

RESEARCH ARTICLE

Straight to heaven: Rectitude as spatial representation of morality

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Received: 20 November 2016

Accepted: 20 November 2017

<https://doi.org/10.1002/ejsp.2358>

Keywords: rectitude, morality, metaphors, embodiment

Abstract

Abundant literature in cognitive sciences has shown that morality is grounded in bodily experience. Four studies tested the perceptual association between the spatial dimension of straightness and the abstract concept of morality. Study 1 ($n = 61$) employed an IAT and revealed an association between straight figures and moral related words. Study 2 ($n = 83$) employed a similar paradigm and further revealed that the effect we found in Study 1 cannot be attributable to the general association between straight figures and positivity. Study 3 ($n = 64$) revealed that participants showed a stronger preference for straight figures after recalling moral (vs. immoral) deeds. Study 4 ($n = 183$) showed the specific role of morality, in this sense, as recalling sociable (vs. unsociable) deeds had no significant influence on figure preferences. A small-scale meta-analysis confirmed the robustness of our findings. Results are discussed in light of the embodiment theory.

A growing body of research has shown that our sensory states affect the encoding of abstract concepts and the process through which this happens is defined as *embodiment* (for reviews, Barsalou, 2008; Meier, Schnall, Schwartz, & Bargh, 2012; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Suitner, Giacomantonio, & Maass, 2015). A key domain where complex constructs are grounded in human bodily experiences is morality (for reviews, Meier et al., 2012; Schnall, Benton, & Harvey, 2008; Schnall, Haidt, Clore, & Jordan, 2008; Strojcek & Zhong, 2014). Indeed, prior research has shown that the physical experience of cleanliness influences moral judgment and moral decision-making. As such, Zhong and Liljenquist (2006) revealed that a threat to the participants' moral image induced the need to clean themselves by taking antiseptic wipes (for a critical discussion, see Fayard, Bassi, Bernstein, & Roberts, 2009). Further studies revealed that individuals who were made to feel physically clean (vs. those who felt physically dirty) expressed harsher moral judgments on abortion and pornography (Zhong, Strojcek, & Sivanathan, 2010). In a similar vein, it has been shown that participants reminded of physical cleansing (compared to participants in the control group who were not given such a reminder) displayed more severe moral judgments toward violations of sexual purity (Helzer & Pizarro, 2011). Taken together, these findings reveal that morality is grounded in bodily experience.

Another interesting series of studies has investigated the association between morality and light colors.

Specifically, individuals recognized faster words with an immoral meaning when they were written in black (vs. white). By contrast, moral words were encoded faster when they were written in white (vs. black; Sherman & Clore, 2009). Moreover, investigating the association between the color of uniforms and the proclivity to aggressive behaviors in the previous 25 seasons of National Hockey League penalty-minute data, Webster, Urland, and Correll (2012) reported that players wearing black (vs. light) uniforms were penalized more. Similarly, Banerjee, Chatterjee, and Sinha (2012) showed that individuals judged a room as brighter when they previously recalled an ethical (vs. unethical) deed (however, see also Brandt, IJzerman, & Blanken, 2014).

Consistent with the embodiment approach is Lakoff and Johnson's theory of conceptual metaphor (Lakoff, 1996; Lakoff & Johnson, 1980), according to which most of our fundamental concepts (including the moral ones) are organized in terms of spatial metaphors (see also Bourdieu, 1998; Yu, Wang, & He, 2016). For this purpose, a relevant example of spatial metaphor is *verticality*, often adopted in the common language to differentiate what is good from what is bad. Meier, Sellbom, and Wygant (2007) found that participants recognized moral words faster when paired with upper visual cues or when presented in a high vertical location. Hill and Lapsley (2009) revealed that immoral personality traits are encoded more slowly when they are located high in the visual field. By the same token, individuals remember morally related images associated with God as

occurring higher in the screen than they actually appear (Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007, Study 3).

Beyond verticality, another relevant moral spatial metaphor involves the *straightness* dimension. Visual art and everyday language document such association. Dante (1265–1321), in the incipit of the *Divine Comedy* reports that he started his journey through the *Inferno* (i.e., Hell—the place where evil is located) after losing a *straightforward* pathway. In several European languages, the concept of morality is expressed through the metaphor of walking along a straight path, while, on the contrary, the concept of immorality is associated with the metaphor of abandoning a straight path or deviating from it. For instance, the association between straightness and the abstract concept of moral conduct is present in the Italian word *Rettitudine*, in the French and English word *Rectitude*, and in the Spanish word *Rectitud*, all of which derive from the common Latin words *rectitudo*–*rectus*, which mean both moral and straight. Interestingly, the spatial metaphor of straightness for moral conduct also concerns languages with no Greek or Latin roots. In Russian, the word for rectitude is *прямота*–*prjamota* coming from the term *прямой*–*prjamoj* which means straight. In Arabic, the word *أرى المستقيم* - *A-irā al-mustaqīm* expresses the association between a straight path and a moral conduct, and in Chinese, the characters 道德 (*dào dé*) and 义 (*yì*) emphasize the connection between a moral behavior and a straight line.

