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Spatial metaphors in thinking about other people

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ABSTRACT

Spatial metaphors contribute to our capacity for abstract thought. Consistent with this idea, it has been shown that processing semantic information (related to valence, power, etc.) can bias performance in a spatial task. Advancing this line of work, the present study examined whether spatial metaphors have a role in thinking about other people. Participants read short vignettes about academic performance, health or social life, which described students in superior and inferior states. In Experiment 1, after reading each vignette, participants were explicitly asked to assign a location to each protagonist using a pen-and-paper task. Findings from this experiment provided initial indication that thinking about the protagonists could recruit spatial metaphors. In Experiments 2 and 3, each vignette was immediately followed by an implicit test of spatial association. In Experiment 2, participants performed a name-recognition task in response to the protagonists' names presented above or below the central fixation. In this experiment, metaphorical congruency facilitated performance. In Experiment 3, participants were presented with names at central fixation, followed by a visual discrimination target ("X"/"O") above or below fixation. In this experiment, metaphorical congruency interfered with performance. The diverging patterns of results are explained in terms of the conjunction and separation of the conceptual and perceptual components of the recognition task, respectively, in Experiments 2 and 3. Overall, the findings support the role of spatial metaphors in thinking about other people and, more generally, for the spontaneous use of space in conceptual processes.

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Our sense of space is integral to our capacity for perception and action (e.g., Baldauf & Deubel, 2008; Desimone & Duncan, 1995; Deubel & Schneider, 1996), and it has been argued that the sense of space continues to play a role in higher cognition, particularly in our understanding of abstract concepts (e.g., Boroditsky, 2000; Casasanto, 2017; Lakoff & Johnson, 1999; Meier & Robinson, 2004). Empirical investigation of this idea has involved examining the effect of concepts on various measures of sensorimotor bias, indicating that concepts automatically activate their associated spatial codes (e.g., Chasteen, Burdzy, & Pratt, 2010; Fischer, Castel, Dodd, & Pratt, 2003; Gozli, Chasteen, & Pratt, 2013a; Gozli, Chow, Chasteen, & Pratt, 2013b; Gozli, Pratt, Martin, & Chasteen, 2016; Marmolejo-Ramos, Montoro, Elosúa, Contreras, & Jiménez-Jiménez, 2014; Meier & Robinson, 2004; Santiago, Lupáñez, Pérez, & Funes, 2007; Sasaki, Yamada, & Miura, 2016; Schubert, 2005; Wang, Lu, & Lu, 2016; Xie, Wang, & Chang, 2014, 2015; Zhang, Hu, Zhang, & Wang, 2015). In the present study, we asked whether spatial metaphors can be engaged spontaneously as we think about other people, particularly people we read about for the first time. Before providing the details of the present study, it is helpful to begin with an overview of two types of experimental tasks that have been employed in studying the role of spatial metaphors in conceptual understanding.

Among the commonly used methods for examining space–concept associations are variants of the spatial Stroop task (Lu & Proctor, 1995) and the attentional cueing task (Posner, 1980). In a spatial Stroop task, participants are presented with words whose physical location could be compatible or incompatible with their meaning. For instance, words "LEFT" and "YESTERDAY" are expected to receive faster responses when appearing at the left of fixation, compared to when they appear at the right (e.g., Huffman & Pratt, 2016; Weger & Pratt, 2008; Zwaan & Yaxley, 2003). Attentional cueing tasks, on the other hand, involve presenting participants with a sequence of two events: a cue and a target. What is manipulated is

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the compatibility between the meaning of the cue (e.g., "YESTERDAY") and the physical location of the target (e.g., Chasteen et al., 2010; Fischer et al., 2003; Gozli et al., 2013a). The two effects have both been explained by presupposing that concepts can activate their spatial associations which, depending on the concept's match or mismatch with a to-be-attended physical location, impact processing efficiency.

Meier and Robinson (2004) used both types of tasks in examining the role of spatial metaphors in understanding valence. In their spatial Stroop task, they presented single words above/below fixation and instructed participants to categorize the words as positive or negative. They found positive categorization to be faster above fixation, while negative categorization was faster below fixation (see Lakens, 2012). We should note that, in the spatial Stroop task, spatial orienting (above/below) and categorization (positive/negative) are aspects of a single task. A participant could orient above fixation to categorize the word "HAPPY", in which case the positive valence and *up* are two features of a single event, which is why the compatibility between the two features facilitates performance (Hommel, Müsseler, Aschersleben, & Prinz, 2001).

In their attentional cueing task, Meier and Robinson (2004) presented a word at fixation, which again participants were required to categorize as "positive" or "negative". After the word, a target letter ("p" or "q") was presented above or below fixation, and participants had to identify this letter target. The authors found that after a positive word, letter identification was faster above fixation; after a negative word, identification was faster below fixation. These results indicate that valence can bias attention toward the metaphorically compatible location. These interactions between spatial and conceptual processing have been observed across many studies (e.g., Ansorge, Khalid, & Koenig, 2013; Goodhew, McGaw, & Kidd, 2014; Gozli et al., 2013a, 2013b, 2016; Lu, Zhang, He, Zheng, & Hodges, 2014; Quadflieg et al., 2011; Schubert, 2005; Taylor, Lam, Chasteen, & Pratt, 2015; Zanolie et al., 2012). Some studies have demonstrated that the cue–target compatibility effect depends on how the cue is processed, which suggests some degree of flexibility over whether a concept can activate a spatial metaphor (e.g., Dodd, Van der Stigchel, Leghari, Fung, & Kingstone, 2008; Torralbo, Santiago, & Lupiáñez, 2006; Zanolie & Pecher, 2014).

It is important to note that, in an attentional cueing task, the cue (i.e., the concept with a spatial association) and the target (e.g., target letter "p"/"q") are two separate events and, therefore, responding to "p" above fixation and categorizing the word "HAPPY" involve two events that share a single feature (*up*) in common (Hommel, 2004; see also, Amer, Gozli, & Pratt, 2017; Boulenger et al., 2006; Gozli & Pratt, 2011; Sato, Mengarelli, Riggio, Gallese, & Buccino, 2008). Assuming that attending to each perceptual event involves integration of its constituent features, having a feature in common means that the two events cannot be processed at the same time (e.g., Hommel et al., 2001; Treisman & Gelade, 1980). That is why cue–target compatibility can interfere with performance, particularly when the events have non-overlapping features, appear in close temporal proximity and each require focused attention (Amer et al., 2017; Estes, Verges, & Adelman, 2015; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; Lachmair, Ruiz Fernández, & Gerjets, 2016; Ostarek, Ishag, Joosen, & Huettig, in press; Ostarek & Vigliocco, 2017).

It should be noted that the landmark study by Meier and Robinson (2004) found facilitation, not interference. Here there was a relatively long delay between the presentation of the cue and the presentation of the target, with the two events requiring separate responses (participants first evaluated the cue at fixation as positive/negative, and only then were presented with a target above/below fixation). Separate responses to the cue and the target provide a sufficiently long cue–target delay, such that the cue's spatial feature is no longer occupied by the cue-related response when encountering the target. At the same time, the cue's spatial feature remains sufficiently active to bias performance in favour of the compatible target location. This is thought to be a key reason why Meier and Robinson observed facilitation with cue–target compatibility (Gozli et al., 2013a; Lachmair et al., 2016).

Previous research has examined the effect of pre-existing metaphorical associations (e.g., Meier & Robinson, 2004), or the acquisition of new associations via repeated exposure (Dolscheid, Shayan, Majid, & Casasanto, 2013; Girardi & Nico, 2017; Gozli, Moskowitz, & Pratt, 2014), but not the application of an existing metaphor to new situations. If spatial metaphors are involved in abstract thought, then they should also be recruited on the fly, as we think about new situations and people. Assuming that aspects of a new situation are interpreted in a metaphorical manner similar to a single concept such as valence, the corresponding spatial metaphors should be activated. This question is the focus of the present study. On the basis of literature on spatial associations with concepts (e.g., God/Devil, good/bad, happy/sad being associated with up/down; Chasteen et al., 2010; Gozli et al., 2013a; Meier & Robinson, 2004), we reason that thinking about a person in a superior state should be more readily associated with up/above, while someone in an inferior state should be more readily associated with down/below. In the present article, we use the terms "superior" and "inferior" to refer to a person's academic success/failure, social relatedness/isolation and good/bad health. We predicted that subsequently remembering people in those states would activate spatial associations that would, in turn, influence performance in a spatial orienting task.

