tapraid5/zfr-xge/zfr-xge/zfr00411/zfr2239d11z | xppws | S=1 | 7/7/11 | 11:35 | Art: 2011-0023

Journal of Experimental Psychology: General

0096-3445/11/$12.00 DOI: 10.1037/a0024875

BRIEF REPORT

Are Numbers Gendered?

James E. B. Wilkie and Galen V. Bodenhausen
Northwestern University

We examined the possibility that nonsocial, highly generic concepts are gendered. Specifically, we investigated the gender connotations of Arabic numerals. Across several experiments, we show that the number 1 and other odd numbers are associated with masculinity, whereas the number 2 and other even numbers are associated with femininity, in ways that influence judgments of stimuli arbitrarily paired with numerical cues; specifically, babies' faces and foreign names were more likely to be judged as "male" when paired with odd versus even numbers. The power of logically irrelevant numerical stimuli to connote masculinity or femininity reflects the pervasiveness of gender as a social scaffolding for generating understandings of abstract concepts.

AQ: 1

Keywords: gender, metaphor, numerical concepts

The tendency to ascribe gender to both animate and inanimate objects is commonplace (e.g., Boroditsky, Schmidt, & Phillips, 2003; Grohmann, 2009). Such associations are often formed on the basis of social conditioning processes (Bussey & Bandura, 1999) and grounded in experienced gender differences (e.g., gender–occupation associations reflect actual occupational sex segregation; Cejka & Eagly, 1999). Associations can also arise from conceptual overlap between the cognitive representation of an item and prototypic representational features of gender. Thus, for example, people might associate a consumer product with a particular gender based either on the frequency with which they see it being used by women versus men or on the basis of qualities of the product shared with a given gender category (e.g., a newly encountered product may be perceived as feminine if it is advertised as "gentle"). Gender associations are thus not arbitrary but are grounded in concrete experience as well as conceptual similarity.

The ubiquity of gendered associations for a wide range of stimuli accords with recent research documenting the underlying, organizing dimensions of social meaning. This work has revealed two dimensions that serve as the fundamental scaffolding for social concepts (Fiske, Cuddy, & Glick, 2007; Judd, James-Hawkins, Yzerbyt, & Kashima, 2005; Wiggins, 1991). Although different theorists have used different terminology, there is a general correspondence in the identified dimensions. For our purposes, we refer to these dimensions as *communion* and *agency*. The communal dimension includes expressive, nurturant, and interdependent characteristics of humans and is manifested in the striving for intimacy and relationship; the agentic dimension, in contrast, includes instrumental, achievement-related, and independent characteristics and is manifested in strivings for mastery and power, which enhance differentiation from others (Wiggins, 1991). The conceptual overlap between these dimensions and prototypic representations of femininity and masculinity is evident, as much research has linked femininity to a more relational orientation and masculinity to a more autonomous orientation (e.g., Bakan, 1966; Bem, Martyna, & Watson, 1976; Spence, Helmreich, & Stapp, 1975).

An interesting puzzle arises from the fact that gender associations arise even for highly abstract and ostensibly nonsocial concepts. For instance, ancient folk ontologies such as the Pythagorean philosophy of ancient Greece and the Chinese philosophy of yin and yang viewed many abstract concepts, including numbers, as possessing gender (Lloyd, 1966; Nishiyama, 2006; Osgood & Richards, 1973); specifically, odd numbers were viewed as masculine, and even numbers were seen as feminine. Is it just a coincidence that these divergent philosophies viewed numbers in this way, or might the representation of numerical concepts like "odd" and "even" be scaffolded on social representations that implicate gender? A variety of scholars have argued that representations of abstract concepts must be extrapolated from concrete ones, even when there is little superficial similarity between the two (e.g., IJzerman & Koole, 2011; Lakoff & Johnson, 1980; Landau, Meier, & Keefer, 2010). Indeed, it has been argued that concrete realities of human experience are evoked in order to understand all abstract mathematical concepts (MacLane, 1986; see Lakoff & Núñez, 2000, for review). Might it be the case that the concrete concepts of "female" and "male" are recruited to construct abstract representations of even and odd numbers?