The association between straightness and morality is further captured by the words describing the concept of rightness at different degrees. *Regola*—the Italian word for *rule*—comes from the Latin *regere*, which means *going straight*. Likewise, in Italian, French, and German, the terms to describe the complex of laws that regulate citizens' lives in interaction with the other citizens and the State (*Diritto*, *Droit*, and *Recht*, respectively) all have the common meaning of straight. The English word *deviance* is used to express the set of behaviors violating social norms, and it comes from the Latin *deviare*, which means *to abandon a straight way*. In a similar vein, the word *crooked* means both being corrupt and having curves, not straight. Interestingly, in English, the word *straight* is not only adopted to describe what is linear but also used to describe a heterosexual person whose sexuality has been considered for centuries as the supposed conventional and “moral” sexuality (Herek & McLemore, 2013).

The pervasive presence of such a metaphor in different languages and in different moral domains seems to indicate that the abstract concept of morality is grounded in the spatial experience of straightness. Surprisingly, no previous study has addressed empirically the link between the spatial dimension of straightness and the abstract concept of morality. To fill this gap, the present research aimed to test the possibility that the spatial concept of straightness is associated with the concept of morality. To examine this possibility, we conducted four experiments. Study 1 employed

the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) to investigate the implicit association between words with moral meanings and the straightness dimension. Study 2 adopted the same paradigm and aimed at ruling out that the hypothesized association between straightness and morality reflected a more generic association between straightness and positivity. Study 3 tested whether priming a moral (vs. an immoral) self-view influences the accessibility of the straight concept. Specifically, we tested whether recalling moral deeds led to a greater preference for straight figures. Study 4 aimed to test the specific role of morality in this sense by considering another evaluative dimension (i.e., sociability). Finally, to test the robustness and reliability of our assumptions, we computed a small-scale meta-analysis.

The four reported studies were conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki, and they fulfilled the ethical standard procedure recommended by the Italian Association of Psychology (AIP). We reported all the independent variables, dependent variables, and measures collected in the studies. Electronic copies of the anonymized raw data, related coding information, and all materials used to collect data in their original wording/language are archived in the online platform Open Science Framework and are available upon request.

Study 1

Study 1 aimed to test our basic hypothesis that the concepts of straightness and morality are inherently linked. To do so, we asked the participants to perform an IAT with moral words and straight figures.

Method

Participants. Prior to data collection, the required sample size was computed based on a power analysis (G*Power 3.1.9.2; Faul, Erdfelder, Lang, & Buchner, 2007). With $\alpha = .05$ and power = .80, the projected sample size needed to detect a medium effect size ($d = .50$) for a *t* test difference from a constant is at least $n = 34$. We advertised the study on campus and 61 Italian undergraduates (51 females; *mean age* = 20.43 years, *SD* = 1.79) were recruited to participate in a computer task.

Materials and procedure. As a cover story, the participants were asked to participate in a study on word recognition. In order to assess the relative strength of the implicit association between straight figures and moral related words, the participants performed a 5-block Implicit Association Test (IAT). The participants were tested individually in a quiet room at the university and they were instructed to categorize, as fast and as accurately as possible, the proposed stimuli using two different keys (i.e., *D*, *K*) of the computer keyboard. Five selected straight images and five selected curved

figures were used for attribute categories “straight” and “curved” (see Figures 1 and 2 for examples). Meanwhile, five moral related words and five immoral related words were selected for the target categories “moral” and “immoral” (see Table 1). Three blocks were single-categorization blocks (i.e., practice blocks) and each one included 20 trials. The other two blocks were critical double-categorization blocks, including 40 trials each. In each block, every stimulus was randomly presented twice, and it appeared on the screen until the participants gave the correct response. A red X below the stimulus followed incorrect responses. In one of the two critical blocks, straight figures and moral related words shared the same response key (i.e., *D*), and, at the same time, curved figures and immoral related word shared the same response key (i.e., *K*). In the other critical block, straight figures and immoral related words shared the same response key (i.e., *D*), and curved figures and moral related words shared the same response key (i.e., *K*). To avoid order effects, the order of the presentation of the two critical blocks was counterbalanced across participants. At the end, the participants were asked to indicate their age and gender and were fully debriefed and thanked.