Before testing our hypothesis using the spatial Stroop (Experiment 2) and attentional cueing (Experiment 3) paradigms, we needed to generate vignettes about people in superior and inferior states, in order to gather some evidence in favour of the idea thinking about others can activate spatial representations. To do this, in our first experiment we asked participants to read a set of vignettes, and we asked them to place each protagonist on a two-dimensional space by marking the initial of each name (e.g., "P" for "Paul") on a sheet of paper (horizontal and vertical midlines were drawn on the paper). Thus, participants were asked to explicitly assign names of the protagonists to locations within a spatial frame of reference. To preview the findings, we found explicit assignment of names to locations was consistent with the metaphorical association: on average, names of superior protagonists were assigned to locations to the right and above the centre, while the names of inferior protagonists were assigned to locations to the left and below the centre.

Having found that our vignettes produced the expected spatial biases in an explicit localization task, we used the same vignettes in the following two experiments. In Experiment 2, participants completed a name recognition task. Following the logic of the spatial Stroop paradigm, on each trial, a single name appeared above or below fixation (i.e., metaphorically compatible or incompatible with their superior/inferior state), and participants were instructed to report whether the name was presented in the preceding vignette.

In Experiments 2–4, we expected that recognition of protagonists would activate the associated spatial metaphors, e.g., superior-is-up. In Experiment 2, spatial orienting and name-recognition were part of one task. On each trial, a name was presented above or below fixation (compatible or incompatible with its metaphorical association) and participants responded whether they recognized the name from the preceding vignette. Thus, for Experiment 2, we expected faster responses when names were presented at metaphorically compatible locations (e.g., name of a superior protagonist above fixation), relative to when names appeared at incompatible locations (e.g., name of a superior protagonist below fixation).

In Experiments 3–4, each trial consisted of performing two sub-tasks. The two-subtasks consisted of (a) name-recognition at fixation and (b) responding to a peripheral visual target (e.g., "X"/"O"). Participants were instructed to respond the visual target only when the name belonged to the preceding vignette and withhold responding otherwise. In referring to the present experiments, we have reserved the term "recognition" to refer to the treatment of protagonist names, and we have used the terms "discrimination" (Experiment 3) and "detection" (Experiment 4) when referring to responses to the single-lettered, peripheral visual target ("X"/"O") above/below fixation.

Recognition of a centrally presented name, on the one hand, and responding to a peripheral visual target ("X" or "O"), on the other hand, were part of two sub-tasks in Experiments 3–4. We reasoned that the first sub-task, i.e., name recognition, could interfere with the second sub-task, i.e., responding to the visual target, when they require a common feature (Hommel et al., 2001; see also, Boulenger et al., 2006; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; Sato et al., 2008). Thus, we expected faster responses when the name and the following visual target did not share a common spatial feature (e.g., name of a superior protagonist, followed by a target below), relative to when the two events did share a common feature. Participants performed a *visual discrimination* task in Experiment 3, which we expected would be relatively more prone to interference from the name recognition task. In Experiment 4, participants performed *visual detection* task, which we expected would be less prone to interference from the name recognition task (Gozli et al., 2013a). If slower responses on compatible trials were, indeed, caused by the name-recognition task interfering with visual discrimination, then the findings should be weak or absent in a detection task. This was confirmed in Experiment 4.

Experiment 1

In this experiment, we tested the effectiveness of a set of descriptions (of other people) in producing spatial bias in an explicit localization task. Participants read about fictional undergraduate students who were either doing well (superior) or poorly (inferior) with regard to their academic performance, health or social life. Each participant read a total of three vignettes, each containing two protagonists. After reading a vignette, we used a pen-and-paper localization task, which required participants to assign the name of each protagonists to a location within a two-dimensional plane. Within this frame of reference, we measured deviations from the centre along both the horizontal and vertical axes. We predicted upward deviations for protagonists in a superior state and downward deviations for protagonists in an inferior state.

Method

Participants

Forty-eight undergraduate students (29 female) at the University of Toronto gave informed consent and took part in this experiment in exchange for course credit. Prior to their participation, the participants were all unaware of the purpose of the study and this was confirmed in the debriefing phase (this was true for all four experiments). Moreover, given that we did not aim to address individual differences, in all the following experiments we did not collect any demographic information regarding the participants' academic performance, health or social life. All experimental protocols were approved by the Research Ethics Board of the University of Toronto (protocol reference number: 26353; application title: "How do concepts and perceptual simulations affect visual attention?").

Stimuli and procedure

The experiment was conducted in dimly lit rooms. Male participants were given vignettes about male protagonists, and female participants were given vignettes about female protagonists. Each vignette described one superior protagonist and one inferior protagonist. Sample vignettes are included in Appendix 1 and the names used in the experiments appear in Appendix 2. The names used for superior and inferior protagonists were counterbalanced across participants. (e.g., for half of the male participants, "Paul" was the superior protagonist name while it was the inferior protagonist name for the second half of the male participants). Each vignette was divided into four pages. Participants were instructed to read the vignette carefully and remember as much information about the two protagonists as possible. They could navigate through the four pages using the left/right arrow keys.

After reading each vignette, participants were presented with a single 8.5 by 11 (letter size) sheet of paper. On the paper, the two major axes (horizontal and vertical) were drawn, intersecting at the centre of the paper. The paper was otherwise empty. Participants were told that the study aimed to find out how we assign locations to people. They were asked to imagine themselves to be represented by the central location in the paper and assign a location to each of the two protagonists by writing the initial of each name (e.g., "P" for "Paul") somewhere on the sheet. Participants were given a chance to take a short break before reading the next vignette.

Design

Each participant read three vignettes on the topics of academic performance, health and social life (Appendix 1). Immediately after each vignette, participants performed the location assignment task, resulting in collecting six responses from each participant. The order in which the vignettes were presented to the participants was counterbalanced.

Results and discussion

Responses in the localization task were measured in millimetres in terms of their deviation from the horizontal axis (vertical deviation) and from the vertical axis (horizontal deviation). The averaged responses are presented in Figure 1, which clearly demonstrate a difference between responses to the inferior and superior protagonists. We submitted vertical deviations and horizontal deviations to two separate repeated-measures ANOVAs, with independent

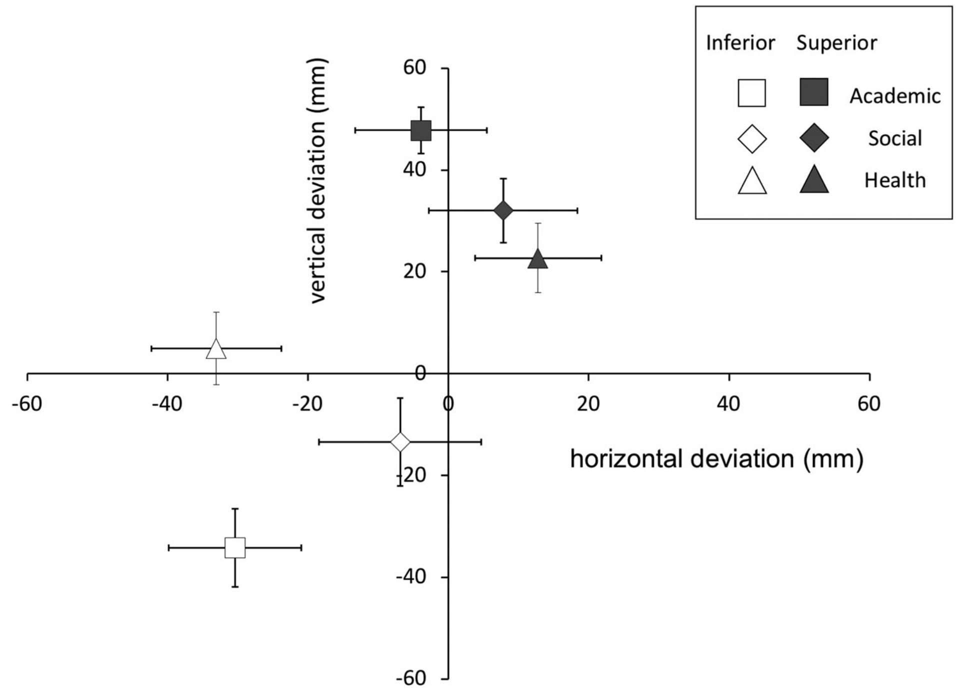

Figure 1. Result of the localization task in Experiment 1. Each participant read three vignettes about different aspects of student life (academic performance, health, social affiliations). Each vignette included two protagonists, one doing poorly (inferior protagonist) and one doing well (superior protagonist). The results show average deviation from the centre, along the horizontal and vertical axes, in millimetres. Error bars represent 95% within-subject confidence intervals.

factors being vignette category (academic, health, social) and protagonist type (inferior vs. superior).

For vertical deviations, we found no main effect of vignette category ($F[2, 94] = .914$), but a main effect of protagonist type ($F[1, 47] = 44.651$, $p < .001$, $\eta_p^2 = .487$) and an interaction between the two factors ($F[2, 94] = 14.080$, $p < .001$, $\eta_p^2 = .231$). The interaction indicates different inferior-to-superior distance for the different vignette categories. Namely, the distance was largest for the academic vignette (85 mm, $d_z = 1.37$), followed by the vignettes about social life (45 mm, $d_z = .66$) and health (18 mm, $d_z = .22$).

