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ORIGINAL ARTICLE

The embodiment of power as upward/downward movement in Chinese-English bilinguals

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Abstract
Using an action compatibility task, we investigated whether POWER is embodied in terms of upward and downward movement in two languages (first and dominant language: Chinese; second language: English). Chinese-English bilinguals were asked to quickly and accurately categorize power-related words (e.g., "boss," "intern") as "powerful" or "powerless." The response to indicate that the word was "powerful" required an upward movement in the compatible condition, while the response to indicate "powerless" involved a downward movement. These responses were reversed in the incompatible condition ("powerful"-downward/"powerless"-upward). When the response actions were compatible rather than incompatible, participants were faster to categorize the words. Furthermore, the action compatibility effect was observed in both languages, but surprisingly the action compatibility effect was larger in their L2. The findings support the psychological reality of the "POWER IS UP" conceptual metaphor that is active when participants process language in both their primary and secondary languages.

Keywords: bilingualism; power metaphor; upward/downward movement

The embodiment of power as upward/downward movement in Chinese-English bilinguals

According to embodiment theories, concepts are represented in our physical experiences while interacting with the environment (Barsalou, 1999; Gibbs, 2005). Embodiment theories, in contrast to amodal theories of concepts, posit that concepts are represented modally and rely on the reactivation of subsets of neurons that were active when the concept was first perceived and interacted with (Barsalou, 1999). During language processing, there is an occurrence of sensory-motor simulation (Kiefer & Pulvermuller, 2012). The activation of effector-specific motor regions occurs during action word processing, even in situations of passive reading (Hauk, Johnsrude, & Pulvermuller, 2004). The processing of concepts leads to the

engagement of brain areas associated with the corresponding actions or perceptions (e.g., Gonzalez et al., 2006; Kiefer et al., 2008).

Abstract concepts have been characterized as mental representations denoting entities that are neither exclusively physical nor spatially constrained (Barsalou & Wiemer-Hastings, 2005; see also Borghi et al., 2022). Because abstract concepts are not directly experienced via our body's perception and action systems, cross-domain metaphorical mappings to tangible domains are frequently used to express them (Barsalou, 2008; Lakoff & Johnson, 1980; Gibbs, 2005). For instance, idioms like "It's important how you package your ideas" and "That idea just won't sell" demonstrate that IDEAS are frequently understood in terms of embodied experiences of COMMODITIES. Cross-domain mappings, commonly referred to as "conceptual metaphors" (Gibbs, 2017; Lakoff & Johnson, 1980; Lakoff, 2006; McGlone, 2007; Yang et al., 2021; Yu et al., 2016), are assumed to emerge from shared features within individuals' life experiences. For instance, the embodied experience of VERTICALITY becomes fundamental to the abstract concept of morality, allowing people to think and talk about it in terms of something concrete and directly perceived, as evidenced in expressions such as "he has the moral high ground" or "she has fallen into moral depravity." This phenomenon of cross-domain mappings has been studied in the field of cognitive linguistics. For example, a behavioral experiment by Meier et al. (2007) observed that participants categorized moral words faster when paired with upward asterisks, and categorized immoral words faster when paired with downward asterisks, suggesting that individuals implicitly associate moral concepts with vertical space.

Conceptual metaphors are a hot research topic in cognitive linguistics (see Gibbs, 2017, for a recent summary of the empirical evidence for and against conceptual metaphors). Among them, ontological conceptual metaphors and orientational conceptual metaphors are two common types (Lakoff & Johnson, 1980). Ontological metaphors involve projecting entity or substance status onto concepts that do not inherently possess those attributes (Lakoff & Johnson, 1980). A common example is the metaphor "Thinking is a machine," which maps the ontological properties of machines, such as varying levels of performance, wear and corrosion, and fuel consumption, onto the abstract domain of thinking. Orientational metaphors, on the other hand, map abstract concepts onto concrete spatial domains (Lakoff & Johnson, 1980). For instance, orientational metaphors structure concepts in terms of vertical orientation (MORE IS UP, FUTURE IS FORWARD) or movement through space (SUCCESS IS MOVING FORWARD). In addition, direction and movement through space are fundamental bodily experiences (Forceville & Jeulink, 2011; Johnson, 1987; Gibbs, 2005). Typically with such metaphors, there is a correlation in the environment between the abstract and spatial domains. For instance, movement through space is typically goal-oriented, with some destination the mover is intending to reach. Moving forward is correlated with getting closer to this destination, so there is also a direct connection between forward movement and success in the environment (Robinson & Fetterman, 2015; Yang et al., 2021).

In experimental psychological studies, it has been observed that responses are facilitated when a response action is congruent with the embodied representation of