As a starting point for investigating this possibility, we begin by examining whether the first and arguably most prototypic members of these categories (i.e., "1" for odd numbers and "2" for even ones) possess gender connotations. The number 1 implies a soli-

James E. B. Wilkie and Galen V. Bodenhausen, Kellogg School of Management, Northwestern University.

Correspondence concerning this article should be directed to James E. B. Wilkie, Kellogg School of Management, Northwestern University, 2001 Sheridan Road, Evanston, IL 60208. E-mail: j-wilkie@kellogg.northwestern.edu

tary entity (and in some contexts, the most dominant option) and is consistent with the themes of autonomy and power that are central to agency. In contrast, the number 2 implies a pair of linked or related objects, consistent with the relational themes that are central to communion. If this is so, then people may automatically perceive the number 1 to be masculine (as both share features of agency) and the number 2 to be feminine (as both share features of communion).

Experiments 1A and 1B

To examine possible gender connotations of "1" and "2," we used the principle of misattribution: the notion that the associations carried by an object can be revealed by examining how it affects judgments of an ambiguous stimulus with which it is paired (e.g., Payne, Cheng, Govorun, & Stewart, 2005). The premise is that participants will misattribute the associations activated by the target object as a response toward the paired ambiguous stimulus. We expected that relatively gender-ambiguous stimuli (foreign names) paired with the number 1 would be perceived as more masculine than those same ambiguous stimuli when paired with the number 2. We also examined whether people hold such associations at the explicit level.

Method

Participants. For Experiment 1A, 74 American participants (84.2% White, 71% female; M_{age} = 37.1 years, SD = 15.3) were recruited from Amazon's Mechanical Turk (MTurk) website. For Experiment 1B, 82 American participants (78% White, 70.7% female; M_{age} = 41 years, SD = 13.9) were recruited via MTurk. Respondents received $0.25 in compensation for their participation.

Materials and procedure. Participants were informed that the purpose of the study was to examine the cross-cultural perception of names. To this end, participants were informed that they would be evaluating a randomly selected subset of foreign names (in Experiment 1A, Bulgarian names; in Experiment 1B, Spanish names) in terms of how masculine or feminine each name seemed to be (1 = *extremely feminine*, 8 = *extremely masculine*). Participants were randomly assigned to evaluate these names in isolation or alongside a number. Respondents in the latter condition were further informed that two data storage bins had been created in order to store all the names used within the study. Consequently, each name would have either a "1" or a "2" alongside it to indicate to the researchers the bin from which it was drawn. Participants were told they could ignore these numbers. In actuality, the numbers served as the key manipulation. Participants evaluated 18 names, half of which were paired with the number 1 and half of which were paired with the number 2. The number–name pairings were counterbalanced (e.g., half the subjects in the numbered condition evaluated "1. Alekseev," and the other half evaluated "2. Alekseev"). After completing the ratings, participants described how they made their choices (to determine whether they made conscious use of the ostensibly irrelevant tracking numbers). Following this, participants completed a second task in which they were presented one by one (in random order) with 10 objects including "1" and "2" as well as fillers (e.g., dogs, cats, math). Participants explicitly rated the gender of each object on a 7-point scale (1 = *extremely feminine*, 7 = *extremely masculine*).

Results and Discussion

Responses were averaged to create two composite scores, one for names paired with "1" and one for names paired with "2." A score closer to 8 indicated that a name next to a given number tended to be evaluated as *extremely masculine*.