For horizontal deviations, we again did not find a main effect of vignette category ($F[2, 94] = 2.981$, $p = .056$, $\eta_p^2 = .060$), although we did find a main effect of protagonist type ($F[1, 47] = 6.596$, $p = .013$, $\eta_p^2 = .123$), with a statistically reliable distance along the horizontal axis between the superior and inferior protagonists (29 mm, $d_z = .37$). There was no interaction between the two factors along the horizontal axis ($F[2, 94] = 1.409$, $p = .249$, $\eta_p^2 = .029$).

In both dimensions, the deviations among the responses for the two protagonists were in the expected direction. On average, the superior protagonists were assigned upward and right-ward locations, whereas the inferior protagonists were assigned downward and left-ward locations. The bias along the vertical axis was relatively more robust, which is consistent with previous findings that also indicate a more robust metaphorical mapping of valence/status onto the vertical domain, compared to the horizontal domain (e.g., de la Vega, De Filippis, Lachmair, Dudschig, & Kaup, 2012; Gozli et al., 2013b; Taylor et al., 2015). In addition to the possibly stronger metaphorical association, the bias along the horizontal axis has been shown to be sensitive to the participants' handedness (e.g., Casasanto, 2009; de la Vega, Dudschig, De Filippis, Lachmair, & Kaup, 2013). Because of these factors, we do not investigate bias along horizontal axis in the following experiments. Rather, we investigate bias along the vertical dimension and note that the biases can, indeed, appear in an explicit localization task. The differences between the three vignettes can serve as a point of reference when evaluating performance in the following implicit tests of spatial bias.

Experiment 2

Having shown the vignettes can produce spatial bias along the vertical dimension in an explicit task, our goal for the second experiment was to demonstrate, using a variant of the spatial Stroop task, that thinking about the protagonists could induce a spatial bias. If recognizing the names of protagonists from the preceding vignette, without categorizing the names in terms of superior/inferior, can induce a spatial bias, this would be evidence that the participants applied spatial metaphors in thinking about the protagonists. After reading a vignette, in a separate task, the names of superior and inferior protagonists were presented above or below the fixation. The to-be-recognized name was presented at a location that was either metaphorically compatible or incompatible with what participants had read earlier about the person. In this paradigm, attentional orienting and name recognition are two attributes of the same event, because (a) the presentation of the name entails (i.e., partly consists of) the onset of a perceptual object above/below fixation, and (b) recognizing the name entails (i.e., partly consists of) having oriented one's attention to the name's location. Therefore, we expect compatibility to facilitate performance in this task.

Method

Participants

Eighteen (six male) new undergraduate students at the University of Toronto gave informed consent and took part in this experiment in exchange for course credit. They all reported normal or corrected-to-normal vision.

Apparatus and stimuli

The experiment was conducted in dimly lit rooms. Displays were presented on 19-inch CRT monitors set at 1024 × 768 resolution and 85 Hz refresh rate. The experimental programme was written in Matlab (MathWorks, Natick, MA), using the Psychophysics toolbox (Brainard, 1997; Pelli, 1997; version 3.0.8). Using a head/chin-rest, the distance from display was fixed at about 45 cm.

The vignettes used were the same as in Experiment 1. In the present experiment, *test* names (Appendix 2) are those that appeared in the story (receiving "yes" responses in the recognition task), whereas *catch* names did not appear in the story (receiving "no" response in the recognition task). As before, the test names used for superior and inferior protagonists were counterbalanced across participants.

Procedure

Each vignette was divided into four screens. Participants were instructed to read the vignette carefully and remember as much information about the two protagonists as possible. They could navigate through the four screens using the left/right arrow keys. After finishing each vignette, participants performed 80 trials of a visual name recognition task.

Each trial of the name recognition task began with a central fixation cross ("+"), presented at the display centre. After 1000 ms, a name appeared above or below the fixation cross (deviating 4° of visual angle). The question on each trial was whether the name belonged to the vignette they had just read. The name remained on display until a response was recorded. Participants pressed the "/" key for "yes" responses (correct response to test names) and the "z" key for "no" responses (correct response to catch names). Participants could receive three kinds of error feedback: if they responded within the first 100 ms following the onset of the name, they received anticipation-error feedback ("TOO QUICK!"); if they responded later than 1500 ms following the onset of the name, they received a delay error feedback ("TOO LATE!"); if they pressed the wrong key, they received an error feedback ("MISTAKE!"). All types of feedback would remain on display for 2000 ms.

Design

Each participant read three vignettes on the topics of academic success, health and social life (Appendix 1). Immediately after each vignette, participants performed the recognition task, which included the two (test) names from the vignette and two new (catch) names, resulting in a total of 120 test trials per participant (i.e., 40 test trials per vignette). An equal number of test names and catch names were used, and appearance of the two name types was equally probable, which means "yes" and "no" responses were equally likely. Test trials were further equally divided into those including superior and inferior names (respectively, the names of the superior and inferior protagonist). Both name locations (above vs. below) during the recognition task were equally likely, and name location varied orthogonally to protagonist category (superior vs. inferior) and recognition response (yes/no). Participants were given a chance to take a short break before reading the next vignette.

Results and discussion

Recognition accuracy was high on test trials (M ± SE = 93% ± 1%) and catch trials (91% ± 1%), with accuracy ranges of 83–97% and 78–98%, respectively, for test and catch trials. Catch trials were not analysed further. Before analysing the response times (RT) on test trials, incorrect responses and responses that fell 2.5 *SD* above or below the total mean were excluded (2.8% of trials). From the remaining data, mean RTs were submitted to a $3 \times 2 \times 2$ repeated-measures ANOVA, with vignette category (academic, health, social), protagonist type (superior vs. inferior) and name location (above vs. below) as factors ($\alpha = .05$). The RT data are graphed in Figure 2. None of the main effects reached significance (vignette category, $F[2,34] = 2.57$, $p = .091$, $\eta_p^2 = .131$, protagonist type, $F[1.17] = .68$, $p = .42$, $\eta_p^2 = .038$, and name location, $F[1.17] = 2.35$, $p = .144$, $\eta_p^2 = .122$). The two-way interactions between vignette category and protagonist type ($F[2,34] = .15$, $p = .86$, $\eta_p^2 = .009$) and between vignette category and name location ($F[2,34] = 2.01$, $p = .15$, $\eta_p^2 = .106$) also did not reach significance. We found, however, a two-way interaction between protagonist type and name location ($F[1,17] = 6.43$, $p = .021$, $\eta_p^2 = .274$), which was not qualified by a three-way interaction ($F[2,34] = .131$, $p = .88$, $\eta_p^2 = .008$). Consistent with the predicted metaphorical associations, responses were faster when names were presented at a metaphorically compatible location (523 ± 13 ms) compared to when they were presented at a metaphorically incompatible location (533 ± 14 ms, $d_z = .604$). It should be noted, however, that this interaction was driven by test trials in which the superior protagonist was presented (518 ± 13 ms vs. 538 ± 16 ms, for compatible and incompatible trials, $d = .62$, $p = .017$), rather than trials with the inferior protagonist (531 ± 16 ms vs. 532 ± 14 ms, $d = .046$, $p = .85$). This finding is relevant when considering alternative explanations of the present findings in the General discussion.

The interaction between protagonist type and name location, although relatively more robust at the level of the aggregate data ($d_z = .604$), appears less robust within each vignette condition (see Figure 2). Two-way interaction effects at the level of each vignette were relatively weak ($d_z = .306$, .371, .143, respectively, for the academic, heath, social-life vignette). It would be hasty to make distinctions between a vignette with which the null hypothesis was rejected vs. one with which the null was not rejected. When dealing with weaker effect sizes (i.e., here, the level of individual vignette), failing to reject the null on a subset of conditions is to be expected (e.g., Francis, 2012). Furthermore, the relatively weaker effects at the level of individual vignette are inconsistent with the idea that the results at the aggregate level were driven by data from one of the three vignettes. The relatively more robust interaction at the aggregate level might be due to individual differences in sensitivity to vignette types or some other source of noise at the level of individual vignettes. It is, therefore, important to keep in mind that our claims are made about the data at the aggregate level (Lamiell, 2000).

A similar ANOVA run on percent error (PE) data did not reveal a significant interaction between protagonist type and name location ($F[1, 17] = .374$), ruling out a possible speed–accuracy trade-off. A non-significant trend ($F[1,17] = 2.82$, $p = .079$, $\eta_p^2 = .171$) indicated slightly lower PE when names were presented above (6% ± 1%) relative to when presented below fixation (8% ± 1%). None of the other main effects or interactions reached statistical significance (F values < 1).

