Abstract

This study investigated whether spatial cognition and experience influence the processing of Mandarin sentences containing spatial terms. Two offline tasks were administered: Experiment 1 employed explicit visual cues (upward/downward arrows) to test the impact of spatial consistency on sentence relatedness judgments, while Experiment 2 utilized implicit spatial cues through vertical scale arrangements to assess sentence comprehensibility. Participants evaluated 32 target sentences—literal (e.g., 他的收入非常低。 tā de shōu rù fēi cháng dī “His income is very low.”), metaphorical (e.g., 他的情商非常低。 tā de qíng shāng fēi cháng dī “His emotional intelligence is very low.”), anomalous (e.g., 他的日常非常低。tā de rì cháng fēi cháng dī “His daily life is very low.”)—and eight filler sentences (e.g., 這台手機非常貴。zhè tái shǒu jī fēi cháng guì “This smartphone is very expensive.”). Results from Experiment 1 revealed a significant main effect of spatial consistency, with consistent arrow–sentence pairings receiving higher relatedness ratings across literal, metaphorical, and anomalous sentences. Experiment 2 demonstrated that implicit vertical arrangements selectively influenced the comprehensibility of metaphorical and anomalous sentences but had minimal effect on literal sentences. These findings demonstrate that explicit spatial cues broadly facilitate sentence processing, while implicit spatial configurations specifically modulate abstract, metaphorical meanings. The results contribute to embodied cognition theory by clarifying how spatial metaphors influence real-world language comprehension and suggest potential applications for enhancing multimodal instructional design in language education.

Keywords: spatial cognition, embodied cognition theory, literal and metaphorical sentences.

摘　要

本研究探討空間認知與經驗是否影響華語中含有空間詞彙句子的處理。研究設計了兩項離線任務：實驗一使用明確的視覺提示（上／下箭頭），以測試空間一致性對句子相關性評分的影響；實驗二則透過縱向排列的量表隱含空間提示，評估句子的可理解性。參與者評估32句目標句——字面意義句子（例如:他的收入非常低。tā de shōu rù fēi cháng dī “His income is very low.”）、隱喻表達句子（例如:他的情商非常低。 Tā de qíng fēi cháng dī “His emotional intelligence is very low.”）、語意異常的句子（例如，他的日常非常低。tā de rì cháng fēi cháng dī “His daily life is very low.”）、及語意控制句子（例如：○○○○○○較低。○○○○○○ jiào dī “○○○○○○ is lower”）。——以及8句填充句（例如:這台手機非常貴。zhè tái shǒu jī fēi cháng guì “This smartphone is very expensive.”）作為與主題無關的試題。實驗一結果顯示，在字面意義、隱喻及異常句中，箭頭方向與句意一致的配對組別，其相關性評分顯著高於不一致配對。實驗二結果指出，縱向排列的隱含空間提示選擇性地影響了隱喻句與異常句的可理解性，但對字面意義句的影響則較小。這些發現表明，明確的空間提示能廣泛促進句子處理，而隱含空間的提示則專門調節抽象、隱喻性意涵的理解。研究結果進一步豐富了體感認知理論，並對語言教育中教學設計的應用提供了具體參考。

關鍵詞：體感認知理論、空間認知、字面意義和隱喻語句

Introduction

Metaphor is a fundamental mechanism by which speakers map concrete experiences onto abstract concepts, thereby simplifying complex ideas and enhancing communication (Lakoff & Johnson, 1980; Sopory & Dillard, 2002). Embodied cognition theory further suggests that such metaphors are not merely linguistic expressions but reflect the ways in which our sensorimotor experiences shape cognitive structures (Barsalou, 1999). Empirical studies have demonstrated that metaphors can increase persuasive power by capturing attention and promoting deeper engagement (Gerrig & Gibbs, 1988; Ottati, Rhoads, & Graesser, 2010).

However, most research has focused on English, and many studies have relied on reaction time measures or neuroimaging methods that tap into automatic language processing. Relatively few studies have examined how individuals consciously evaluate spatial metaphors. In particular, the conscious processing of vertical spatial metaphors (e.g., “high” vs. “low”) in Mandarin has received limited attention. This study addresses this gap by investigating the effects of explicit (e.g., upward/downward arrows) versus implicit (e.g., vertically arranged response options) spatial cues on the conscious comprehension of metaphorical and literal expressions in Mandarin.

Problem Statement

Although extensive research has examined metaphors in embodied cognition—often using reaction-time tasks or neuroimaging (Boroditsky, 2000; Santana & De Vega, 2011)—little is known about how speakers consciously interpret and evaluate spatial metaphors. Reaction-time measures primarily tap automatic, early stages of semantic processing, whereas explicit judgment tasks can reveal deliberate semantic inference and contextual evaluation. Moreover, most metaphor studies focus on English, leaving Mandarin spatial

metaphors underexplored. This study addresses these gaps by examining how Mandarin speakers consciously process vertical spatial metaphors under **explicit** (arrow cues) versus **implicit** (vertical arrangement of response options) conditions.