Experiment 1A. Scores of participants who saw numbered Bulgarian names (N = 38) were entered into an analysis of variance (ANOVA) with repeated measures on number type (1 vs. 2). The analysis revealed a significant main effect, $F(1, 37) = 4.45$, $p = .04$, $\eta_p^2 = .11$. As predicted, participants rated names paired with "1" (M = 5.51, SD = 0.81) as more masculine than names paired with "2" (M = 5.17, SD = 0.78). No participants indicated that they considered the numbers in making their judgments, suggesting that the numerical influence occurred outside awareness.

Because the name stimuli cannot be assumed to be perfectly gender neutral, we used the control condition (in which no numerical cues were present) as a baseline against which to gauge the impact of having a "1" or "2" presented next to the names. Independent-samples t tests comparing the rating of names paired with "1" and "2," respectively, against the control condition (N = 36) yielded a marginally significant difference between the control condition (M = 5.51, SD = 0.78) and the names paired with "2" (M = 5.17, SD = .078), $t(72) = 1.84$, $p = .06$, $d = 0.43$, but no difference between the control condition and the names paired with "1" (M = 5.51, SD = 0.81), $t(72) = 0.04$, $p = .97$, $d = 0.01$. Thus, although these findings support the proposition that the number 2 is feminine, they fail to indicate that the number 1 is masculine.

An analysis was then performed on the explicit ratings of "1" and "2" collected from all participants after the main task. These ratings were entered into an ANOVA with repeated measures on number type. There was a significant main effect, $F(1, 73) = 35.22$, $p < .001$, $\eta_p^2 = .33$, such that subjects rated "1" (M = 4.62, SD = 1.16) to be more masculine than "2" (M = 3.24, SD = 1.10). One-sample t tests comparing these means against the midpoint of the scale (4, denoting the gender-neutral response) revealed significant differences in both cases. The mean rating of the number 1 was significantly more masculine than the gender-neutral midpoint, $t(73) = 4.63$, $p < .001$, $d = 0.53$, and the mean rating of the number 2 was significantly more feminine than the neutral midpoint, $t(73) = -5.94$, $p < .001$, $d = 0.69$. Thus, participants' explicit ratings support the proposition that people tend to view the number 1 as masculine and the number 2 as feminine.

Experiment 1B. The fact that the Bulgarian names used in Experiment 1A were rated as being relatively masculine overall in the baseline, control condition might have constrained our ability to find any difference between the "1" cue and the no-number control condition in Experiment 1A. In Experiment 1B, we used Spanish names that were, in the aggregate, pretested to be more feminine than the Bulgarian names. Otherwise the methods were identical to Experiment 1A. Once again, a within-subjects analysis of the numbered names (N = 44) revealed that participants judged names paired with "1" (M = 4.51, SD = 0.93) to be more masculine than names paired with "2" (M = 4.29, SD = 0.92), $F(1, 43) = 4.22$, $p < .05$, $\eta_p^2 = .09$, but in contrast to the Bulgarian names study, independent-samples t tests against the no-number control condition (M = 4.16, SD = 0.65) indicated that the results

tapraid5/zfr-xge/zfr-xge/zfr00411/zfr2239d11z | xppws | S=1 | 7/7/11 | 11:35 | Art: 2011-0023

were driven by the names paired with "1," $t(80) = -1.97$, $p = .05$, $d = 0.42$, and not by names paired with "2," $t(80) = -0.71$, $p = .48$, $d = 0.16$. These participants' explicit measures of "1" and "2" replicated previous results; "1" was rated ($M = 4.56$, $SD = 0.96$) to be more masculine than "2" ($M = 3.50$, $SD = 0.97$), $F(1, 81) = 30.31$, $p < .001$, $\eta_p^2 = .27$. One-sample t tests comparing these means with the gender-neutral scale midpoint showed that "1" ratings were significantly more masculine than the gender-neutral midpoint of the scale, $t(81) = 5.31$, $p < .001$, $d = 0.58$, and ratings of "2" were significantly more feminine than the neutral midpoint, $t(81) = -4.66$, $p < .001$, $d = 0.52$.