Consistent with our prediction, name-recognition performance varied systematically as a function of the relationship between protagonist type and name location. The pattern is consistent with the metaphorical compatibility effect, with the qualification that the compatibility pattern in this experiment was driven by the superior protagonists, which on average caused faster responses above fixation than below fixation. Unlike Experiment 1, the implicit test employed in the present experiment did not distinguish between the vignettes – the three-way interaction was far from statistical significance.

To provide converging evidence for the activation of the visuospatial features in thinking about the vignette protagonists, in Experiment 3 we used the attentional cueing task, which decouples name recognition from spatial orienting into two separate sub-tasks.

Experiment 3

In this experiment, rather than presenting the name of the superior or inferior person above/below fixation, the name was presented at fixation. After presenting

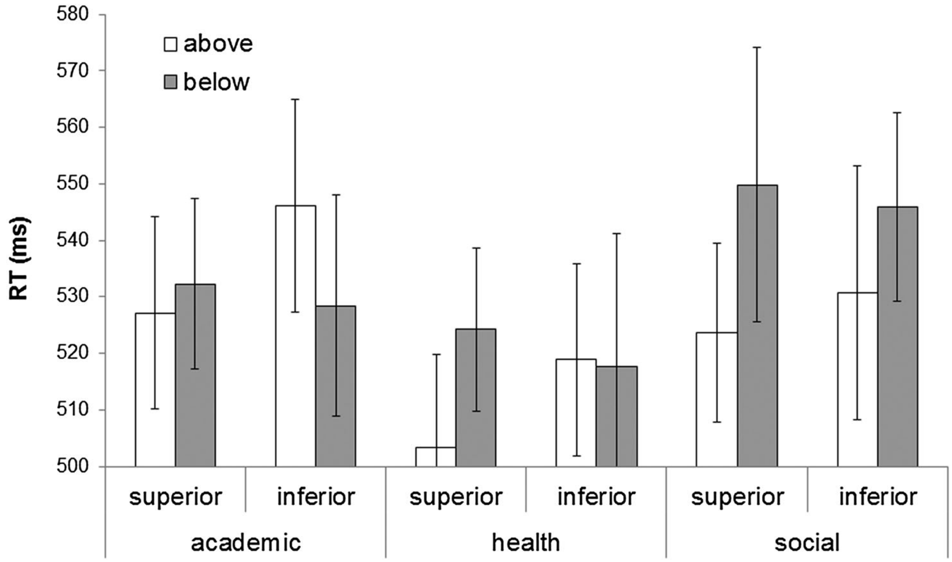

Figure 2. Response time data from Experiment 2 (name recognition task) graphed as a function of vignette category (academic, health, social), protagonist (superior vs. inferior) and name location (above vs. below). Error bars represent 95% within-subject confidence intervals.

the name, a target letter (X/O) was presented above or below fixation, such that the location of the visual target could be metaphorically compatible or incompatible with the metaphorical-spatial association with the protagonist. Thus, in this paradigm, name recognition and attentional orienting were aspects of two separate events. This has important consequences for performance, as when two consecutive cognitive events require the same feature, processing time is delayed relative to when the two events do not share any common feature.

We employed a cueing method in which the cue (event 1) and the target (event 2) can be spatially compatible, while they otherwise remain perceptually incompatible. Estes, Verges, and Adelman (2015) and Ostarek and Vigliocco (2017) have demonstrated that cue–target congruence can facilitate performance when there is both spatial and perceptual congruency between the two stimuli (e.g., "BIRD" followed by an image of a bird above fixation; "SKY" followed by an image of a cloud above fixation). Thus, if the two consecutive stimuli are sufficiently congruent across multiple dimensions, then the two stimuli can be represented as a single event and cue–target compatibility yields facilitation. By contrast, if the two stimuli are perceptually dissimilar (e.g., "BIRD" followed by the letter "X" or "O" above fixation), then spatial compatibility yields interference (Amer et al., 2017; Estes, Verges, & Adelman, 2015; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; Ostarek et al., in press; Ostarek & Vigliocco, 2017). That is because the cue–target dissimilarity prevents the two stimuli from being processed as a single event, and the partial compatibility of the two stimuli (i.e., a common feature) can interfere with performance. Such interference is consistent with the framework of the Theory of Event Coding (TEC; Hommel et al., 2001).

According to TEC, once the common feature is bound to the representation of the first event, it is temporarily unavailable for the processing of the second event. In the present experiment, the two events are (a) activation of a protagonist's mental representation and (b) spatial orienting for the identification of the target letter. The possible common features in the two events are the spatial codes, *up* and *down*. If both events require the same spatial feature, responses should be delayed relative to when the two events require different spatial features (Estes, Verges, & Adelman, 2015; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; Gozli & Pratt, 2011; Ostarek & Vigliocco, 2017; Richardson, Spivey, Barsalou, & McRae, 2003). Therefore, metaphorical compatibility should lead to interference (slower RT on compatible trials compared to incompatible trials).

Previous studies have demonstrated that the temporal delay (stimulus onset asynchrony; SOA) between the two event presentations can modulate the interaction between conceptual and spatial processing (e.g., Gozli et al., 2013a; Ostarek & Vigliocco, 2017). With implicitly spatial words, not associated with any context or referent (e.g., "HAPPY", "BIRD"), interference with visual discrimination can be observed with relatively shorter SOAs, about 300 ms (e.g., Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; see also, Bergen, Lindsay, Matlock, & Narayanan, 2007). In the present study we do not use concepts that have pre-existing spatial associations, and each name is associated with a context and referent that is learned during the study session. Thus, based on the relatively richer and more concrete associations with the names, we considered the possibility that an interference can be observed with relatively longer SOAs (600–1000 ms). If both the spatial codes (up/down) remain occupied by the simulation of their corresponding (superior/inferior) protagonist, then responses in the metaphorically compatible trials (superior + above) should be delayed relative to when the incompatible trials.

Method

Participants

Eighteen (seven male) undergraduate students at the University of Toronto gave informed consent and took part in this experiment in exchange for course credit. They all reported normal or corrected-to-normal vision, and they were all unaware of the purpose of the study.

Apparatus, stimuli and procedure

The apparatus and stimuli were identical to those in Experiment 2. In this experiment, however, after reading each vignette, participants performed 80 trials of a visual discrimination task. Each trial of this task began with the presentation of a fixation cross ("+"), which remained on display for 1000 ms. Next, one name replaced the fixation cross at the centre. After a delay (randomly selected from the interval between 600–1000 ms), a visual target (letter "X" or "O") was presented above or below the name (deviating by 4° of visual angle from the centre). Participants were instructed to respond to this visual target only if the central name belonged to the recently read vignette (using the "/" key for "X" and the "z" key for "O"). If the name did not belong to the vignette, they were instructed to withhold responding (catch trial).

Similar to Experiment 2, participants could receive three kinds of error feedback. If they responded within the first 100 ms following the onset of the name, they received anticipation-error feedback ("TOO QUICK!"). If they responded later than 1500 ms following the onset of the name, they received missed-trial feedback ("TOO LATE!"). In addition, if a participant responded on a catch trial, or if they responded with the wrong key on a test trial, they received a keypress-error feedback ("MISTAKE!"). All error feedback remained on display for 2000 ms.

Design

Similar to Experiment 2, each participant read three vignettes. Immediately after each vignette participants performed a name-recognition task, which included the two (test) names from the vignette and two new (catch) names. The appearance of the two name types were equally probable, resulting in a total of 120 test trials per participant (i.e., 40 test trials per vignette). Test trials were further equally divided into those including superior and inferior names. Target locations (above vs. below) were equiprobable and varied orthogonally to protagonist type (superior vs. inferior) and target letter ("X" vs. "O"). Participants were given a chance to take a short break before reading the next vignette.

