock Institute of Human Relations Doc. No. 664, mimeograph reproduced in Taylor, B., & Wills, G. (Eds.) (1969). *Pricing strategy*, London: Staples Press, 98–111.
- Fechner, G. T. (1860). Elemente der Psychophysik. In Herrnstein, R. J. & Boring, E. G. (Eds.) (1965). *A source book in the history of psychology*. Cambridge, MA: Harvard University Press, 562–572.
- Fias, W., Lammertyn, J., Reynvoet, B., Dupont, P., & Orban, G. A. (2003). Parietal representation of symbolic and nonsymbolic magnitude. *Journal of Cognitive Neuroscience*, 15, 47–56.
- Gabor, A., & Granger, C. W. J. (1969). The attitude of the consumer to prices. In B. Taylor & G. Wills (Eds.), *Pricing strategy* (pp. 132–151). London: Staples Press.
- Gallistel, C. R., & Gelman, R. (1992). Preverbal and verbal counting and computation. *Cognition*, 44, 43–74.
- Goldman, A. (2006). *Simulating minds: The philosophy, psychology, and neuroscience of mindreading*. Oxford: Oxford University Press.
- Grewal, D., & Marmorstein, H. (1994). Market price variation, perceived price variation, and consumers' price search decisions for durable goods. *Journal of Consumer Research*, 21, 453–460.
- Heath, T., Chatterjee, S., & France, K. R. (1995). Mental accounting and changes in price: the frame dependence of reference dependence. *Journal of Consumer Research*, 22, 90–97.
- Kalwani, M. U., & Yim, C.-K. (1992). Consumer price and promotion expectations: an experimental study. *Journal of Marketing Research*, 29, 90–100.
- Kalyanaram, G., & Winer, R. (1995). Empirical generalizations from reference price research. *Marketing Science*, 14(3), G161–G169.
- Krishnan, H. S., & Chakravarti, D. (1999). Memory measures for pretesting advertisements: an integrative conceptual framework and a diagnostic template. *Journal of Consumer Psychology*, 8, 1–37.
- Lichtenstein, D. R., Bloch, P. H., & Black, W. C. (1988). Correlates of price acceptability. *Journal of Consumer Research*, 15, 243–252.
- Luna, D., & Kim, H. M. (2006). Remembering prices: Numeric cognition, language, and price recall. In C. Pechmann & L. L. Price (Eds.), *Advances in consumer research*, vol. 33 (p. 235). Duluth: Association for Consumer Research.
- Luna, D., & Kim, H. M. (2009). How much was your shopping basket? Working memory processes in total basket price estimation. *Journal of Consumer Psychology*, 19, 346–355.
- Mazumdar, T., & Jun, S. Y. (1992). Effect of price uncertainty on consumer purchase budget and price thresholds. *Marketing Letters*, 3, 323–330.
- Mazumdar, T., & Jun, S. Y. (1993). Consumer evaluations of multiple versus single price change. *Journal of Consumer Research*, 20, 441–450.
- McCloskey, M. (1992). Cognitive mechanisms in numerical processing: evidence from acquired dyscalculia. *Cognition*, 44, 107–157.
- McCloskey, M., & Macaruso, P. (1995). Representing and using numerical information. *American Psychologist*, 50, 351–363.
- Monroe, K. B. (1968). *A method for determining product line prices with end-price constraints*. unpublished doctoral dissertation, Graduate College, University of Illinois: Urbana-Champaign.
- Monroe, K. B. (1971). Measuring price thresholds by psychophysics and latitudes of acceptance. *Journal of Marketing Research*, 8, 460–464.
- Monroe, K. B. (1973). Buyers' subjective perceptions of price. *Journal of Marketing Research*, 10, 70–80.
- Monroe, K. B. (2003). *Pricing: Making profitable decisions* (3rd ed.). New York: McGraw-Hill Book Co.
- Monroe, K. B., & Lee, A. Y. (1999). Remembering versus knowing: Issues in buyers' processing of price information. *Journal of the Academy of Marketing Science*, 27, 207–225.