In order to use stimuli in the IAT, we developed *ad hoc* eight abstract curved and eight abstract straight images. We then aimed to ascertain that these stimuli were rated differently for straightness but similarly for likeability. Thus, 40 participants (19 females, *mean age* = 21.51 years, *SD* = 2.29) were asked to assess how much each figure was straight or rather curved on a 7-



Fig. 1: Study 1–2. Example of straight figure



Fig. 2: Study 1–2. Example of curved figure

Table 1. Stimulus words used in the IAT (Study 1, Study 2)

Moral words		Immoral words	
<i>Rispettare</i>	Respect	<i>Violare</i>	Disobey
<i>Sostenere</i>	Support	<i>Tradire</i>	Betray
<i>Aiutare</i>	Help	<i>Uccidere</i>	Kill
<i>Soccorrere</i>	Assist	<i>Rubare</i>	Steal
<i>Collaborare</i>	Collaborate	<i>Mentire</i>	Lie

point scale (1 = *totally curved*, 7 = *totally straight*). The participants also rated each figure on a scale of likeability (7-point scale, from 1 = *not at all* to 7 = *very much*). The selected 5 pairs of figures did not differ from each other for likeability ($M_{\text{straight}} = 4.15$, $SD_{\text{straight}} = 1.05$; $M_{\text{curved}} = 3.87$, $SD_{\text{curved}} = 1.08$), $t(39) = 1.59$, $p = .119$, $d = .25$, 95 % CI [-.07, .56], but they differed significantly from each other in terms of the level of straightness ($M_{\text{straight}} = 6.41$, $SD_{\text{straight}} = .81$; $M_{\text{curved}} = 2.30$, $SD_{\text{curved}} = 1.04$), $t(39) = 17.20$, $p < .001$, $d = 2.72$, 95 % CI [2.04, 3.39]. A further pilot study was conducted to ascertain that the selected words were perceived differently in terms of morality. Eighteen participants (14 females, *mean age* = 22 years, *SD* = .97) evaluated how much the content of each word referred to the field of immorality vs. morality (from 1 = *totally immoral* to 7 = *totally moral*). Results showed that the words differed according to moral perception ($M_{\text{immoral}} = 1.73$, $SD_{\text{immoral}} = .60$, $M_{\text{moral}} = 6.67$, $SD_{\text{moral}} = .49$), $t(17) = 21.68$, $p < .001$, $d = 5.11$, 95 % CI [3.34, 6.87].

Results and Discussion

Individual association scores were calculated using the *D*-algorithm proposed by Greenwald, Nosek, and Banaji (2003). The computation of *D* required several steps. First of all, eight participants were excluded from the analysis because of 25 % or higher error rates in at least one of the two critical blocks (Rudman, 2011); thus, the final sample included 53 participants. Then, trials with response latencies higher than 10 000 milliseconds were excluded; trials with response latencies lower than 300 milliseconds were replaced with 300 milliseconds. Moreover, latencies from incorrect responses were recoded using error penalties. Specifically, they were replaced with the block mean latency of correct responses plus an error penalty of 600 milliseconds.

Finally, the *D*s were calculated by subtracting the mean latency of the “moral-straight” block from the mean latency of the “immoral-straight” block divided by the inclusive standard deviation of the two critical blocks. A higher *D* indicated a stronger implicit association between “moral” and “straight,” rather than between “moral” and “curved.”

Next, we conducted a *t* test in order to compare the *D* to zero, indicating the absence of association. We found that the mean of *D*s ($M = 0.94$, $SD = 1.19$) was significantly different from zero, $t(52) = 5.72$, $p < .001$, $d = .79$, 95 % CI [.47, 1.09]. Thus, we found that the participants strongly associated the concept of “straight” with the concept of morality.

Therefore, Study 1 supported our hypothesis and revealed that the concepts of morality and straightness are inherently linked.

Study 2

Study 2 sought to replicate and extend the findings of Study 1 by ruling out the role of valence in driving our

findings. Indeed, Study 1 did not allow us to test whether straightness is specifically associated with morality or more in general with positivity. As such, it is possible that our results speak about a more general positive/negative effect, according to which straight and curved stimuli are generally positive and negative, respectively. Study 2 addressed this specific issue by testing whether the association between morality and straightness goes beyond positivity. Thus, the participants were asked to perform two IATs: the first one tested the association between straightness and morality and the second one tested the implicit association between straightness and positivity.

Method

Participants. Prior to data collection, the required sample size was computed based on a power analysis (Faul *et al.*, 2007). It was estimated that a sample size of at least 34 participants would be required to observe a medium effect size in both *t* test difference from a constant ($d = .50$) and *t* test difference between two dependent means ($dz = .50$), with $\alpha = .05$ and power = .80. The study was advertised on campus and all the students who responded were involved in the study. Thus, 83 undergraduates (66 females, *mean age* = 21.28 years; *SD* = 3.92) were recruited, and they voluntarily participated in the study.