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a concept being classified, which is referred to as the "action compatibility effect." For instance, in a study by Glenberg and Kaschack (2002), participants were required to evaluate the sensibility of sentences through a response that involved a bodily movement either toward or away from themselves. The participants encountered challenges in making sensibility judgments when a sentence suggested an action in a specific direction (e.g., "Close the drawer" implying movement away from the body) that conflicted with the required response (e.g., in this case, a movement toward the body). This suggests that the cognitive processing of action-related language is grounded in the sensorimotor system, with the activation of specific motor representations facilitating the comprehension of the described actions (Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006). The action compatibility effect occurs only when individuals have the chance to organize their motor reaction while processing the statement (Borreggine & Kaschak, 2006). Importantly, the same effect occurs when phrases describe actions that are more abstract, such as "Marie told you the story" and "You told Marie the story." Despite the fact that Borreggine and Kaschak did not interpret the findings in terms of Conceptual Metaphor Theory, this finding with abstract actions supports the psychological reality of the "CONDUIT" metaphor (Lakoff & Johnson, 1980; Reddy, 1979), as participants were shown to conceptualize abstract communication in terms of physical transference. The "CONDUIT" metaphor conceptualizes ideas or meanings as physical objects that are "sent" or "transferred" from a speaker to a listener. For example, common expressions like "She gave me that idea," "His words didn't get through to me," or "I can't get my point across" all reflect the "CONDUIT" metaphor, where communication is understood as the movement of objects (ideas, meanings) through a conduit (language) from one person to another (Lakoff & Johnson, 1980). The finding that the "CONDUIT" metaphor influences performance on action compatibility tasks provides empirical support for the view that abstract communicative processes are understood through mappings to sensorimotor experience.

In previous research, Yang et al. (2021) examined the manifestation of POWER as forward or backward movement using action compatibility tasks with both Chinese and English native speakers. Because individuals with social power have greater access to resources, they have a greater potential to influence others through incentives and punishments (Galinsky et al., 2003; Keltner et al., 2003), and therefore, social power affords greater flexibility and means to pursue objectives. Consistent with this, research has shown that when people are made to feel strong, they are more inclined to participate in goal-directed activity (Galinsky et al., 2003; Keltner et al., 2003; Smith & Bargh, 2008). According to conceptual metaphor theory, goal-directed activity is conceptualized in terms of the SOURCE-PATH-GOAL schema, which structures goal-directed behavior in terms of a starting point, a path, and a destination (Forceville & Jeulink, 2011; Gibbs, 2005; Johnson, 1987). As such, pursuit of one's goals is conceptualized as forward movement toward that goal. Based on this, Yang et al. (2021) hypothesized that because POWER facilitates goal-directed behavior, and because goal-directed behavior is fundamentally tied to forward movement, there may be a conceptual connection between POWER and forward movement. This hypothesis was empirically supported as an action

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compatibility effect was observed between POWER and FORWARD MOVEMENT and between POWERLESSNESS and BACKWARD MOVEMENT for both English speakers categorizing English words and Mandarin speakers categorizing Chinese words. The results therefore supported the psychological reality of a "POWER IS MOVING FORWARD" conceptual metaphor, and furthermore, the action compatibility effect was observed in both the Chinese and English speakers, suggesting the metaphor exists in both cultures. Importantly, this research also demonstrates that the action compatibility task may be used to explicitly investigate the psychological reality of conceptual metaphors.

In the current study, we used the action compatibility task to examine the activation of a generic primary conceptual metaphor, "POWER IS UP," in Chinese-English bilinguals' primary and secondary languages. The "POWER IS UP" conceptual metaphor is a widely used and conventional way of conceptualizing power in Chinese and a large body of linguistic and psychological research suggests that powerfulness is associated with "up," whereas powerlessness is associated with "down" (Schubert, 2005; Giessner & Schubert, 2007; Lakens et al., 2011; Winter et al., 2020). The English expressions "I have power *over* the situation," "He *oversees* multiple employees," and "they are *under* her supervision" all exemplify the POWER IS UP conceptual metaphor (Lan, 2000; Lakoff & Johnson, 1980). In Chinese, people are elected to a higher power position through "提拔" (English translation equivalent: promote; the first character "提" is related to upward movement in Chinese), and when a demotion occurs, Chinese people often refer to this as "落马" (English translation equivalent: downfall; the first character "落" is related to downward movement in Chinese). When people lack a position of power, they are sometimes described as being at the "bottom" of society or being a member of the "lower" class, with lack of opportunities to "climb" the social ladder. Conversely, when people have more resources, they are often described as "upper" class. All in all, linguistic evidence suggests that discussions of POWER frequently incorporate metaphors related to UPWARD and DOWNWARD movement.

The connection between POWER and UPWARD movement has been demonstrated in multiple psychological studies as well. In English, the link between power and verticality was demonstrated by Schubert (2005) who employed a power detection task[1] in which participants were asked to detect the more powerful or less powerful word in a pair of words (e.g., professor-student). He discovered that when the powerful word was placed on the top of the computer screen, participants were faster to identify it, and when the powerless word was presented on the bottom of the computer screen, participants were faster to identify it. Zanolie et al. (2012) used an event-related potential (ERP) task in which participants first rated whether a target word was powerful or powerless, and then a letter was presented in either the top or bottom region of the screen. As rapidly as possible, the participant was asked to indicate which letter was presented. In the compatible condition, a powerful word was followed by a letter displayed at the top of the screen and a powerless word was followed by a letter displayed at the bottom of the screen; the matching was reversed in the incompatible condition (powerful—bottom position/ powerless—top position). N1 amplitudes, a component associated with distinguishing between targets at an attended location, were shown to be larger in the compatible condition than in the incompatible condition. This finding

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suggests that words associated with power increased attention in a way that corresponds to the UP and DOWN conceptual representations of POWER and POWERLESSNESS.

The relationship between verticality and power is also expressed visually in film, for instance, when powerful villains are seen from low-angle shots to make them appear taller, or when high-angle shots, which make actors appear smaller, are employed to depict characters losing control (Winter et al., 2020). As such, the metaphorical link between power and verticality is evident in a variety of domains and has been demonstrated empirically in linguistic, behavioral and neuroimaging research. However, these studies did not examine whether there is a compatibility effect between motor responses and the UP/DOWN conceptualization of POWER, nor did they compare the influence of this conceptual metaphor in bilinguals' first and second languages.