Results and discussion

Accuracy was high on test trials (M ± SE = 94% ± 1%) and catch trials (99% ± .3%), with accuracy ranges of 77–98% and 97–100%, respectively, for test and catch trials. Catch trials were not analysed further. Before analysing the response times (RT) on test trials, incorrect responses and responses that fell 2.5 *SD* above or below the total mean (3.1% of trials) were excluded. From the remaining data, Mean RTs were submitted to a repeated-measures ANOVA, with vignette category (academic, health, social), protagonist type (superior vs. inferior) and visual target location (above vs. below) as factors ($\alpha = .05$). The findings are graphed in Figure 3. None of the main effects reached significance (for vignette category, protagonist type, and target location, respectively, $F[2,34] = .539$, $p = .59$, $\eta_p^2 = .031$, $F[1.17] = 2.381$, $p = .141$, $\eta_p^2 = .123$, and $F[1.17] = .307$, $p = .59$, $\eta_p^2 = .018$). The two-way interactions between vignette category and protagonist type ($F[2,34] = 1.07$, $p = .35$, $\eta_p^2 = .059$) and

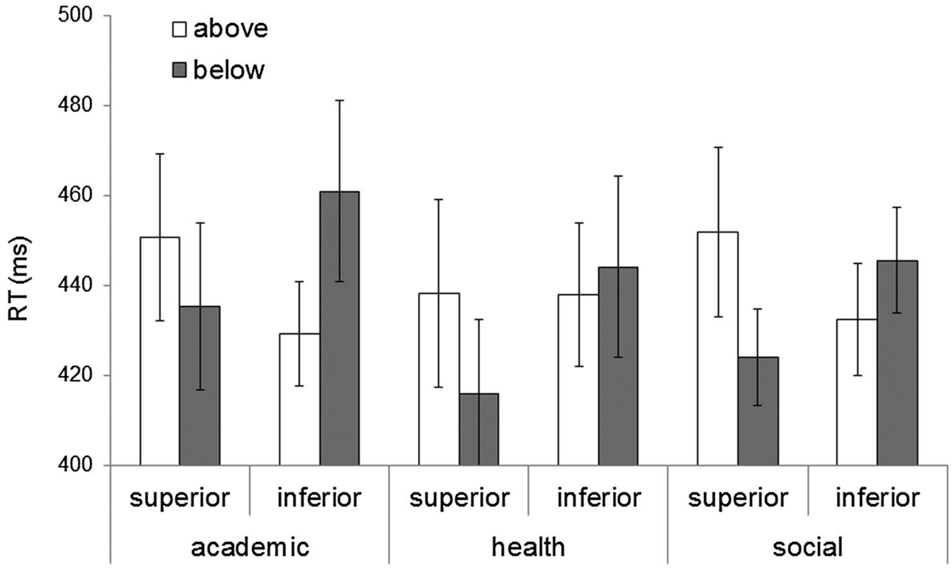

Figure 3. Response time (RT) data from Experiment 3 (visual discrimination task) graphed as a function of name type (superior vs. inferior) and visual target location (above vs. below). Error bars represent 95% within-subject confidence intervals.

between vignette category and target location also did not reach significance (F[2,34] = 1.74, p = .19, η_p^2 = .093). Most importantly, we found an interaction between protagonist type and target location (F[1,17] = 24.42, p < .001, η^2 = .590). Responses were slower when targets were presented at a metaphorically compatible location (448 ± 12 ms) compared to when they were presented at a metaphorically incompatible location (429 ± 11 ms, d_z = 1.22). The two-way interaction was present for both the superior protagonists (447 ± 11 ms vs. 425 ± 11 ms, respectively, for compatible and incompatible trials, d = 1.00, p < .001), and the inferior protagonists (450 ± 13 ms vs. 433 ± 12 ms, d = .62, p = .018), the implications of which will be discussed in considering alternative accounts in the General discussion. Finally, consistent with Experiment 2, the three-way interaction was far from statistical significance (F[2,34] = .274, p = .762, η_p^2 = .016).

Mean PEs were submitted to the same ANOVA, which did not reveal a significant two-way interaction between protagonist type and target location (F[1,17] = 2.64, p = .123, η_p^2 = .134). Matching the RT findings, mean PE was higher on compatible trials (7% ± 1%) than the incompatible trials (5% ± 1%). None of the other main effects or interactions reached statistical significance (F < 1.93, p > .16).

With regard to the temporal delay between the onset of the names and the onset of the visual targets, we should point out that previous research suggests that obtaining interference with overlearned stimuli (e.g., words referring to positive/negative valence or high/low power) requires short SOAs of around 300 ms (Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a). The necessity of short SOAs with known words suggests that there is a brief period in which the spatial features are required for processing the words (i.e., the period in which the same spatial feature cannot participate in representing another event). By contrast, we found interference with relatively longer SOAs (average of 800 ms), which suggests a relatively longer temporal interval in which the spatial feature is engaged by thinking about the protagonists.

Was the compatibility effect influenced by the cue–target SOA? To address this question, we categorized SOAs into "short" (600–800 ms) and "long" (800–1000 ms), then submitted the RT data to a repeated-measures ANOVA with cue–target spatial compatibility (compatible vs. incompatible) and cue–target SOA (short vs. long) as factors. This analysis found a main effect of compatibility (F[1,17] = 24.21, p < .001, η_p^2 = .588), a main effect of SOA, (F[1,17] = 30.32, p < .001, η_p^2 = .641), and a marginally significant interaction (F[1,17] = 4.19, p = .057, η_p^2 = .198). The main effect of SOA reflects slower responses with short cue–target delay (449 ± 11 ms) compared to long cue–target delay (429 ± 11 ms). The interaction reflects a relatively smaller compatibility effect with short cue–target delay (15 ms, $d_z = .81$) compared to long cue–target delay (24 ms, $d_z = 1.43$). Thus, unlike several previous studies that found a diminishing interference effect with longer cue processing time (e.g., Gozli et al., 2013a; Lachmair et al., 2016; Ostarek & Vigliocco, 2017; see Ostarek et al., in press), we found an effect that was – within the range of our experimental design – larger with increased cue processing time. One may attribute this observation to the relatively rich and long-lasting nature of mental simulations involved in thinking about the protagonists. Unlike tasks in which participants respond to single words, without a context in which those words acquire meaning, the cues in the present experiments are associated with relatively concrete contexts. The duration of time in which simulation of the context, in which the protagonists' status is meaningful, might very well outlast the duration of time necessary for recognizing the name as belonging to the preceding vignette. As such, the present findings point out that methods that rely on the presentation of overlearned, out-of-context words might underestimate the effect and duration of mental simulation that occur when our thinking is embedded within more realistic situations. Rather than the time-course of the interference effect, what was primarily important for us was the very fact that a visual interference *can* happen using the names referring to the superior/inferior protagonists. In Experiment 4, we attempted to test whether the interaction found in Experiment 3 was driven by interference on the metaphorically compatible trials.

Experiment 4

The findings of Experiment 3, i.e., faster responses on metaphorically incompatible trials, are consistent with two interpretations. According to the first interpretation, thinking about the protagonist activated the associated spatial metaphor (e.g., superior is up), which then interfered with discriminating a visual target at a compatible location. When the two sub-tasks (or two distinct events) require a common feature (e.g., spatial feature *up*), the second sub-task slows down because the shared feature is temporarily integrated in, and thus occupied by, the first sub-task (Hommel et al., 2001; for similar accounts see, Estes, Verges, & Adelman, 2015; Ostarek & Vigliocco, 2017). According to a second interpretation, thinking about the protagonist orients the participants toward the metaphorically incompatible location (e.g., orienting downward after thinking about a superior protagonist). This would also slow down responses at the metaphorically compatible location, as a result of a bias in favour of the incompatible location and not as a result of a simulation-driven interference. We favour the first interpretation, although both are logically possible. Experiment 4 is an attempt to distinguish the two interpretations.

If slower responses on compatible trials resulted from a spatial orienting toward the incompatible location, then this orienting would have generated a similar pattern of results for both a visual discrimination task and a visual detection task (e.g., Posner, 1980). On the other hand, if the slower responses on compatible trials resulted from interference at the compatible locations, i.e., difficulty in distinguishing the two possible targets, then the interference should be reduced or eliminated in a less demanding detection task, in which participants simply report the presence of a visual target (Gozli et al., 2013a, Experiment 3A). It is, indeed, possible that a simulation-driven interference would turn to a facilitation when we replace the discrimination task with a detection task or with identification of a visual target that fits into the simulation and thus resulting in the representation of a single event (Estes, Verges, & Adelman, 2015; Ostarek & Vigliocco, 2017; Ostarek et al., in press).

We used a similar procedure as Experiment 3 but replaced the visual discrimination task with a visual detection task. Participants now pressed one key (spacebar) when they detected the presence of a visual target (always the letter "O") above or below the centrally presented name. The kind of bias that could facilitate discrimination responses (at the incompatible location) is a general spatial bias that would continue to facilitate responses in a detection task. Therefore, if the findings of Experiment 3 resulted from spatial orienting toward the incompatible locations, the present modification is likely to replicate the effect. However, if the findings of Experiment 3 resulted from a simulation-driven interference at the compatible locations, such a bias would likely cease to interfere with performance if the target feature is irrelevant, i.e., in detection task. Therefore, if the compatibility effect in Experiment 3 resulted from interference at the compatible locations, then removing the necessity to discriminate the targets should reduce or eliminate the effect.

Method

Eighteen new undergraduate students participated in this control experiment. The experimental setup, procedure and design were identical to Experiment 3. We merely changed the visual discrimination task to a detection task, meaning that participants now pressed one key (spacebar) when they detected the presence of a visual target (always the letter "O") above or below the centrally presented name.