Materials and procedure. As a cover story, the participants were asked to participate in a study based on two computer-administered tasks on word recognition. As in Study 1, the relative strength of the implicit association between straight figures and moral related words was assessed by asking the participants to perform a 5-block IAT. Further, to extend the results provided by Study 1, the relative strength of the implicit association between straight figures and positive words was assessed by administering a second 5-block IAT. The two IATs were administered one after the other. Importantly, the order of administration of the two critical double-categorization blocks within each IAT and between the two IATs, respectively, was counterbalanced between the participants to avoid order effects.

The IAT assessing the relative strength of the implicit association between straight figures and moral related words was the same as that in Study 1. As for the IAT assessing the relative strength of the implicit association between straight figures and positive words, the five straight and five curved figures used were the same as those adopted for the other IAT. Further, five positive words and five negative words were selected for the target categories “positive” and “negative” (see Table 2), from a set of positive–negative words used previously by Mucchi-Faina, Pacilli, and Pagliaro (2011). Similar to the other IAT, three blocks were practice blocks including 20 single-categorization trials each and the other two were critical double-categorization blocks, including 40 trials each. In one of the two critical blocks,

Table 2. Stimulus words used in the IAT (Study 2)

Positive words		Negative words	
<i>Miele</i>	Honey	<i>Veleno</i>	Poison
<i>Farfalla</i>	Butterfly	<i>Zanzara</i>	Mosquito
<i>Giardino</i>	Garden	<i>Palude</i>	Swamp
<i>Favola</i>	Fairy tale	<i>Incubo</i>	Nightmare
<i>Cielo</i>	Sky	<i>Alluvione</i>	Flood

straight figures and positive words shared the same response key (i.e., *D*), and, at the same time, curved figures and negative words shared the same response key (i.e., *K*). In the other critical block, the pairing between figures and evaluative words was reversed in comparison to the aforementioned block.

After completing the two IATs, the participants were asked to indicate their age and gender. Moreover, since the association we explored could change in relation to a dispositional individual factor related to sensitivity to morality, we measured the Honesty–Humility trait of HEXACO model of personality (Ashton & Lee, 2009). The scale comprised of 16 items (Cronbach’s $\alpha = .71$) and higher scores indicated the tendency to avoid manipulating others for personal gain and to feel a little tempted to break rules.

Results and Discussion

Three participants were discarded because they did not complete one of the two IATs. Thus, the following analyses were restricted to those 80 participants who completed the experimental session.

After following the same procedure as that adopted in Study 1, individual association scores were calculated for each IAT using the *D*-algorithm proposed by Greenwald *et al.* (2003), with a higher *D* indicating a stronger association between “moral” and “straight” (vs. “moral” and “curved”) and between “positive” and “straight” (vs. “positive” and “curved”), respectively.

Next, we conducted two *t* tests in order to compare our *D*s to the zero, indicating the absence of association. For the IAT assessing the relative strength of the implicit association between straight figures and moral related words, in line with Study 1, we found that the mean value of *D*s ($M = 0.95$, $SD = 1.31$) was significantly different from zero, $t(79) = 6.49$, $p < .001$, $d = .73$, 95 % CI [.48, .97]. For the IAT assessing the relative strength of the implicit association between straight figures and positive words, the mean values of *D*s ($M = 0.44$, $SD = 1.58$) emerged as significantly different from zero, $t(79) = 2.50$, $p = .015$, $d = .28$, 95 % CI [.06, .50].

We then conducted a paired *t* test to test if there was a significant difference between the two indices of the relative strength of the implicit association. The analysis showed that the association between straight figures and moral related words ($M = 0.95$, $SD = 1.31$) was significantly stronger than the association between straight figures and positive words ($M = 0.44$, $SD = 1.58$), $t(79) = 2.64$, $p = .010$, $d = .30$, 95 % CI [.07, .52].

Moreover, to further test whether the implicit association between moral related words and straight figures may be at least partially explained by a more general positive/negative effect, we followed the procedure described by Smith-McLallen, Johnson, Dovidio, and Pearson (2006). Specifically, we first conducted correlation analysis between the two *D* scores, and then we used the score of the IAT assessing the implicit association between straight figures and positive words to predict the score of the IAT assessing the implicit association between straight figures and moral related words in a regression analysis. While the significance of the association between IAT predictor variable and IAT criterion variable indicates whether the association between straightness and positivity explained amount of variance in the association between straightness and morality, the significance value of intercept indicates whether the association between straightness and morality is still significantly different from zero when controlling for the effect of the association between straightness and positivity (Smith-McLallen *et al.*, 2006). Results from regression analysis revealed that the implicit association between straightness and positivity significantly predicted the implicit association between straightness and morality ($\beta = .30, p = .006$). The intercept of this model (i.e., the implicit association between straightness and morality when the implicit association between straightness and positivity is zero) was $b = .84$ and it was significantly different from zero, $t(79) = 5.75, p < .001$. This indicates that if participants did not implicitly associate straightness with positivity, then the original value of the implicit association between straightness and morality, which was .95, was reduced to .84, a 11.6 % reduction (i.e., $.95 - .84$ divided by .95), yet still would have produced a statistically significant effect.