The current study aimed to test whether this embodied representation of power is consistent across languages, as well as whether there is a vertical action compatibility effect in general. Power and authority are viewed very differently in Chinese and Western societies (Bond & Hwang, 1986; Hofstede, 1980; Shi & Wang, 2011). Chinese people, in comparison to Westerners, are more tolerant of power imbalances (Hofstede, 1980; Shi & Wang, 2011), have a more idealistic view of those in positions of leadership and authority (Pye, 1985; Spencer-Oatey, 1997), and may have stronger social norms for treating those higher and lower in the social hierarchy (Bond & Hwang, 1986). The Chinese culture's focus on hierarchical relationships may result in more salient vertical representations of POWER (Lan, 2000; Lakoff & Johnson, 1980; Schubert, 2005; Yang et al., 2021; Zanolie et al., 2012). In corpora analyses, Lan (2000) discovered that in Chinese, a higher percentage of UP/DOWN occurrences are connected with SOCIAL HIERARCHY than in English. This suggests that the connection between verticality and POWER may be stronger in the Chinese language, and therefore, there may be a larger vertical action compatibility effect when the task is conducted with Chinese rather than English words. Therefore, in this study, we chose to recruit Chinese-English unbalanced bilingual participants who learned both languages while growing up in the People's Republic of China to complete the action compatibility task in both their first and dominant language (Chinese) and in their second language (English). This allowed us to compare how strongly vertical representations are activated when participants process words related to power in both languages.

Metaphor processing may also vary across L1 and L2, especially when bilinguals are less familiar with the metaphorical meanings of words in their L2. According to the Graded Salience Hypothesis, both literal and figurative language comprehension depend upon salience, with more salient meanings (figurative or literal) being processed first (Giora, 1997). This stands in contrast to traditional theories of metaphor where it was assumed that literal meaning is always activated first, and metaphorical meaning is only activated if no adequate literal interpretations are found (Grice, 1975; Searle, 1979). According to the Graded Salience Hypothesis, for a conventional idiom like "spill the beans," the metaphorical meaning of *revealing a secret* is likely processed first not because of a literal/figurative distinction, but because this is the salient meaning associated with this phrase. Word frequency, familiarity, conventionality, and prototypicality are all characteristics that

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determine salient meanings. Non-salient meanings, on the other hand, are less often used, less recognizable, and require longer to activate, necessitating extra-inferential procedures (Giora, 2003). Although the graded salience hypothesis is not a theory of bilingual language processing, it implies that bilingual characteristics may impact metaphor understanding in bilinguals. Specifically, factors like language proficiency and language dominance could influence the relative salience of different meanings, including metaphorical ones, across a bilingual's two language systems. For example, for the English metaphorical expression "spill the beans," if a bilingual individual is more dominant in English, the metaphorical meaning of "reveal a secret" may be more salient and readily accessible compared to the literal meaning. However, the situation could be reversed if English is their secondary language, and the literal meaning may be more prominent. Furthermore, the overall language proficiency level of bilinguals may also impact their metaphor understanding. Bilinguals with stronger language skills are likely better able to inhibit the activation of literal meanings and more quickly activate the intended metaphorical meanings. In contrast, those with weaker language abilities may be more easily constrained by the salience of the literal interpretations. As a result, the literal meaning of a conventional metaphor expression may be more salient in L2, especially when the individual is less fluent in their L2, and metaphorical meanings may only become salient when the individual becomes more fluent and experienced in this language (e.g., Heredia & Muñoz, 2015). Consistent with this, the literal-salience resonant model (Cieślicka, 2006; 2015) proposes that when bilinguals interpret idioms in their L2, the literal meanings of the idioms' elements are more prominent than their figurative meanings.

Although the above research suggests that there may be differences in processing metaphorical expressions between L1 and L2, to our knowledge, less research has directly compared the activation of conceptual metaphors in L1 and L2. Recently, Yang et al. (2023) directly compared the activation of conceptual metaphors in Chinese-English bilinguals' first and second languages. They found that reading expressions based on the same underlying conceptual metaphor led participants to falsely recognize other expressions based on the same mapping, suggesting that the underlying conceptual metaphor mapping was activated during reading (see Reid & Katz, 2018, 2022, for further discussion of this task). Interestingly, the same effect occurred in both Chinese and English, and after statistically correcting for multiple comparisons, Yang et al. found that the percentage of false recognition for metaphorically consistent expressions was comparable across the two languages. The major difference between languages was that participants falsely recognized more *literal* sentences related to the SOURCE domain of the conceptual metaphors. That is, reading a list of TIME IS MONEY metaphorical expressions caused participants to falsely recognize literal statements about MONEY, but only in L2. This suggests that while conceptual metaphor activation occurs in both L1 and L2 to about the same extent, literal meanings are also activated in L2 (consistent with the graded salience hypothesis). However, this task depended on processing metaphorical expressions and did not test for non-linguistic activation of conceptual metaphors in L1 and L2 (see Gibbs, 2011; McGlone, 2011). Therefore, in the current study, we examined whether the POWER IS UP conceptual metaphor facilitates motoric responses in a way that is consistent with this conceptual mapping.

