Spring 3-18-2021

Spatial Expressions and Consumer Perceptions of Quantity

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ABSTRACT

Marketplaces and media sources frequently present consumers with information or measurements that involve "extreme" quantities (e.g., the size of the national debt or the number of pounds of plastic in the Earth's oceans). Often, communicators express these quantities in spatial terms in an effort to influence the perceptual impact of the information (e.g., expressing the national debt in terms of the number of miles it would extend if laid out in paper currency form). Across three experiments, we find evidence that perceptual impact diminishes with spatial dimensionality (e.g., expressing a quantity as a length makes it seem larger than expressing it as a volume).

EXTENDED ABSTRACT

Consumers frequently encounter information or measurements that involve "extreme" quantities. For example, in early 2021, the Bloomberg Billionaires Index estimated that the three people with the highest total net worth in the world were Elon Musk ($199B), Jeff Bezos ($189B), and Bill Gates ($133B). Similarly, the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) reports that the largest marine oil spill in U.S. history was 134M gallons in three months (Deepwater Horizon drilling platform).

The question of whether and how consumers comprehend, evaluate, remember, or reason about such measurements has been posed by a variety of interested observers, including educators, information architects, academic researchers, and consumer advocates (Barrio, Goldstein, and Hoffman 2016; Brown and Siegler 1993; Camilleri and Larrick 2014; Hullman et al. 2018; Landy, Silbert, and Goldin 2013; Schkade and Payne 1994; Ungemach et al. 2018).

One tactic that many communicators deploy is to express a measured quantity in spatial terms, with the presumed intention of enhancing the perceptual impact of the information. For example, a politician campaigning against income inequality might choose to point out that Bill Gates could use his total net worth of $133B to create a line of $100 bills that extends for 128,885.7 miles. Yet, some expressions of measurements may have an effect that is the opposite of a communicator's intentions. For example, NOAA describes the 134M gallon Deepwater Horizon marine oil spill as "…*equivalent to the volume of over 200 Olympic-sized swimming pools*." This shift from a small unit (“gallons”) to a large unit (“Olympic-sized pools”) results in a much smaller numerical component for the measurement (200 versus 134M). As a result, the expression may inadvertently lead consumers to conclude that the oil spill was not particularly large or perhaps not as large as they originally thought (Burson, Larrick, and Lynch 2009; Hsee and Zhang 2010; Lembregts, Christophe and Pandelaere 2013; Monga, and Bagchi 2012; Resnick et al. 2017; Weathers, Swain, and Carlson 2012).

The present research examines the extent to which consumers’ responses to spatial expressions for extreme quantities are influenced by changes in dimensionality (i.e., volume > area > length). Hypotheses regarding the influence of spatial dimensionality are derived from research in developmental psychology and psychophysical perception. These literatures document a general tendency for individuals to underestimate quantities to a greater degree in higher (versus lower) spatial dimensionalities (e.g., Carbon 2016; Ekman and Junge 1961; Krider, Raghubir, and Krishna 2001; Teghtsoonian 1965).

In Experiment 1a ($n = 258$, within-subjects design), participants were provided with three different expressions of a national debt of \$17,000,000,000. Specifically, the debt was expressed either as an amount of dollars, the length of a line of \$1 bills, or the number of Olympic-sized pools that could be filled with \$1 bills. Participants viewed the three unique pairings of expressions and indicated which expression made the debt seem larger. More participants (79.1%, $p < .001$) felt that expressing the debt as a length (66,157 trips around the equator) made it seem larger than expressing it as a volume (7,704 Olympic-sized swimming pools). Similarly, a majority of participants felt that the debt seemed larger as a length than it did as a dollar value (58.5%, $p < .005$) but only a minority felt the same way when the debt was expressed as a volume (39.9%, $p < .001$).

Experiment 1b replicated experiment 1a, using \$100 bills instead of \$1 bills to compute length and volume ($n = 112$, within-subjects design). The results were similar to those of experiment 1a. More participants (77.7%, $p < .001$) felt that expressing the debt as a length (662 trips around the equator) made it seem larger than expressing it as a volume (77 Olympic-sized swimming pools). Similarly, a majority of participants felt that the debt seemed larger as a length than it did as a dollar value (63.4%, $p < .005$) but only a minority felt the same way when the debt was expressed as a volume (40.2%, $p < .01$).

Experiment 2 ($n = 235$, between-subjects design) focused on perceptions of volume and involved expressions for the size of a marine oil spill. Participants were randomly assigned to view one of two spill sizes (smaller, larger) and one of four possible expressions (number of gallons, number of barrels, number of tanker trucks, number of Olympic-sized swimming pools). Participants rated the spill expressions using the item, “The size of the oil spill seems…” (1 = small, 7 = large). In the smaller spill condition, participants viewed the spill as larger when expressed as 2,000 gallons ($M = 5.06$) than when expressed in equivalent but larger units of volume: 48 barrels ($M = 3.8$, $p < .01$), $1/5^{th}$ of a tanker truck ($M = 3.93$, $p < .05$), and .30% of an Olympic-sized pool ($M = 3.87$, $p < .01$). The effects were similar, though smaller, in the larger spill condition. Participants viewed the spill as larger when expressed as 200,000 gallons ($M = 5.76$)

than when expressed in equivalent but larger volume units: 4,762 barrels (M = 5.2, p < .10), 22 tanker trucks (M = 5.15, p < .10), and 30% of an Olympic-sized pool (M = 4.82, p < .05).

In summary, we find that quantities are perceived as significantly larger when expressed in a lower (versus higher) spatial dimensionality. When holding spatial dimensionality constant, we find evidence of a numerosity effect (smaller units, and thus larger numbers, led to perceptions of a quantity as larger). These findings hold important implications for communicators, educators, policy makers, and individual decision makers.

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