Finally, from the correlational analyses, it emerged that neither the index of the association between straightness and morality ($r = .18, p = .106$) nor the index of the association between straightness and positivity ($r = .07, p = .540$) were significantly related to the Honesty–Humility trait.

Study 2 confirmed the results of Study 1 by showing that the concepts of morality and straightness are related to each other. Moreover, Study 2 extended results of Study 1 by showing that although the implicit association between straightness and positivity is correlated with the implicit association between straightness and morality, the implicit association between straightness and morality remained significant beyond any effect of positivity.

Study 3

Study 1 and Study 2 did not allow us to test for causality. Thus, Study 3 sought to replicate the findings of Study 1 and 2 by manipulating the recall of personal moral vs. immoral episodes and measuring its effects on the accessibility of straight (vs. curved) figures. Research on embodied cognition has provided

preliminary indications that retrieving past knowledge induces the activation of associated and congruent sensory and motor states (Banerjee *et al.*, 2012; Niedenthal, 2007, but for relevant exceptions, see Zhong & Liljenquist, 2006). In line with results of Study 1 and Study 2 and in accordance with previous research showing that recalling moral behavior influences sensorimotor perception of an associated concrete concept (Banerjee *et al.*, 2012), we hypothesized that the recall of personal moral episodes would increase accessibility of the straight concept.

Method

Participants. For the recruitment of participants, we took advantage of a psychology lesson and a subsequent snow-ball strategy. In this way, we recruited 64 participants (females = 49; *mean age* = 22.92 years, *SD* = 7.60). We advertised the study and enrolled all individuals who responded and volunteered to participate. We determined sample size on the basis of participants' availability and no *a priori* power analysis was conducted in this case.

Materials and procedure. To cover the real aim of the experiment, we asked the participants to participate in a pre-test study aimed at determining the average visual, memory, and cognitive abilities of the student population. Thus, the participants were randomly assigned to either the moral ($n = 33$) or the immoral ($n = 31$) condition. The participants assigned to the moral condition were asked to write on a white sheet of paper about two past experiences where they felt themselves as highly moral (for a similar procedure, see Banerjee *et al.*, 2012; see also, Galinsky, Gruenfeld, & Magee, 2003). We asked the participants to recall two episodes as moral conduct is usually perceived a collection of acts rather than a single act. As a part of our cover story, the task was framed as aimed at defining the memory abilities of remembering past events. The participants assigned to the immoral condition were asked to write about two past experiences where they felt that they lacked morality. After recalling and describing the two episodes, the participants were presented with nine pairs of figures and were asked to choose from each pair the one they preferred the most. These figures were previously selected and tested in order to have, in each pair of figures, two figures that were similar for what they represented but different in their straight/curved dimension. Specifically, the pre-test involved 22 participants (13 females, *mean age* = 23.45 years, *SD* = 3.56) who were asked to assess a sample of 12 pairs of figures selected for their different level of straightness. They evaluated how much each figure was straight or rather curved (from 1 = *totally curved* to 7 = *totally straight*) and how much they liked each figure (7-point scale, from 1 = *not at all* to 7 = *very much*). We thus selected nine pairs of images that did not differ from each other for likeability, $t(21) = .06, p = .95, d = .01, 95\% \text{ CI} [-.41,$

.43], but that differed significantly from each other in terms of the level of straightness ($M_{\text{straight}} = 5.62$, $SD_{\text{straight}} = .63$; $M_{\text{curved}} = 3.78$, $SD_{\text{curved}} = .74$), $t(21) = 9.35$, $p < .001$, $d = 1.99$, 95 % CI [1.26, 2.72].

Considering that the choice of the figures could be influenced by the personal tendency of creativity, we asked the participants in the main study to express their agreement (from 1 = *totally disagree* to 7 = *totally agree*) to four items taken from an earlier work by Gino and Ariely (2011): “I think I’m a creative person”; “I have many creative ideas”; “I like to do things in an original way”; “I like the activities that stimulate my creativity” (Cronbach’s alpha = .90). As a manipulation check, the participants were asked to think about the deeds they recalled and to indicate how the behavior they described was moral (from 1 = *not at all* to 7 = *totally*). At the end, the participants were thanked and fully debriefed.

Results and Discussion

To test the effectiveness of the experimental manipulation, we performed a *t* test on the manipulation check item. Differences in the degrees of freedom are due to instances of missing data. The analysis yielded a significant effect of the experimental condition $t(62) = 14.56$, $p < .001$, $d = 3.64$, 95 % CI [2.83, 4.44], showing that the participants assessed the episodes described as more moral ($M = 6.21$, $SD = 1.17$) in the moral condition rather than in the immoral condition ($M = 1.74$, $SD = 1.29$).