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The current study

In the current study, using an action compatibility task, we investigated whether POWER and POWERLESSNESS are associated with upward and downward movement, respectively. Participants were given words from their native and second language that were either associated with powerfulness (e.g., "boss") or powerlessness (e.g., "intern") and were asked to classify each word as "powerful" or "powerless." The response actions were either compatible, in which case the response for "powerful" words involved an upward movement and the response for "powerless" words involved a downward movement, or incompatible, in which case these response movements were reversed ("powerful"-downward; "powerless"-upward). All participants completed the action compatibility task in both Chinese and English, with the only difference being the language. As such, this study allows a comparison of embodied representation during first language (L1) and second language (L2) reading. We hypothesize that when the response actions are compatible, participants will classify the power-related words more quickly. In general, we predict similar action compatibility effects for both the Chinese and English power words based on our previous research indicating that conceptual metaphor activation occurs in both L1 and L2 (Yang et al., 2023). However, we also considered the possibility that the action compatibility effect may be stronger in participants' first language, Chinese, especially if the connection between verticality and POWER is more salient in this language due to the emphasis on hierarchical relationships in Chinese culture (Yang et al., 2021; Lan, 2000).

Method

Participants

Forty Chinese-English unbalanced bilinguals from Zhejiang Gongshang University participated in this experiment in return for receiving 1 volunteer service hour. All participants reported that they were proficient in reading Simplified Chinese as well as reading lowercase English words and that Chinese was their first and dominant language whereas English was their second language. All participants were born in China and were living in China at the time of the experiment. All participants also learned Chinese first, followed by English, and their main language at the time of the experiment was Chinese. Their mean age was 20 years ($SD = 0.96$). Three participants had passed the Test for English Majors-Band 4 (TEM 4), 11 participants had completed the College English Test Band 6 (CET 6) with a mean score of 575, and 26 participants had completed the College English Test Band 4 (CET 4) with a mean score of 577. Participants' self-ratings of the percentage of the day spent using each language, and their self-rated skill in each language (from 1 = none to 10 = very fluent) are presented in Table 1. All participants had normal or corrected-to-normal vision and no reading disorders.

Materials. A total of 72 Chinese words and 60 English words were used, half of which were rated as "powerful words" and half of which were rated as "powerless words." These words were also used by Yang et al. (2021), who had a group of volunteers rate the power and familiarity of the words using a 7-point scale. The ratings ensured that the power level difference between the categories of

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Table 1. Language experience for Chinese-English bilingual participants

	Chinese	English
% of each language usage in daily activities		
Daily usage	73.35	21.85
Self-rating of current skill (out of 10)		
Understanding	9.10	7.55
Speaking	8.85	6.35
Reading	8.88	7.33
Writing	8.25	6.65

"high-power words" and "low-power words" was maximized, while also ensuring that participants had the same level of familiarity with the words in both categories.

According to Yang et al.'s (2021) norming results, for Chinese words, the average power level of powerful words ($M = 5.89$) was significantly greater than that of powerless words ($M = 2.38$), $t(70) = 28.18$, $p < .001$. In contrast, there was no difference between the two types of words in terms of familiarity (5.7 vs. 5.83 for powerful and powerless words, respectively), $t(70) = -1.15$, $p = .253$. Similarly, for English words, the average power level of powerful words ($M = 5.7$) was significantly greater than that of powerless words ($M = 2.42$), $t(58) = 19.61$, $p < .001$, but there was no difference in familiarity scores (5.45 vs. 5.29), $t(58) = 0.7$, $p = .485$. Stimuli selection followed established procedures from previous metaphor research (Schubert, 2005; Yang et al., 2015; Tang & Ye, 2015). Chinese words were selected mainly from prior Chinese research (Yang et al., 2015; Yang et al., 2021), while English stimuli originated primarily from earlier English studies (Schubert, 2005; Zanolie et al., 2012). The stimuli selection procedure aimed to identify the most representative powerful and powerless concepts in each language.

Procedure. A 2 (Language: Chinese vs. English) by 2 (Compatibility: compatible vs. incompatible) by 2 (Power Level: powerful vs. powerless) design was employed with all three variables being within-subject variables. After the participants arrived in the laboratory, the experimental operator instructed the participants to read the letter of information placed on the table and verbal consent was obtained from all participants before the start of the experiment.

Participants were instructed to classify words presented on the computer screen as either "powerful" or "powerless" as fast and precisely as possible. The dependent variable was response time, which was how quickly the participant classified the word, but only from responses that were correct. The experiment was conducted on computers using the E-Prime software package (Psychology Software Tools, Pittsburgh, PA; see Schneider et al., 2001). Response times were recorded using a Thrustmaster® USB joystick (see Yang et al., 2021; Robinson & Fetterman, 2015).