- Morwitz, V. G., Greenleaf, E. A., & Johnson, E. J. (1998). Divide and Prosper: Consumers' Reactions to Partitioned Prices. *Journal of Marketing Research*, 35(4), 453–463.
- Nelson, L., & Simmons, J. (2009). On southbound ease and northbound fees: literal consequences of the metaphoric link between vertical position and cardinal direction. *Journal of Marketing Research*, 46(6), 715–724.
- Noel, M.-P. (2001). "Numerical cognition. In B. Rapp (Ed.), *Handbook of cognitive neuropsychology: What deficits reveal about the human mind* (pp. 495–518). NY: Psychology Press.
- Noel, M., & Seron, X. (1993). Arabic number reading deficit: a single case study. *Cognitive Neuropsychology*, 10, 317–339.
- Noel, M.-P., & Seron, X. (1997). On the existence of intermediate representations in numerical processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 23, 697–720.
- Ofir, C. (2004). Reexamining latitude of price acceptability and price thresholds: predicting basic consumer reaction to price. *Journal of Consumer Research*, 30(4), 612–621.
- Pavese, A., & Umiltà, C. (1998). Symbolic distance between numerosity and identity modulates Stroop interference. *Journal of Experimental Psychology: Human Perception and Performance*, 24, 1535–1545.
- Pesenti, M., Thioux, M., Seron, X., & De Volder, A. (2000). Neuroanatomical substrates of Arabic number processing, numerical comparison, and simple addition. *Journal of Cognitive Neuroscience*, 18, 1820–1828.
- Peters, E., Vastfjäll, D., Slovic, P., Mertz, C. K., Mazzocco, K., & Dickert, S. (2006). Numeracy and decision making. *Psychological Science*, 17(5), 407–413.
- Pinel, P., Le Clech, G., Van de Moortele, P.-F., Naccache, L., LeBihan, D., & Dehaene, S. (1999). Event-related fMRI analysis of the cerebral circuit for number comparison. *Neuroreport*, 10(7), 1473–1479.
- Pinel, P., Piazza, M., Le Bihan, D., & Dehaene, S. (2004). Distributed and overlapping cerebral representations of number, size, and luminance during comparative judgments. *Neuron*, 41, 983–993.
- Roediger, H. L., & McDermott, K. B. (1993). Implicit memory in normal human participants. In F. Boller & J. Grafman (Eds.), *Handbook of neuropsychology*, 8 (pp. 63–131). Amsterdam: Elsevier.
- Schuldt, Konrath, & Schwarz. (2012). The right angle: visual portrayal of products affects observers' impressions of owners. *Psychology and Marketing*, 29, 705–711.
- Scitovsky, T. (1944–45). Some consequences of the habit of judging quality by price. *Review of Economic Studies*, 12, 100–105.
- Seron, X., & Fias, W. (2006). How images of the brain can constrain cognitive theory: the case of numerical cognition. *Cortex*, 42, 406–410.
- Suri, R., & Monroe, K. B. (2001). The effects of need for cognition and trait anxiety on price acceptability. *Psychology & Marketing*, 18(1), 21–42.
- Thomas, M., & Morwitz, V. (2009). Heuristics in numerical cognition: Implications for pricing. In V. R. Rao (Ed.), *Handbook of pricing research in marketing* (pp. 132–149). Northampton: Edward Elgar Publishing.
- Thomas, M., Simon, D., & Kadiyali, V. (2010). The price precision effect: evidence from laboratory and market data. *Marketing Science*, 29(1), 175–190.
- Tzelgov, J., Meyer, J., & Henik, A. (1992). Automatic and intentional processing of numerical information. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 166–179.
- Vanhuele, M., Laurent, G., & Drèze, X. (2006). Consumers' immediate memory for prices. *Journal of Consumer Research*, 33, 163–172.
- Weber, E. H. (1834). De Pulsu, resorptione, auditu et Tactu: Annotations anatomicae et physiologicae. In Herrnstein, R. J. & Boring, E. G. (Eds.) (1965). *A source book in the history of psychology*. Cambridge, MA: Harvard University Press, 172–175.