In order to test our main hypothesis, a *t* test was conducted with recalling immoral/moral deeds as the independent variable and the synthetic index of preference for straight figures (i.e., total number of straight figures chosen out of the nine pairs of straight/curved figures presented) as the dependent variable. A significant effect of the experimental condition emerged, $t(61) = 2.88$, $p = .006$, $d = .72$, 95 % CI [.21, 1.22]. In line with the main hypothesis, we found that recalling moral deeds led the participants to prefer more straight figures ($M = 4.78$, $SD = 1.24$) than recalling immoral episodes ($M = 3.74$, $SD = 1.61$).

In order to explore whether the effect of recalling moral deeds on the preference for the straight figures was moderated by individual differences in personal creativity, we performed a moderation analysis. Thus, we adopted PROCESS, the macro for SPSS developed by Hayes (2013), and considered model number 1 (with 5000 resampling). Experimental condition (coded as 0 = *immoral deeds* and 1 = *moral deeds*) was entered as the independent variable and creativity as a continuous moderator. The crucial two-way interaction on the participants’ preference for the straight figure was not significant ($b = -.39$, $SE = .30$, $t = -1.30$, $p = .198$, 95 % CI: $-.99$, $.21$). Thus, our results suggest that individual differences in personal creativity did not moderate the effect of recalling moral deeds on participants’ preference for the straight figures.

Study 4

Study 4 had two different aims. First, we aimed to test whether the association with the straightness dimension involves only the moral dimension. Thus, we compared the effect of recalling two moral past experiences with that of recalling two sociable past experiences on the preferences for straight (vs. curved) figures. Indeed, prior research has shown that morality and sociability are two related, yet distinct, characteristics linked to the broader dimension of social warmth (Brambilla & Leach, 2014; Leach, Ellemers, & Barreto, 2007). Second, we aimed to rule out an alternative explanation of the effect of recalling immoral/moral events on the preference for straight figures in terms of retrieval fluency/difficulty. Thus, considering that the experience of retrieval ease vs. difficulty can influence subsequent judgments as misattributions (Winkielman, Schwarz, & Belli, 1998), in this study, we directly assessed this difficulty of retrieval and co-varied its effect.

Method

Participants. An a priori power analysis was conducted for sample size estimation (Faul *et al.*, 2007). With alpha = .05 and power = .80, the projected sample size needed to detect a medium effect size ($f = .25$, Cohen, 1988) is approximately $n = 128$ for a between-groups comparison (ANCOVA with 4 groups and 1 covariate). Thus, we recruited a total of 183 participants through an online call (146 females, *mean age* = 22.92 years, $SD = 7.28$). We advertised the study and enrolled all individuals who responded and volunteered to participate in this online procedure.

Materials and procedure. The procedure was almost identical to that of Study 3, with some relevant exceptions. Here we adopted a 2 (*dimension*: morality vs. sociability) \times 2 (*valence*: positive vs. negative) between participants design. Thus, the participants were assigned randomly to one of the four conditions: morality/positive (that is, they were asked to write about two past experiences where they felt that they were moral; $n = 44$); morality/negative condition (that is, they were asked to write about two past experiences where they felt that they lacked morality; $n = 45$); sociability/positive condition (that is, they were asked to write about two past experiences where they felt themselves as highly sociable; $n = 44$); and sociability/negative condition (that is, they were asked to write about two past experiences where they felt themselves as lacking sociability; $n = 50$).

We then assessed the participants’ perception of the ease vs. difficulty experience of retrieval by means of five items (e.g., *to what extent did you find it difficult to retrieve the [moral/immoral/sociable/unsociable] events?*; 5-point scale, from 1 = *not at all* to 5 = *very much*; Cronbach’s alpha = .83). Although previous literature has shown that it is the experience of retrieval—ease vs. difficulty—that can influence subsequent judgments

as misattributions (Winkielman et al., 1998), we further recorded the time that the participants took to retrieve the two events. Then, the participants were presented with the same nine pairs of figures of Study 3 and were asked to choose from each pair the one they preferred the most. Finally, as in Study 2, the participants were asked to fill in the Honesty–Humility subscale of the HEXACO (Cronbach's alpha = .76) to explore the moderating role of individual differences in sensitivity to morality.