Prior to the main experiment, all participants completed a short practice session to familiarize themselves with the task procedure. This practice session ensured that participants fully understood the requirements of the action compatibility task before moving on to the experimental trials. Once the practice session was

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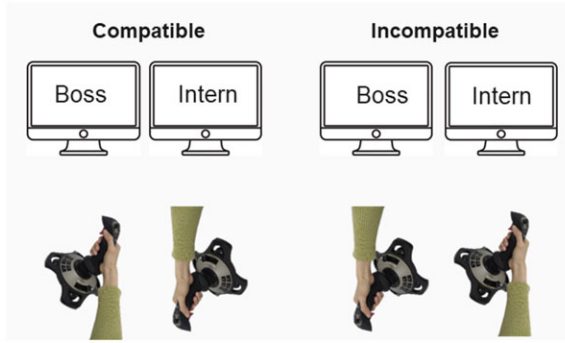

Figure 1. Depiction of the experimental scenario. The joystick was rotated so that movements required pushing the joystick upward or downward.

completed successfully, participants proceeded to the formal experiment, which followed the same structure as the practice session. After 10 practice trials with feedback, participants were required to finish 72 experimental trials in Chinese and 60 experimental trials in English. The participants were instructed to press the button on top of the joystick to start each trial. Each trial began with the word "Ready" presented in the center of the screen, after which the participant could press the button to begin the trial. Immediately after pressing the button, a cross appeared in the center of the screen for either 1,600 or 1,800 milliseconds before the power word was presented (the two different durations were so that participants could not anticipate exactly when the word would appear). The joystick was affixed to a box placed on the table such that the joystick was rotated 90 degrees from its typical position, and therefore, moving the joystick involved vertical up/down movements (see Figure 1). Under the compatible block, when the participants saw a powerful word, they were asked to push the joystick upward, and when they saw a powerless word, they were asked to push the joystick downward; the movements in the incompatible condition were reversed. The order of the compatible and incompatible blocks was counterbalanced across participants. As with the order of the compatible/incompatible conditions, the order of language (Chinese before English or English before Chinese) was also counterbalanced across participants.

The main experimental tasks across the two languages took about 15–20 min to complete. After the experiment was complete, in order to understand the participants' Chinese and English proficiency and provide a reference for later data analysis, the participant was required to fill out a language experience questionnaire, which took about 5–10 min to complete. Therefore, the entire study took approximately 20–30 min to complete. This research was approved by the foreign languages department of Zhejiang Gongshang University. All participants provided oral informed consent before starting the study.

Results

For the response time analysis, response times less than 300 ms or greater than 5000 ms, response times that were more than three standard deviations from the

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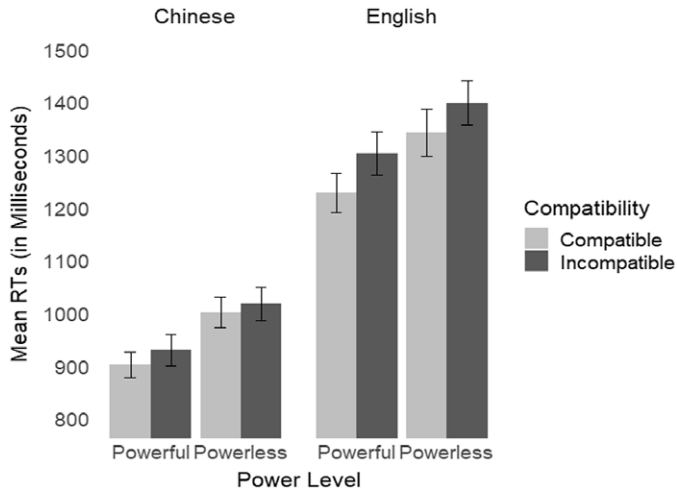

Figure 2. Response latencies by language, power level, and compatibility. Error bars represent the standard error of the mean.

participant's mean latency, and incorrect responses (9.5% of the data) were excluded from analysis. The larger upper reaction time limit was used in removing outliers because the handle movements required a longer reaction time. The latencies after cleaning are displayed in Figure 2.

The data were analyzed using Linear mixed effects (LME) models and lmerTest (Kuznetsova et al., 2017) in R (Bates et al., 2015; R Core Team, 2015). Because the LME analysis requires a normal distribution of RTs whereas raw RTs usually have a positively skewed distribution, RTs were transformed into Log RTs. Language (Chinese vs. English), compatibility (compatible vs. incompatible), and power level (powerful vs. powerless) were entered as fixed factors whereas subjects, items, and block (Chinese block first vs. English block first) were entered as random factors. Before running the model, R-default treatment contrasts were altered to sum-to-zero contrasts (Levy, 2014; Singmann & Kellen, 2019). Post hoc analyses were conducted using the emmeans package (Russell, 2020). For the latency analysis of word targets, the model was RT = lmer (log (RT) ~ Power Level* Compatibility * Language + (1 |subject) + (1 |item) + (1 |block), control = lmerControl(optimizer = "bobyqa," optCtrl = list(maxfun = 1e+06))). For the error rate analysis of word targets, the model was: Accuracy = glmer (accuracy ~ Power Level* Compatibility * Language + (1 |subject) + (1 |item) + (1 |block), family = "binomial," control = glmerControl(optimizer = "bobyqa," optCtrl = list(maxfun = 1e+06))). The raw data used for the analyses, analysis code, and word stimuli are publicly available at https://osf.io/3pq8t/.