Thus, considering both experiments, there is converging evidence supporting the notion that the number 1 is considered masculine and the number 2 is considered feminine and that these number–gender associations inadvertently influence evaluations of items with which they are arbitrarily paired, although the magnitude of the effect is constrained by stimulus characteristics.

As we noted, ancient traditions viewed odd numbers as generally masculine and even numbers as generally feminine. Evenness or oddness hinges, obviously, on divisibility by 2. Even integers are always exactly divisible by 2, and the concept of evenness thus may share features that are associated with this central and most prototypic category exemplar, including associated feminine–communal themes. Odd integers cannot be divided by 2 without leaving a remainder of 1. The concept of oddness thus may share features associated with its central and defining feature (the leftover "1"), including associated masculine–agentic themes. The second experiment examined this possibility.

Experiment 2

Method

Participants. Fifty American participants (80% White, 80% female; $M_{age} = 41.2$ years, $SD = 12.6$) were recruited from MTurk. Respondents received $0.25 in compensation for their participation.

Materials and procedure. Participants evaluated the same Bulgarian names paired with numerical cues as those used in Experiment 1A; however, in this experiment these cues consisted of three-digit numbers in which all digits were either even or odd (always excluding the digits 1 and 2). Participants were informed that the names were randomly drawn from a memory bin that contained hundreds of names and that the numbers simply allowed the experimenter to track the selected names; they were told they could ignore these numbers.

After the main task, participants were again asked to rate the gender associated with 10 objects, this time including the concepts "odd numbers" and "even numbers" among the fillers, on a 7-point scale (1 = *extremely feminine*, 7 = *extremely masculine*).

Results and Discussion

Responses were averaged to create two composite scores, one for names paired with odd numbers and one for names paired with even numbers, with scores closer to 8 indicating that a name was evaluated as being more masculine. Odd and even scores were entered into a repeated-measures ANOVA. The analysis revealed a main effect of number, $F(1, 49) = 4.91$, $p = .03$, $\eta_p^2 = .09$. As predicted, participants tended to rate names paired with odd numbers ($M = 5.43$, $SD = 0.80$) as more masculine than names paired with even numbers ($M = 5.15$, $SD = 0.98$). No participants indicated that they considered the numbers in forming their judgments, suggesting that the numerical influence occurred outside of awareness.

An repeated-measures analysis of the explicit ratings of "odd numbers" and "even numbers" yielded a significant main effect, $F(1, 49) = 7.35$, $p = .009$, $\eta_p^2 = .13$, such that odd numbers ($M = 4.46$, $SD = 1.09$) were rated as more masculine than even numbers ($M = 3.80$, $SD = 1.05$). One-sample t tests comparing these scores against the gender-neutral point of the scale (4) revealed that the mean rating of "odd numbers" was significantly more masculine than the gender-neutral midpoint, $t(49) = 2.98$, $p = .004$, $d = 0.42$, but the mean of "even numbers," although in the predicted direction, was not significantly more feminine, $t(49) = -1.35$, $p = .18$, $d = 0.19$.

Experiment 3

This study was a conceptual replication of Experiment 2, with a different kind of ambiguous stimulus. Although the biological sex of human adults is commonly perceptually obvious, babies' faces are often more ambiguous. In this study, we examined whether people would be more likely to believe a baby was male if an odd (rather than even) number was arbitrarily associated with it.

Method

Participants. Thirty-six individuals (91.2% White, 75% female; $M_{age} = 36.3$ years, $SD = 11.8$) were recruited from MTurk. Respondents received $0.50 in compensation for their participation.