Results and Discussion

In order to test our main hypothesis, we conducted a 2 (*dimension*: morality vs. sociability) \times 2 (*valence*: positive vs. negative) ANCOVA on the synthetic index of preference for straight figures (i.e., total number of straight figures chosen out of the nine presented) as dependent variable. The perception of the ease vs. difficulty experience of retrieval was entered as a covariate. The effect of the covariate was not significant, $F(1, 176) = .02$, $p = .895$; thus the preference for straight figures was not influenced by the perception of ease vs. difficulty experience of retrieval. Neither the main effects of dimension, $F(1, 176) = .26$, $p = .610$, nor the main effects of valence, $F(1, 176) = .85$, $p = .357$, were yielded by the analysis. The hypothesized two-way interaction approached significance, $F(1, 176) = 3.44$, $p = .065$, $\eta_p^2 = .02$. Interestingly, an analysis of the simple effects showed that, in line with our prediction, the difference in preference for the straight figures due to the valence of the retrieval was significant within the morality condition ($M_{\text{moral}} = 4.95$, $SD = 1.24$; $M_{\text{immoral}} = 4.30$, $SD = 1.86$), $t(87) = 2.00$, $p = .048$, $d = .42$, 95 % CI [.003, .84], but not within the sociability condition ($M_{\text{sociable}} = 4.43$, $SD = 1.42$; $M_{\text{unsociable}} = 4.62$, $SD = 1.63$), $t(92) = -.59$, $p = .55$, $d = -.12$, 95 % CI [-.29, .53].

Moreover, a 2 (*dimension*: morality vs. sociability) \times 2 (*valence*: positive vs. negative) between participants ANOVA showed that neither the main effects of dimension, $F(1, 179) = .89$, $p = .346$, nor that of valence, $F(1, 179) = 2.74$, $p = .100$, nor the interaction, $F(1, 179) = 1.67$, $p = .198$, were reliable in affecting the time the participants took to retrieve the two events. Thus, at an implicit level there was no indication of an effect due to the ease vs. difficulty of retrieval.

Thus, we confirmed that recalling moral deeds led the participants to prefer more straight figures than recalling immoral episodes and that this effect did not occur when the participants recalled sociability-related episodes. Moreover, the effect of recalling moral deeds on the preference for straight figures did not depend upon the participants' perception of the ease vs. difficulty of retrieval.

In order to explore whether the effect of recalling moral deeds on the preference for straight figures was moderated by individual differences in sensitivity to morality, we performed a moderation analysis. Thus, we used PROCESS (model number 3 with 5000 resampling, Hayes, 2013), to compute a conditional model in

which valence (coded as 0 = *negative* and 1 = *positive*) was entered as the independent variable, dimension (coded as 0 = *sociability* and 1 = *morality*) was entered as the first moderator, and the global score on the Honesty–Humility subscale of HEXACO as a second continuous moderator. The crucial three-way interaction on the participants' preference for the straight figure was not significant ($b = -.22$, $SE = .83$, $t = -.26$, $p = .791$, 95 % CI [-1.86, 1.42]). Thus, the interaction effect between valence and dimension on the participants' preference for the straight figures was not moderated by individual differences in sensitivity to morality.

Small-scale Meta-analysis

In our studies, we obtained consistent evidence about the hypothesized association between morality and straightness. Thus, Study 1 showed the first evidence of the association between morality and straightness; in Study 2 the IAT revealed that such an association remained significant beyond the association between general positive concepts and straightness; in Study 3 and Study 4 the participants showed a preference for straight images after recalling moral episodes rather than immoral ones.¹ Indeed, in all studies, the 95 % CI of the difference between the morality condition and the respective control condition never included the zero (Cumming, 2012, 2014). According to Cumming (2012, 2014), an additional value of 95 % CIs is that they provide information about the replicability of the findings. In the long run, a 95 % CI will include, on average, 83 % of the means of replication experiments. That is, the probability that a replication of one of our studies will give a mean that falls within the particular 95 % CI we obtained for that study is, on average, .83 (Cumming, 2012).

Although our experiments provided the first empirical support of our hypothesis, to combine the results obtained in these different studies and to increase the precision of the parameter estimates, we computed a small-scale meta-analysis (we excluded Study 1 where the control condition was not introduced in the design).

Therefore, we meta-analytically combined the results from the effect sizes reported in Studies 2–4. The meta-analysis showed that the weighted combined Z-score for the comparison between morality and the control condition ($N = 233$) was statistically significant, $z = 4.13$, $p < .001$. The random effects meta-analysis (ESCI procedure; Cumming, 2012) produced the overall effect size $d = .41$, 95 % CI [.19, .64]. Moreover, we tested the heterogeneity between the different studies: this

¹Regarding the role of socio-demographic variables, in Study 1 we found a significant relationship between age and IAT score ($r = .332$, $p = .017$); in Study 2 this significant relation did not emerge ($r = -.097$, $p = .397$). Moreover, in Study 3 and Study 4, age did not emerge as a significant covariate in the tested model (Study 3: $F(1, 59) = .095$, $p = .759$; Study 4: $F(1177) = .697$, $p = .405$). Given that the samples of our studies were unbalanced on gender, we could not test whether the gender of participants influenced our effects.

revealed the three studies to be homogeneous, $Q(2) = 2.01$; $p = .36$.