In the latency analysis, the results revealed significant main effects of Language, Compatibility, and Power Level (p's $< .001$). Chinese words were categorized faster overall than English words, which is unsurprising as Chinese is the participants' first and dominant language. Powerful words were also categorized faster than powerless words (see Yang et al., 2021, for a similar finding). More critically, words were

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Table 2. Mean lexical decision latencies (RTs, in milliseconds) and percentage error rate with standard deviations in brackets for Chinese and English participants

	Powerful words		Powerless words	
	RT	%E	RT	%E
Chinese version				
Compatible	902 (156)	1.5 (2)	1002 (182)	2.0 (3)
Incompatible	931 (188)	2.0 (4)	1017 (202)	2.4 (4)
Difference	29	0.5	15	0.4
English version				
Compatible	1228 (232)	9.2 (6)	1342 (280)	10.9 (7)
Incompatible	1302 (260)	9.4 (6)	1398 (267)	12.1 (8)
Difference	74	0.2	56	1.2

Note. RT = reaction time; %E = percentage error rate.

categorized faster in the compatible condition than in the incompatible condition, suggesting that there is an action compatibility effect between POWER and vertical movement. Finally, there was a significant interaction between Language and Compatibility, $ß < .01$, $SE < .01$, $t = 2.10$, $p = .036$. Interestingly, this interaction was due to a *larger* compatibility effect for English words than for Chinese words. None of the other interactions reached significance, p's $> .05$.

Post hoc tests were conducted to determine if the compatibility effect was significant in both languages (separate analyses on "powerful" and "powerless" words were not performed because there was no significant interaction between compatibility and power level). Words were classified quicker in the compatible condition than in the incompatible condition in both languages, z's < -2.50, p's$< .001$. Despite the difference in magnitude, the compatibility effect was robust across both English and Chinese.

The error rates were also examined with a similar generalized linear mixed effects model. The model revealed that there was only a significant main effect of Language, $ß = 0.88$, $SE = 0.14$, $z = 6.27$, $p < .001$, as there was a higher percentage of errors for English words than Chinese words. Again, this is not surprising as one would expect more errors in participants' less proficient language. None of the other main effects, two-way interactions, nor the three-way interaction reached significance, all $p's > 0.05$[2]. The error rates and response latencies (after cleaning) from a subject-based analysis are displayed in Table 2.

We introduced order as an extra fixed-effects variable to the linear mixed effects model for latency to test if there was a significant impact of compatibility order (i.e., whether the first block was compatible or incompatible). The model revealed that Language, Compatibility, and Power Level all had significant main effects (p's $< .001$). Critically, the two-way interaction between Language and Compatibility remained significant ($t = 2.15$, $p = .032$). There was also a significant interaction between Compatibility and Order, $ß = 0.03$, $SE < .01$, $t = 8.08$, $p < .001$, such that the overall action compatibility effect was greater when

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switching from incompatible to compatible than when switching in the opposite direction. The three-way interaction between Compatibility, Language, and Order was also significant, $ß = -0.01$, $SE < .01$, $t = -4.33$, $p < .001$. None of the other main effects or interactions were statistically significant (p's $> .05$). In general, compatibility order did interact with language in some ways, but critically, the main effect of compatibility remained significant after adding order as a fixed effect into the analysis.

Lastly, to rule out that the compatibility effect was driven by the valence of the words rather than their power level, we conducted a similar linear mixed effects model analysis with valence added as a covariate (see Yang et al., 2021). That is, because power is generally desirable, powerful words may be perceived more positively, and verticality is associated with many positive and negative concepts (e.g., HAPPY IS UP, HEALTH IS UP, MORE IS UP, etc.). Therefore, the compatibility effect could potentially be due to the activation of a POSITIVE IS UP conceptual mapping rather than the POWER IS UP/POWERLESSNESS IS DOWN mapping. Yang et al. (2021) previously found that the valence of the powerful and powerless words employed here differed. For Chinese words, powerful words were more positively evaluated than powerless words (5.5 vs. 4.0, respectively), $t(70) = 9.96$, $p < .001$. For English words, the difference was smaller, but powerful words were also rated more positively than powerless words (4.4 vs. 3.8, respectively), $t(58) = 2.5$, $p = .015$.

To test if the compatibility effect remained significant after controlling for valence, we first normalized the valence ratings and then included the valence rating for each word as a fixed factor in the linear mixed effects model. There were significant main effects of Language, Power Level, and most critically, Compatibility (all p's $< .05$), indicating that the compatibility effect remained significant after adding valence into the model. The two-way interaction between Language and Compatibility was marginally significant ($t = 1.95$, $p = .052$). Furthermore, there was a significant two-way interaction between Power Level and Valence ($t = -3.78$, $p < .001$). None of the other main effects or interactions were statistically significant (p's $> .05$). In conclusion, the main effect of compatibility remained significant after valence was included in the model, indicating that the compatibility effect was not driven by valence. This is consistent with Yang et al. (2021) who found that a horizontal (forward/backward) action compatibility effect for power also remained significant after accounting for valence.

Discussion

The purpose of this study was to explore whether there is a conceptual metaphor mapping between POWER and verticality in bilinguals' first and second languages and whether this mapping would be embodied in participants' motor responses in a way that is consistent with this mapping. In both participants' first language, Chinese, and second language, English, we observed a vertical action compatibility effect between POWER and upward movement and POWERLESSNESS and downward movement. Even though the magnitude of the compatibility effect differed between the two languages, the effect was reliable in both cases, suggesting that this embodied representation is robust across both languages.

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We interpret these findings as evidence that people engage in an embodied simulation of verticality when processing words related to POWER. That is, when a powerful word is encountered, this activates a representation of height or upward movement, whereas when a powerless word is encountered, this activates a representation of lowness or downward movement. As such, in the case of the action compatibility effect, when a powerful word activates an upward embodied simulation, it facilitates physical upward movement but interferes with downward movement (and vice versa for powerless words).