Materials and procedure. Participants were shown a sample of baby photos, ostensibly randomly selected from a larger bin of photos, with the task of determining how likely it was that each baby was male (1 = *not at all likely*, 7 = *extremely likely*). Each photo consisted of the upper half of a baby's body. Only photos containing no overt gender cues were used (e.g., all babies wore white clothing). Pretesting confirmed that the sex of each baby was perceptually ambiguous. Participants were further informed that tracking numbers accompanying each picture were for the experimenter's use and could be safely ignored. Participants evaluated 16 photos of babies; half were paired with numbers consisting of three even digits (e.g., 486), and half were paired with numbers consisting of three odd digits (e.g., 573); this time, all digits (including 1 and 2) were examined. The number–baby pairings were counterbalanced such that each baby's face was paired equally often with an even versus odd tracking number. The mean magnitude of the odd and even numbers was also equated.[1] After completing the ratings, participants described how they made their choices.

[1] An exploratory analysis revealed no difference in perceived gender based on the actual magnitude of the number string presented.

Results and Discussion

Responses were averaged to create two composite scores, one for babies paired with even numbers and one for babies paired with odd numbers. Higher scores indicated that a baby was perceived as more likely to be male. A repeated-measures ANOVA revealed a main effect of number type, $F(1, 35) = 6.36$, $p = .016$, $\eta_p^2 = .15$. In line with the previous findings, participants tended to believe that babies paired with odd numbers were more likely to be male ($M = 3.79$, $SD = 0.53$) than babies paired with even numbers ($M = 3.47$, $SD = 0.59$). Again, no one reported using the tracking numbers in making their judgments.

General Discussion

Collectively, these findings indicate that numbers are indeed gendered. Although perhaps surprising, given the abstract nature of number concepts, the differential gender associations ascribed to odd versus even numbers follow from the claim that abstract concepts come to be understood through the application of metaphors that use more concrete entities as the source domain for specifying the nature of more abstract target concepts (Lakoff & Johnson, 1980; Landau et al., 2010). IJzerman and Koole (2011) argued that the realities of social life often serve as scaffolds for such metaphoric processes; the concretely experienced differences between female and male individuals that are experienced from early life onward (Maccoby, 1990) provide an obvious candidate for the social scaffolding of the conceptual world. Recent evidence that agency and communion form the psychological foundations for understanding a variety of social concepts (e.g., Judd et al., 2005) fits this assumption very well. The present findings indicate that the meaning of numerical oddness or evenness consists, in part, of gender-laden notions of agency or communion.

The effects observed in our studies occurred despite the logical irrelevance of the explicitly arbitrary numerical cues and despite participants consistently showing no awareness of the activation or influence of these associations. Because numerical stimuli are so ubiquitous in decision contexts, the biasing influence of such associations may be common in everyday life, particularly when individuals are not motivated or able to deliberate in a systematic way about the object of judgment.

The generality of these effects across cultures is a question of interest for future research. Given that both Eastern and Western philosophical traditions pointed toward these particular numerical associations, it may indeed be a universal human tendency to project gendered meanings onto numbers. In a brief online survey with 52 MTurk participants from India, we were able to replicate our finding that the concept "odd numbers" is rated as more masculine than "even numbers" (Ms = 4.56 vs. 3.62 on the same 7-point scale as in Experiment 2), $F(1, 51) = 5.00$, $p = .03$, $\eta_p^2 = .09$, providing an initial sense of the cross-cultural generality of our effects—which would be expected, given the cross-cultural consensus in gender roles relating to agency and communion (Barry, Bacon, & Child, 1957). Finally, given that qualitative as well as quantitative information is carried by natural numbers, future research should examine other possible qualitative numerical associations. As an extension of the present findings, it may be that even numbers are associated with a range of stereotypically "feminine" qualities, such as pleasantness or emotionality, whereas odd numbers are associated with "masculine" qualities, such as instrumentality or analytical thinking.

References

Bakan, D. (1966). *The duality of human existence: An essay on psychology and religion.* Skokie, IL: Rand McNally.