In conclusion, the small meta-analysis supports the results that arose in our experimental studies.

General Discussion

Morality is not only the outcome of abstract reasoning but it has also evolved from the embodied reality of human experience (Zhong & House, 2014). Prior to our research, evidence of the association between straightness and morality was purely anecdotal. Our article is the first attempt to thoroughly examine the crucial role of the spatial metaphor of straightness in the morality domain, at least to our knowledge. Through four studies, we found an implicit association between straightness and words with a moral meaning (Study 1, Study 2) and showed that preference for straight figures was higher when the participants recalled moral deeds than when they recalled immoral deeds (Study 3, Study 4). Thus, Study 3 and 4 suggested that recalling moral deeds induced a congruent preference for straight figures in line with previous research on the relationship between recalling moral deeds and accessibility of light colors (Banerjee *et al.*, 2012), and differently from the research by Zhong and Liljenquist (2006) on the incongruent association between recalling immoral deeds and physical cleanliness. Interestingly, Studies 2–4 indicated that the implicit association between straightness and morality as well as the preference for straight figures did not change according to a dispositional individual factor of morality—the Honesty–Humility trait of the HEXACO model of personality (Study 2 and Study 4)—or of creativity (Study 3).

These studies significantly extend our knowledge about the way morality is rooted in our body and may potentially have substantial implications in understanding the way in which the straightness dimension may drive ethical decisions (see also Zhong & Liljenquist, 2006). For instance, reversing what we found in Study 2, we could hypothesize that straightness is likely to elicit ethical behavior. If so, how can we prime straightness in real life in order to make people behave ethically? For instance, the Psychology of Architecture (e.g., Edgerton, Romice, & Spencer, 2007; Gifford, 2007) has long noted how space organization and the use of spatial cues are likely to affect human emotions, cognition, and behavior as pro-social actions (Vohs, Redden, & Rahinel, 2013). Thus, we cannot exclude that architecture unknowingly manipulates or is likely to shape straightness or curves to convey symbolic messages, including meanings related to morality (e.g., Spiro & Kostof, 1985). However, considering the domain of space as well, Meier and Robinson (2004) showed that even though an evaluative concept (good vs. bad) primed attention to physical space (high vs. low), the reverse was not true. Similarly, in the domain of time, Casasanto and Boroditsky (2008) found that people infer duration from spatial information but not the reverse. Thus, a possible reversed relation from straightness to morality needs

ad hoc empirical examination in the future. Future studies should also consider an indirect measure and not only self-report measures of creativity in order to better ascertain whether our results would change according to individuals' levels of creativity.

Further research is also required to determine the cross-cultural validity of our results, replicating these studies with a non-Italian sample. Moreover, since life in different religions is metaphorically meant as a path and a virtuous life as a straight path, further research is needed to ascertain the role of individuals' religiosity in the connection between straightness and morality.

Understanding the link between straightness and morality provides new insights into the metaphorical structure of morality as Zhong and House (2014) have recently defined it. However, while our work has shown an implicit association between the abstract concept of morality and the spatial metaphor of straightness, it still does not explain why this association occurs. As Lakens (2014) suggests, an interesting approach in embodiment research is examining the influence of sensorimotor information on the accessibility and salience of social information. For this purpose, interesting evidence could come from neuroscientific studies that show a key role of the cerebellum in regulating moral behavior (Demirtas-Tatlidede & Schmahmann, 2013; Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005; Scarpa & Raine, 1997). The key role of the cerebellum in the human motor functions is well known. In reaching a target, individuals with a damaged cerebellum make errors in movement such as abnormally curved trajectory (Bastian, Martin, Keating, & Thach, 1996). If confirmed, this relation between morality and straight motor behavior would support an "embodiment perspective" on the phenomenon. As embodied cognition suggests (see Barsalou, 2008; Semin & Smith, 2008), our conceptual system and, therefore, some aspects of our language are structured by the features of our bodies and are grounded in our brain's sensorimotor systems. Thus, a possible explanation of the pervasiveness of the spatial metaphor of straightness in such different languages could be found in the key role of the cerebellum in regulating moral behavior.

A number of intriguing lines of research start from what we have reported here, but interesting insights on the relation between straightness and morality seem to emerge from what we found.

Acknowledgements

We would like to express our gratitude for the linguistic advice to Amerigo Pochini (Chinese Language), Francesco Randazzo (Russian Language) and Sarah Sciò (Arabic Language). We are grateful to the editor and three anonymous reviewers who provided insightful comments that allowed us to realize Study 2 and Study 4.

This work was supported by a grant from the Italian Ministry of Education, University, and Research (FIRB: RBFR128CR6).

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