According to Grady (1997), primary metaphors involve an embodied mapping of a physical experience to an abstract concept wherein the two concepts co-occur in the natural environment. For example, the conceptual metaphor "CARE IS WARMTH" has an experiential basis—when a mother cares about her child, she often gives the child a warm embrace, therefore, the child simultaneously experiences both CARE and WARMTH. Likewise, the concepts of POWER and verticality co-occur in the natural environment as well. For instance, height is usually correlated with physical strength. Furthermore, in a physical altercation, typically the stronger individual is left standing whereas the weaker individual may be left lying on the ground. This extends to more abstract forms of social power as well, for instance, often bosses and CEOs will have offices on the highest floors of buildings (Winter et al., 2020), reinforcing the mapping between POWER and height.

The metaphorical link between POWER and upward movement is likely also reinforced through the language we use. Both Chinese and English speakers use vertical movement verbs to express abstract concepts of power. For instance, in Chinese, when people talk about someone gaining power, they often say "他走上权力的高位" (English translation equivalents: he is rising to the top position), with the verb "走上" (English translation equivalents: go up) expressing upward movement. Similarly, when speaking of people who lose power, a common expression is "他跌入社会底层" (English translation equivalents: he fell to the bottom of the social hierarchy), with the verb "跌入" (English translation equivalents: fell to) expressing downward movement. Similar expressions are evident in English as well (e.g., "she's *rising* through the ranks"; "she's *under*employed"). Therefore, based on a large number of metaphorical instances and life experiences, the mapping between up/down movement and power concepts is formed and reinforced.

Just as these embodied experiences shape our conceptualization of power, part of the process of interpreting meaning in communicative exchanges relies on cultural conceptualizations. In cases where the foundation of our linguistic engagement is cultural as opposed to idiosyncratic, cultural conceptualizations are denoted by cultural schemas, categories, and metaphors (Sharifian, 2011). This can be illustrated by the phrase "This land is me" uttered by an Aboriginal Australian, which signifies the speaker's conceptualization of the land. Within the traditional Aboriginal perspective, individuals are frequently viewed as integrated components of the land. Cultural conceptualizations like this are not uniformly shared among all individuals in a cultural group (Sharifian, 2007). While they originate from shared cultural experiences, at the individual level, such conceptualizations are not equally etched into the psyche of each member but are rather possessed to differing extents among group members (Sharifian, 2007). This uneven distribution of cultural

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conceptualizations across individuals has implications for second language learning. Second language learners absorb schemas, categories, and metaphors from both linguistic and non-linguistic experiences. In this context, second language acquisition may grow increasingly intricate, contingent upon the extent to which cultural schemas of the learner's first language intersect with those traditionally linked to the second (Sharifian, 2007). To investigate this further, this current study was conducted to examine conceptual metaphors in first and second languages.

Although there was a compatibility effect in both languages, the size of the effect differed, and contrary to our predictions, we observed a larger action compatibility effect when participants categorized words in their L2, English. We reasoned that vertical representations of power may be stronger in Chinese culture due to the more salient societal rules for treating people above and below you in the social hierarchy (Bond & Hwang, 1986). Verticality is implied by hierarchies, and if norms for hierarchical interactions are more prominent in Chinese culture, we reasoned that this could result in a stronger vertical action compatibility effect in Chinese than in English. In line with this, corpora data show that in Chinese, a higher percentage of UP/DOWN instances are linked to SOCIAL HIERARCHY than in English (Lan, 2000). However, we found a smaller action compatibility effect in Chinese than in English. That being said, the participants were still culturally Chinese, and even when doing the task in their second language, it is likely that verticality is still a major source for how the participants represent POWER. After all, conceptual metaphors are considered to go deeper than language, with the language we use simply reflecting the mappings that exist in thought (Lakoff & Johnson, 1980). Therefore, it makes sense that when thinking about concepts in a second language, the fundamental mappings used to understand these concepts stay intact. In fact, the larger action compatibility effect suggests that conceptual mappings might be drawn upon to an even greater extent in L2, perhaps because of the difficulty of processing words in a second language. For instance, Türker (2016) found that bilinguals better understand metaphor expressions in their L2 when they are based on conceptual mappings that also exist in their L1, suggesting that bilinguals draw upon the mappings they have already learned in their L1 to process language in their L2. Nonetheless, this should be interpreted with some caution as the response latencies were longer overall in L2 than in L1, which can lead to spurious interaction effects (Faust et al., 1999). Furthermore, the larger action compatibility effect in L2 may be confounded by valence. When valence was included as a fixed factor in the Linear Mixed Effects (LME) model, the interaction between compatibility and language was only marginally significant. This suggests that factors such as word valence might play a crucial role in modulating the action compatibility effect across languages.

There are some limitations in this study that should be noted. First, all the participants were bilingual learners with a Chinese cultural background, and their understanding and judgment of English words during the experiment is likely different from how native English speakers from a Western cultural background would understand and judge these words. Therefore, our study can only discuss the embodiment of power concepts in Chinese-English bilinguals when processing concepts in their L1 and L2. In the future, further research should explore vertical conceptualizations of power in more language groups and with participants from

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different cultural backgrounds. As mentioned earlier, the Chinese culture's focus on hierarchical relationships may result in a stronger and more salient conceptual metaphor mapping between POWER and verticality compared to some other cultures (Lan, 2000; Lakoff & Johnson, 1980; Schubert, 2005; Zanolie et al., 2012; Yang et al., 2021). In addition, the potential confounding effect of word valence on the action compatibility effect warrants further investigation. Further research could involve carefully controlling for word valence across conditions and languages. Such research could provide deeper insights into how valance might influence the action compatibility effect of power concepts across languages. Lastly, future studies should explore whether bilingual participants' proficiency in their L2 has an effect on conceptual metaphor activation. We recruited only L1 dominant Chinese-English bilinguals, but it could be interesting to explore how more balanced bilinguals perform in this task as well.