Results and discussion

Accuracy was high on test trials (M ± SE = 97% ± 1%) and catch trials (99% ± .2%), with accuracy ranges of 83–99% and 97–100%, respectively, for test and catch trials. Catch trials were not analysed further. Before analysing the RTs on test trials, incorrect responses and responses that fell 2.5 *SD* above or below the total mean (5.3% of trials) were excluded. Mean RTs were submitted to the repeated-measures ANOVA with vignette category (academic, health, social), protagonist type (superior vs. inferior) and visual target location (above vs. below) as factors ($\alpha = .05$, see Figure 4). The analysis revealed a main effect of protagonist type ($F[1,17] = 13.893$, $p = .002$, $\eta_p^2 = .304$), with faster responses after superior protagonists (M ± SE = 320 ± 11 ms), compared to inferior protagonists (M ± SE = 328 ± 11 ms). We found no main effect of target location ($F[1,17] = .429$), no interaction between protagonist type and target location ($F[1,17] = .022$), and no three-way interaction ($F[1,17] = .275$). Most important for our purpose was the absence of interaction between protagonist type and target location, performance was similar on compatible (322 ± 12 ms) and incompatible trials (323 ± 10 ms).

Given the null results in the present experiment, and given our aim to use these results in achieving a better understanding of the results of Experiment 3, we ought to include the two sets of data in one analysis (e.g., Nieuwenhuis, Forstmann, & Wagenmakers, 2011). The null findings of Experiment 4 would be more informative in light of a three-way statistical interaction between task (discrimination vs. detection), protagonist type (superior vs. inferior), and target location (above vs. below). Thus, we submitted the data to a 3 × 2×2 × 2 mixed ANOVA, with vignette category, protagonist type, target location as within-subject factors, and task as the between-subject factors. This analysis revealed a two-way interaction between protagonist type and target location, $F(1,34) = 9.042$, $p = .002$, $\eta_p^2 = .210$, which was qualified by a three-way interaction between protagonist type, target location, and task, $F(1, 34) = 10.38$, $p = .003$, $\eta_p^2 = .234$. Therefore, the analysis confirmed the difference in the compatibility effects across Experiments 3 and 4.

The findings do not favour a facilitation account (i.e., attentional orienting toward the incompatible location), because such a facilitation would persist with the visual detection task (Gozli et al., 2013a, Experiments 1A and 1B). Instead, the null effect in Experiment 4 suggests that the findings of Experiment 3 were more likely driven by a simulation-driven interference at the metaphorically compatible location. We would expect such an interference to be more robust in the case of the relatively more demanding discrimination task.

What about the possible role of cue–target SOA in modulating spatial compatibility? Same as Experiment 3, we submitted the RT data to a separate repeated-measures ANOVA, with cue–target compatibility and SOA ("short" [600–800 ms] vs. "long" [800–1000 ms]) as factors. This analysis revealed no main effect of compatibility ($F[1,17] < 1$), although it did reveal a main effect of SOA ($F[1,17] = 37.64$, $p < .001$, $\eta_p^2 = .689$). The two-way interaction did not reach significance ($F[1,17] = 2.69$, $p = .120$, $\eta_p^2 = .136$). The main effect of SOA reflects slower responses with short cue–target delay (337 ± 12 ms) compared to long cue–target delay (312 ± 10 ms). Numerically, the RT difference (incompatible – compatible) would be consistent with interference at short SOA (−6 ms, $d_z = .19$) and with facilitation at long SOA (9 ms, $d_z = .38$). Therefore, the results of Experiment 4 do not in any way indicate a bias in favour of the incompatible locations.

The dissimilarity of the results of Experiments 3 and 4 speak against another alternative account of Experiment 3, which is based on inhibition of return (IOR). An IOR account would propose participants initially orient to the compatible location and then inhibit it, leading to an advantage for the incompatible location

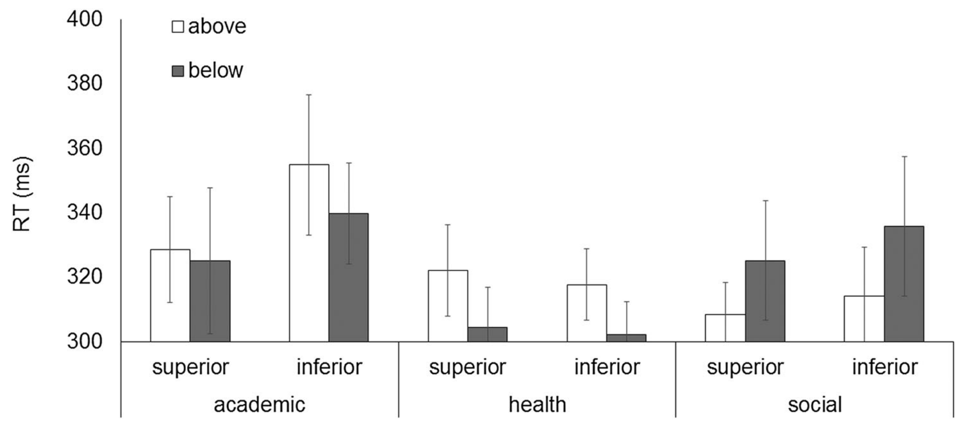

Figure 4. Response time (RT) data from Experiment 4 (visual detection task) graphed as a function of name type (superior vs. inferior) and visual target location (above vs. below). Error bars represent 95% within-subject confidence intervals.

(Klein, 2000). However, IOR would be expected in a detection task and, therefore, not finding it in Experiment 4 is an indication against IOR. In previous studies, short cue–target SOAs have yielded similar interference patterns (e.g., Estes, Verges, & Adelman, 2015; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a). Estes, Verges, and Barsalou (2008) directly tested and ruled out the IOR alternative. To the best of our knowledge, IOR has not been found with symbolic, uninformative cues. What is found is early interference, followed by late facilitation, consistent with the TEC (Hommel, 2004) prediction that the common feature required in processing the cue and the target leads to interference when the two events appear in close temporal proximity (Gozli et al., 2013a; Lachmair et al., 2016). The pattern of results from the SOA × Compatibility analysis (although not significant) would fit with a late facilitation effect, rather than IOR. Recent studies have provided further evidence in favour of the interference explanation, ruling out IOR as a viable alternative (Amer et al., 2017; Estes, Verges, & Adelman, 2015; Ostarek & Vigliocco, 2017).

General discussion

Our capacity to represent space grounds our understanding of many abstract concepts (e.g., Chasteen et al., 2010; Fischer et al., 2003; Meier & Robinson, 2004; Mills, Chasteen, Boychuk, & Pratt, 2018; Schubert, 2005; Taylor et al., 2015; Weger & Pratt, 2008). In the present study, we examined whether thinking about other people can also recruit the spatial metaphor of superior-is-up and inferior-is-down. Our participants read short vignettes, each introducing two protagonists (one doing well, one doing poorly). Each vignette was immediately followed by a task that involved name-recognition of the vignette protagonists and visuospatial orienting. Experiment 1 found that explicitly asking participants to assign locations to the protagonists resulted in a pattern consistent with the metaphorical association. Moving to implicit tests of the association, Experiment 2 involved recognition of names presented above or below fixation. In this task, activating a protagonist's mental representation and spatial orienting were components of a single task. In Experiment 3, spatial orienting and name-recognition were decoupled; name-recognition was performed at fixation and visual letter identification was performed above or below fixation. Metaphorical congruency led to facilitation and interference, respectively, in the first and second experiments. This represents an important extension of previous work, by showing that the contribution of spatial metaphors is not restricted to processing abstract concepts (e.g., "happy", "sad", etc.), but also when these concepts are being used to think about relatively more concrete situations.

The approach in the present study differs from previous work by virtue of examining how an existing metaphor is applied in a new situation, in this case thinking about other persons. Previous research has examined the effect of existing metaphors by directly evoking the association (e.g., Casasanto, 2009; Chasteen et al., 2010; Fischer et al., 2003; Marmolejo-Ramos et al., 2014; Meier & Robinson, 2004; Santiago et al., 2007; Sasaki et al., 2016; Schubert, 2005; Wang et al., 2016; Xie et al., 2014, 2015; Zhang et al., 2015). That is, if one domain is metaphorically understood in terms of a second domain, then activating the first domain can be expected to activate the second. Another approach has examined whether new metaphorical associations can be learned (e.g., Casasanto & Chrysikou, 2011; Dolscheid et al., 2013) and whether there are superordinate associative principles that determine which metaphorical associations can be learned (e.g., Casasanto, 2017). The present study did not examine learning a new metaphor, but the application of an existing metaphor (e.g., superior/inferior is up/down) in thinking about new persons.

Examining how an existing association can be extended to understanding a new person is useful in ruling out the purely linguistic account of the metaphorical congruency effect. Some authors have considered the possibility that, for instance, valence–space associations are grounded in the frequency with which the corresponding linguistic items co-occur (Goodhew et al., 2014). According to this view, the word "HAPPY" evokes its associates (e.g., up) because these associates tend to co-occur frequently in language (Skinner, 1977). The application of spatial metaphors in understanding other persons is relatively more difficult to explain with the linguistic account because the protagonist names do not have any intrinsic associations with spatial features above/below. We used each name equally often as a superior and an inferior protagonist across different participants. Participants in Experiments 2 and 3 were in no way encouraged to adopt a spatial metaphor in thinking about the protagonists. Therefore, the more likely explanation for the results is a spontaneous recruitment of the spatial metaphor as an aspect of thought, and not as an aspect of language (Casasanto, 2017).