Barry, H., III, Bacon, M. K., & Child, I. L. (1957). A cross-cultural survey of some sex differences in socialization. *Journal of Abnormal and Social Psychology, 55,* 327–332. doi:10.1037/h0041178

Bem, S. L., Martyna, W., & Watson, C. (1976). Sex typing and androgyny: Further explorations of the expressive domain. *Journal of Personality and Social Psychology, 34,* 1016–1023. doi:10.1037/0022-3514.34.5.1016

Boroditsky, L., Schmidt, L. A., & Phillips, W. (2003). Sex, syntax, and semantics. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in mind: Advances in the study of language and cognition* (pp. 61–80). Cambridge, MA: MIT Press.

Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review, 106,* 676–713. doi:10.1037/0033-295X.106.4.676

Cejka, M. A., & Eagly, A. H. (1999). Gender-stereotypic images of occupations correspond to the sex segregation of employment. *Personality and Social Psychology Bulletin, 25,* 413–423. doi:10.1177/0146167299025004002

Fiske, S. T., Cuddy, A. J. C., & Glick, P. (2007). Universal dimensions of social cognition: Warmth and competence. *Trends in Cognitive Sciences, 11,* 77–83. doi:10.1016/j.tics.2006.11.005

Grohmann, B. (2009). Gender dimensions of brand personality. *Journal of Marketing Research, 105,* 105–119. doi:10.1509/jmkr.46.1.105

IJzerman, H., & Koole, S. L. (2011). From perceptual rags to metaphoric riches—Bodily, social, and cultural constraints on sociocognitive metaphors: Comment on Landau, Meier, and Keefer (2010). *Psychological Bulletin, 137,* 355–361. doi:10.1037/a0022373

Judd, C. M., James-Hawkins, L., Yzerbyt, V., & Kashima, Y. (2005). Fundamental dimensions of social judgment: Understanding the relations between judgments of competence and warmth. *Journal of Personality and Social Psychology, 89,* 899–913. doi:10.1037/0022-3514.89.6.899

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by.* Chicago, IL: University of Chicago Press.

Lakoff, G., & Núñez, R. (2000). *Where mathematics comes from: How the embodied mind brings mathematics into being.* New York, NY: Basic Books.

Landau, M. J., Meier, B. P., & Keefer, L. A. (2010). A metaphor-enriched social cognition. *Psychological Bulletin, 136,* 1045–1067. doi:10.1037/a0020970

Lloyd, G. E. R. (1966). *Polarity and analogy: Two types of argumentation in early Greek thought.* Cambridge, England: Cambridge University Press.

Maccoby, E. E. (1990). Gender and relationships: A developmental account. *American Psychologist, 45,* 513–520. doi:10.1037/0003-066X.45.4.513

MacLane, S. (1986). *Mathematics: Form and function.* New York, NY: Springer-Verlag.

Nishiyama, Y. (2006). A study of odd- and even-number cultures. *Bulletin of Science, Technology & Society, 26,* 479–486. doi:10.1177/0270467606295408

Osgood, C. W., & Richards, M. M. (1973). From yang to yin to *and* or *but. Language, 49,* 380–412. doi:10.2307/412460

Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89,* 277–293. doi:10.1037/0022-3514.89.3.277

Spence, J. T., Helmreich, R., & Stapp, J. (1975). Ratings of self and peers on sex role attributes and their relation to self-esteem and conceptions of masculinity and femininity. *Journal of Personality and Social Psychology, 32,* 29–39. doi:10.1037/h0076857

Wiggins, J. S. (1991). Agency and communion as conceptual coordinates for the understanding and measurement of interpersonal behavior. In D. Cicchetti & W. Grove (Eds.), *Thinking clearly about psychology: Essays in honor of Paul E. Meehl* (Vol. 1, pp. 89–113). Minneapolis: University of Minnesota Press.

Received January 23, 2011
Revision received June 14, 2011
Accepted June 24, 2011 ■