Conclusion

This study explored the activation of the POWER IS UP conceptual metaphor in Chinese-English bilinguals using an action compatibility task that was conducted in both participants' L1, Chinese, and L2, English. Despite differences in magnitude between the two languages, there was consistent evidence of an action compatibility effect between POWER and upward movement and POWERLESSNESS and downward movement in both languages. Interestingly, the action compatibility effect was larger when the bilingual participants categorized English words rather than Chinese words. This supports the view that POWER is embodied in terms of verticality and that thinking about POWER engages embodied simulations of HIGHNESS and LOWNESS. More generally, our findings support the view that conceptual metaphors ground our representations of abstract concepts in terms of concrete and embodied experiences (Lakoff & Johnson, 1980; Gibbs, 2005).

Replication package. The raw data used for the analyses, analysis code, and word stimuli are publicly available at https://osf.io/3pq8t/.

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Informed consent. All participants provided verbal informed consent before starting the experiment.

Ethical standards. This research was approved by the foreign languages department at Zhejiang Gongshang University to ensure ethical standards. This research adhered to the ethical principles outlined by the American Psychological Association (APA, 2017).

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Notes

1 In each trial of the power detection task, participants were presented with two group labels simultaneously on the screen (e.g., master and servant). The group pairs were chosen such that the two groups were related and a clear power differential between them existed. For each pair, participants had to decide as rapidly as possible which of the two groups was the more powerful one. Each of the pairs was displayed twice, once with the powerful group positioned at the top and once with the powerful group at the bottom. Responses were provided using the cursor up and down keys.

2 Following a suggestion of one of the reviewers, we removed 3 target words (including 孩子(child), 雇工(employee), 经理(manager)) from the Chinese stimuli and 4 target words (including child, baby, employee, manager) from the English stimuli and reconducted the analyses as these stimuli may depend on comparisons (e.g., a 'manager' is powerful when compared to an 'employee', but may be powerless when compared to a 'CEO'). Removing these words did not change any of the findings in the latency analysis as the main effects of Language, Compatibility, and Power Level as well as the two-way interactions between Language and Compatibility remained significant (all p's $< .05$). Post-hoc tests on the reanalyzed data similarly revealed that words were classified quicker in the compatible condition than in the incompatible condition in both languages, z's < -2.50, p's$< .001$. Similarly, the error analysis with these words excluded revealed only a significant main effect of language, $ß = 0.96$, $SE = 0.15$, $z = 6.54$, $p < .001$, with a higher percentage of errors for English words than Chinese words, consistent with the original analysis. As such, removing the words listed above did not result in any significant changes in the findings.

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Appendix A. Powerful and powerless words

These stimuli served as Chinese word targets.

Powerful words (English translation in parentheses): 老板 (boss)、国王 (king)、君主 (monarch)、总统 (president)、领袖 (leader)、总裁 (CEO)、元首 (ruler)、天子 (emperor)、主席 (chairman)、首脑 (head)、总理 (prime minister)、首相 (prime minister)、政府 (government)、首领 (chieftain)、女王 (queen)、司令 (commander)、将军 (general)、董事 (executive)、领导 (leader)、宰相 (chancellor)、权威 (authority)、书记 (secretary)、市长 (mayor)、上司 (superior)、法官 (judge)、校长 (principal)、长官 (senior officer)、总监 (supervisor)、厂长 (factory manager)、部长 (minister)、经理 (manager)、军官 (military officer)、官员 (official)、主管 (supervisor)、政客 (politician)、地主 (landlord)

Powerless words (English translation in parentheses): 囚犯 (prisoner)、乞丐 (beggar)、佣人 (servant)、贫农 (poor farmer)、苦工 (laborer)、穷人 (the poor)、跑腿 (runner)、民工 (rural labourer)、门卫 (gatekeeper)、跟班 (follower)、劳工 (worker)、下属 (subordinate)、保姆 (nanny)、雇工 (hired worker)、学徒 (apprentice)、矿工 (miner)、随从 (attendant)、被告 (defendant)、船员 (sailor)、小贩 (vendor)、新人 (newcomer)、伙计 (clerk)、平民 (civilian)、农民 (farmer)、配角 (supporting role)、店员 (shop assistant)、工人 (worker)、租户 (tenant)、考生 (examinee)、孩子 (child)、职工 (staff member)、百姓 (husbandman)、文员 (clerk)、市民 (citizen)、学生 (student)、助理 (assistant)

These stimuli served as English word targets.

Powerful words: president、command、king、judge、government、queen、billionaire、conqueror、leader、prince、boss、chief、policeman、general、mayor、captain、chairman、director、manager、premier、principal、pope、officer、employer、politician、dean、professor、winner、security、coach

Powerless words: apprentice、student、receptionist、criminal、cashier、sailor、farmer、worker、tenant、cleaner、employee、plumber、thief、patient、defendant、aide、pupil、miner、intern、freshman、victim、child、poor、orphan、loser、refugee、baby、prisoner、servant、slave.

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