In thinking about the protagonists, our participants might have thought in terms of several abstract concepts, such as valence, well-being, esteem or social status; valence and status are both known to recruit spatial metaphors (for studies on valence–space association, see Ansorge et al., 2013; Gozli et al., 2013b; Meier & Robinson, 2004; for studies on power–space association, see Giessner & Schubert, 2007; Schubert, 2005; Zanolie et al., 2012). In the present study, it was more important to demonstrate the application spatial metaphors in thinking about other persons, and not to dissociate the underlying concepts that might have resulted in activating the spatial metaphor (Gozli & Deng, 2018). Given the richness of everyday situations, which might very well be evoked as participants read the vignettes in our experiments, activation of a spatial feature might have coincided with several abstract concepts.

Polarity correspondence

We should consider an influential account of metaphorical compatibility effects, which is based on the general principle of polarity correspondence (Proctor & Cho, 2006; Proctor & Xiong, 2015). According to this principle, within each binary task set, one value is the default, salient or +polar value. In the up/down and left/right spatial dimensions, respectively, up and right are the +polar values. Selecting the +polar values together is more efficient than selecting the -polar values, and aligning the +polar values across task dimensions further benefits performance. Consistent with this logic, the source of metaphorical congruency effects is the +polar conceptual category (Lakens, 2012; Lynott & Coventry, 2014). In essence, the findings are generated because of the structure of the experimental task, independently of whether there is an inherently spatial component of the concepts.

There is, however, evidence suggesting that polarity correspondence is not the only explanation of the congruency effects. First, although it is relatively easy to account for the facilitation effects based on a task-induced polarity mapping, it is difficult to account for the interference found in Experiment 3 (also, Estes, Verges, & Adelman, 2015; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; Lachmair et al., 2016). Second, polarity correspondence makes similar predictions for the vertical and the horizontal domains, because both spatial domains can be represented in terms of polar values. Contrary to this account, the conceptual metaphors related to the vertical domain (e.g., valence, social status) have been shown to cause visual bias only in tasks involving vertical, and not horizontal, spatial orienting (Taylor et al., 2015; Xie, Huang, Wang, & Liu, 2015). Moreover, in a set of experiments, participants read positive/negative affect words and performed a left/right spatial orienting task while their eye movements were monitored (Gozli et al., 2013b). Even though the vertical domain was irrelevant to the task, the results showed that reading positive/negative words biased eye movement trajectories along the vertical space, inconsistent with polarity correspondence.

The polarity correspondence account implies that the effect should be driven primarily by the +polar conceptual category, as seen in Experiment 2 of the present study (Lakens, 2012; Lynott & Coventry, 2014). However, this was not the case in Experiment 3, where a compatibility effect was observed for inferior protagonists as well as the superior protagonists. In a similar cueing task, Xie et al. (2015) found that the dominance of the +polar values appears with relatively long cue–target delays. With relatively brief delays, both positive and negative concepts generated robust spatial bias in the metaphorically congruent direction (Xie et al., 2015). In addition, the P200 event-related potential was modulated by cue–target compatibility after both positive and negative concepts (Xie et al., 2014). These findings indicate that, at least in the cueing tasks, polarity correspondence is not the sole cause of the compatibility effect.

Another attempt to dissociate the polarity correspondence and the metaphorical association accounts involved manipulating the relative salience of response locations in a two-choice task by changing response location eccentricity (Santiago & Lakens, 2015). It was assumed that increasing eccentricity increases the salience of response location and, in turn, the more eccentric response location should be mapped onto the more salient conceptual feature (Proctor & Cho, 2006). However, the same congruency effects were found regardless of manipulating response location salience, suggesting that task-induced mapping between concepts and locations are not the only source of the compatibility effects (Santiago & Lakens, 2015; see also, Gozli, Pratt, Martin, & Chasteen, 2016).

Feature activation versus feature occupation

The findings of Experiment 3 are crucial in dissociating between two competing accounts of the metaphorical mapping effects. The first account assumes that the metaphorical association merely activates the spatial feature that corresponds to the protagonist (see, Girardi & Nico, 2017; Gozli et al., 2014; Lambert, Norris, Naikar, & Aitken, 2000). According to this account, the activation of the spatial feature is a by-product of thinking about the protagonist, and not an essential component of it. The second account assumes that the metaphorical association, in addition to activating the spatial feature, occupies the feature such that the feature is temporarily unavailable for processing other concurrent events (Hommel, 2004; Stoet & Hommel, 1999). According to this account, activation of the spatial feature becomes an integral aspect of thinking about the protagonist. The latter account uniquely predicts the pattern of interference found in experiments in which two distinct events are used to evoke and measure metaphorically induced bias (Estes, Verges, & Adelman, 2015; Estes, Verges, & Barsalou, 2008; Gozli et al., 2013a; Lachmair et al., 2016; Ostarek & Vigliocco, 2017), including the present Experiment 3. Most importantly, we show that the same logic (based on feature activation and occupation) can be employed in explaining both facilitation and interference.

Recently, Amer et al. (2017) directly tested a feature occupation account, which is derived from Theory of Event Coding (Hommel et al., 2001) and the theory of Perceptual Symbol Systems (Barsalou, 1999), against a simpler attentional orienting account of the spatial bias caused by concepts. While the orienting account can predict positive compatibility effects (facilitation), the TEC account makes specific predictions about when interference should be observed. First, if the cues are associated with non-spatial features, then processing the cues involves activation of other perceptual features that are not associated with the target. This leads to the prediction that implicit (e.g., "HAPPY", "BIRD", etc.) but not explicit (e.g., "ABOVE") cues more likely result in interference, which was obtained by the authors (Amer et al., 2017; also Estes, Verges, & Adelman, 2015; Ostarek & Vigliocco, 2017). Second, focused attention to the cue is more likely to result in synchronized activity of cue features (i.e., feature occupation), and thus more likely to result in negative cue–target compatibility effect. Consistent with this prediction, Amer et al. found interference with words that were selected and categorized by the participants, whereas they found facilitation with task-irrelevant words that appeared simultaneously with the task-relevant words and were ignored. Together with our Experiment 3, the findings provide strong evidence for an account that involves both feature activation and feature occupation.

Other considerations

Of potential relevance to the present study are the findings from social cognition, demonstrating that people form immediate evaluative impressions of others during the first encounter (Ambady & Rosenthal, 1993; Anderson & Sedikides, 1991; Gawronski & Quinn, 2013; Smith & DeCoster, 1998; Wyer, 2010). It is possible for these impressions to recruit spatial associations in the same manner that thinking about an abstract concept does. For instance, when learning about a person's superior status, an upward spatial feature might be recruited as part of the cognitive response to that person. Indeed, it has been recently suggested that comparing oneself to others can act as source of spatial bias (Liu, Tong, & Li, 2017). In specific performance domains it has been found that thinking about a famously skilful person, e.g., a well-known soccer player, can interfere with the participant's performance in the related sensorimotor domain, e.g., performing foot responses (Bach & Tipper, 2006; Sinnett, Hodges, Chua, & Kingstone, 2011). These observations are consistent both with the common mechanisms responsible for action and understanding, and with a possible role for social-comparison and self-evaluation in sensorimotor priming.

The literature on social comparison suggests that individuals spontaneously compare themselves with others in superior or inferior positions and that these comparisons might involve activating spatial metaphors such as better-is-above or worse-is-below (Lockwood & Kunda, 1997; Mussweiler, Rüter, & Epstude, 2004a; Wood, 1989). Categorizing individuals as above/superior or below/inferior, relative to the self, seems to occur automatically (Gilbert, Giesler, & Morris, 1995; Mussweiler, Rüter, & Epstude, 2004b; Ruys, Spears, Gordijn, & de Vries, 2007). In the present study, we did not test for the occurrence of social evaluation or social comparison, and thus we cannot make the claim that our results are driven by cognitive processes that are uniquely social. Rather, our aim was to examine whether thinking about people in superior/inferior states would spontaneously recruit spatial associations in a manner similar to the processing of abstract concepts (e.g., Gozli et al., 2013a). Testing a more direct relation between social processes (e.g., social comparison) and spatial metaphors, therefore, is a target for future investigation.

A related question concerns the potential function of spatial metaphors in social processes. Does forming spatial association (e.g., superior-up) serve a function in social cognition? Perhaps such an association can facilitate making distinctions among people, remembering them, placing them within an existing framework/hierarchy, or making probabilistic inferences about them. This interesting question awaits further research, as the present study does speak to this issue (see also, Landau, Meier, & Keefer, 2010).

One might point out possible confounds in generating the spatial bias, including the physical location of names within the vignette displays. Although in one of the three vignettes (academic) the location of the names on the display matched the metaphorical association (i.e., average vertical deviations for superior and inferior protagonists were, respectively, +5 and −1 cm, the negative value signifying a location below the horizontal midline), the average vertical deviations for the names of the two protagonists in the health-related vignette were both equal to zero. For the social-life vignette, the average vertical deviations were both positive, roughly about 2.5 cm above the horizontal midline. Not finding three-way interactions in Experiments 2 and 3 rules out the possibility that the physical location of names within the vignette displays (even in the case of the academic vignette) drove the implicit spatial bias. With regard to the findings of Experiment 1 (explicit assignment of locations to protagonists), we cannot rule out the possibility that the physical location of names added to, or interacted with, the effect of metaphorical spatial mapping, given that the spatial bias was larger for the protagonists in the academic vignette. Indeed, it is possible that the interaction between vignette type and the spatial bias (observed only in Experiment 1) might reflect a role of other factors (physical location of the name) and/or be the outcome of the explicit nature of the spatial assignment task. Regardless, given that spatial biases in the same directions were present for all three vignettes leads us to argue for a unique contribution of metaphorical mapping.

Similarly, the order and frequency of presentation for the two names was switched across the vignettes: for the academic and social vignettes, the superior protagonist was introduced first and was mentioned more frequently (four times) than the inferior protagonist (three times). However, for the health-related vignette, the order was reversed, with the inferior protagonist being introduced first and being mentioned more frequently (four times) than the inferior protagonist (three times). In short, physical location, order of presentation or frequency of presentation do not seem to be viable alternatives as sources of spatial bias.

Conclusion

The present study also represents an attempt to bridge the two research domains of sensorimotor grounding of concepts and social cognition. Future directions might include measures of individual differences in the use of spatial metaphors. As suggested by Moeller et al. (Moeller, Robinson, & Zabelina, 2008; Robinson, Zabelina, Ode, & Moeller, 2008), individual differences in personality might express themselves in our representation of space. Compared to non-dominant individuals, dominant individuals might have a stronger representation of the vertical spatial domain (Moeller et al., 2008) and, in particular, an upward bias in spatial representation. Similarly, affective tendencies have been shown to correlate with spatial bias along the vertical domain. Correlation between high scores on neuroticism and depression, on the one hand, and a spatial downward bias, on the other hand, further supports expression of individual differences in sensorimotor tendencies (Meier & Robinson, 2006).

In sum, the present study found spontaneous recruitment of spatial metaphors in mental representations of novel individuals, inferred through variations in visuospatial orienting. The essential role of space in our conceptual thought is striking and provides compelling evidence for the continuity of mind across lower- and higher-cognition.

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Appendix 1

Vignette 1: academic scholarships or academic probation?

It's no secret that many students find their first year at U of T to be a challenge academically. The transition from high school is, for many, a shock. Students face unfamiliar course material, new methods of evaluation, and professors with expectations that far exceed those of many high school teachers. Most are used to high school classes with fewer than 20 students. Suddenly, they find themselves sitting in PSY100 with 1500 other students, in a room that is more like a theatre than a classroom. In an effort to understand more about why some students succeed and others fail, the Faculty of Arts and Science has recently commissioned a study to examine the factors that determine academic success and well-being at U of T. To get a student perspective on what life is like in first year, The Varsity conducted our own impromptu study: We chatted with a group of PSY100 students as they exited Convocation Hall, the largest first year classroom in Canada.

Mark, who is just finishing his first year in Arts and Science, noted that although there were challenges, he generally found the experience to be very positive. "I wasn't used to multiple choice exams," he observed, "but I don't mind them at all now. I have a 97% in my PSY100 class, and I've been able to get high A's in everything else. Overall, I'd say I had a great year academically. I won a first year scholarship and two other awards for academic achievement based on my grades. I've also been able to make lots of new friends and get involved in some really cool extracurricular activities."

Not everyone, however, is as successful as Mark. Some students find the transition to be extremely tough. Paul, who is also close to completing his first year, notes, "I just couldn't keep up with the readings. I saw my marks dropping to the point where I ended up on academic probation. PSY100 is the worst – I ended up with a 45% after the midterm. I'm worried that if my grades get any lower I'm going to get kicked out of U of T. It has been a terrible year academically." Paul also spoke of his disappointment in how he was coping at U of T more generally. "I've found it really difficult to meet people here, and I don't have many friends. Extracurricular stuff? No time for that!"

What determines who ends up as a success story, like Mark, and who ends up facing failure, like Paul? As one academic advisor noted, "We need to understand why students like Mark win scholarships, and students like Paul face academic probation."

Vignette 2: healthy living or fries on the couch?

Although the Arts and Science study was commissioned primarily to examine academic success, the study organizers recognized the importance of considering factors beyond grades. If students are to be academically successful, they also need to maintain a healthy lifestyle, with a nutritious diet and regular exercise. Some students, however, find it difficult to keep their health in mind while at the same time staying focused on their studies. Whereas students in high school often take phys. ed. as part of their programme, and have access to a wide variety of sports teams and activities, students in university must carve out the time for exercise in their busy schedules. Further, students who were used to eating healthy meals prepared by parents are suddenly faced with the task of putting together a healthy diet from a mix of fast food and cafeteria options on campus. First year students shared their thoughts with us on the challenges of staying healthy at U of T.

"It's really difficult to find time to work out," noted Dave, in his first year of Arts and Science. "I like to exercise, but I just never have the time. I was in pretty good shape in high school, but now I'm putting on the pounds. I spend lots of time sitting in the library studying, and I guess I also drink a fair amount of beer on weekends. I should probably get out more, but I just can't seem to get motivated anymore. It doesn't help that there's all this fast food everywhere. It's a lot easier to get some fries from a truck outside Sid Smith than it is to go home and make a salad." Dave, who notes that he has gained ten pounds since starting his first year, is having difficulty balancing school with a healthy lifestyle.

Other students, however, describe more positive experiences. John, for example, has taken up new activities since starting at U of T: "I really like the Athletic Centre," he commented. "It's so convenient – I can work out between classes or before I head home at night. And there are so many sports activities that I can get involved in. I feel like I'm in better shape than I've ever been in before." When asked how he copes with the challenge of healthy eating, John observes, "Well, I just stay away from the fast food. There are stir fries and salads available everywhere now. There's no reason to eat garbage all the time, when there are so many healthy options available."

As part of the first year life experiences study, the Faculty of Arts and Science will be looking at how students like Dave end up adopting an unhealthy lifestyle, and how students like John manage to incorporate healthy eating and exercise activities into their daily lives. The study will try to determine why someone like Dave ends up as a couch potato, and someone like John ends up healthier than ever.

Vignette 3: social network or social Siberia?

In the final phase of the first year life experience study, Arts and Science will be examining social factors contributing to the student experience. As one academic advisor commented, "It's not just about making sure that students are maintaining good grades and eating well. We also want to understand what contributes to their overall social experience. Some students really enjoy it here, some just don't."

We asked our PSY100 group to tell us about their lives outside school, and how they are faring socially in their first year at U of T.

Jeff, a charismatic and extraverted PSY100 student was happy to discuss his experiences. "I really like it here. I've made lots of friends and my roommates are great. I look forward to hanging out with friends on weekends, and it's great how easy it is to meet people here." Jeff observed that for him, the transition to U of T was not difficult in term of his social life. "I really enjoy meeting new people. I like to spend time with my old friends, but I've also really enjoyed having the opportunity to connect with another group of people. My girlfriend is great, and we really enjoy spending time together and with each other's friends. I would say that I have found U of T to be a fantastic social experience."

Although Jeff enjoys a busy and fun social life, not all students have such a positive experience. Brad has worked hard at making new friends at U of T, but he says he still spends much of his time alone. "I'm a little shy," he notes, "and that may be why I find it harder to connect with people. I don't see my old friends much, and I haven't really made any new friends here." When asked about his perceptions of social life at U of T, Brad commented, "I find it to be very isolating here. I don't really have anyone to hang out with on weekends, and I don't have a girlfriend, so I'm by myself most of the time. It kind of sucks, actually." Brad's difficulty in making social contacts has made his first year a very difficult one.

The Faculty of Arts and Science notes that the contrast between the very positive social experience of students like Jeff, and the very negative social experience of students like Brad, is one of the key reasons they believe their study of first year life is so important. If students can develop a more supportive social network, not only will they be happier, they will also perform better academically.

Study results are expected to be published in July 2012.

Appendix 2

Names used in the experiments

Vignette topic	Female (test)	Female (catch)	Male (test)	Male (catch)
Academic	Emma, Laura	Kate, Beth	Paul, Mark	Alex, Dave
Health	Nicole, Jessica	Nancy, Jennifer	Dave, John	Tim, James
Social	Emily, Amy	Abby, Jane	Brad, Jeff	Eric, Jack