Research Questions

Accordingly, the research questions that are addressed in this thesis:

1. Does spatial configuration in the real world affect Mandarin speakers' judgments of space-related metaphorical expressions?

2. How do explicit versus implicit spatial cues differentially affect comprehension and evaluation of the metaphors?

Overview of Experiments

To address these questions, we conducted two offline rating tasks. In Experiment 1, participants judged on a five-point Likert scale how well upward and downward arrow cues matched sentences, where 1 indicated "completely irrelevant" and 5 indicated "highly related." The stimuli comprised literal sentences (e.g., 他的收入非常低。tā de shōu rù fēi cháng dī "His income is very low"), metaphorical sentences (e.g., 他的情商非常低。Tā de qíng shāng fēi cháng dī "His emotional intelligence is very low"), anomalous sentences (e.g., 他的日常非常低 tā de rì cháng fēi cháng dī "His daily life is very low"), control sentences created by replacing the critical noun with symbols (〇〇〇〇〇〇 非 常 低 。 〇〇〇〇〇〇 fēi cháng dī "〇〇〇〇〇〇 is very low.") and eight filler sentences (such as 這台手機非常貴。zhè tái shǒu jī fēi cháng guì "This smartphone is very expensive") to minimize salience.

In Experiment 2, the same sentences were presented without arrows. Instead, the 5-point comprehensibility scale was arranged vertically, with "非常不容易理解" ("very difficult to

understand," coded 1) at one end and "非常容易理解" ("very easy to understand," coded 5) at the other. Consistent versus inconsistent spatial arrangements served as implicit primes.

By comparing explicit and implicit spatial cues, we examine whether vertical spatial metaphors can be activated automatically and how they shape conscious comprehension and evaluation in Mandarin.

Literature review

Embodied Cognition Theory and Evidence

Embodied cognition posits that human thought emerges from continuous interactions among sensory, motor, and neural systems rather than solely within an isolated brain module (Varela, Thompson, & Rosch, 1991). Barsalou (1999) formalized this view by proposing that perceptual symbols—grounded in bodily experience—serve as the building blocks of even the most abstract concepts. For example, when we think of "grasping an idea," we unconsciously draw upon neural circuits originally evolved for hand movements. Neurophysiological research has substantiated this claim: mirror neurons in the premotor cortex fire both when an individual performs an action and when observing the same action in others, demonstrating a direct link between perception and action (Rizzolatti & Craighero, 2004). As shown in Figure 1, the Situated Action Cycle proposed by Barsalou (2020) illustrates how perception, action, and cognition form a continuous feedback loop, emphasizing the dynamic interaction between bodily experiences and conceptual processes. Beyond neural evidence, behavioral studies reveal that gesture production enhances memory retention and comprehension during learning tasks (Goldin-Meadow, 2003). Similarly, body posture experiments show that adopting expansive "power poses" can increase feelings of confidence and risk tolerance (Carney, Cuddy, & Yap, 2010). Together, these findings

underscore that cognition is not disembodied computation but is deeply scaffolded by our bodily interactions with the environment, forming a dynamic feedback loop in which perception shapes thought and thought influences action.

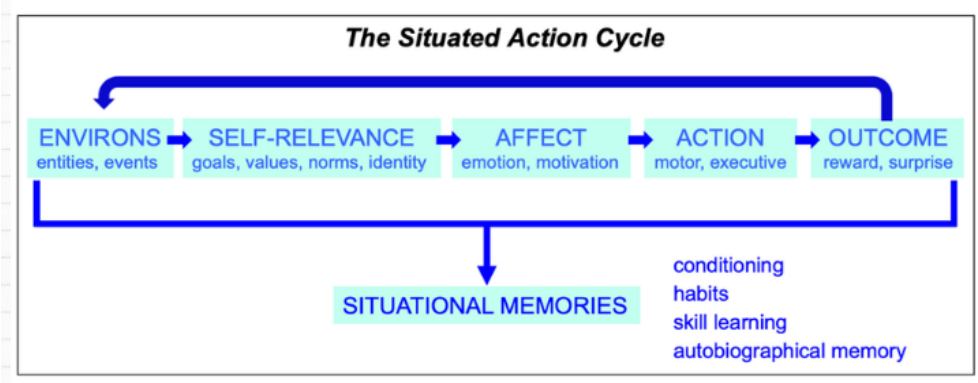

Figure 1. The Situated Action Cycle (Barsalou, 2020)

Conceptual Metaphor Theory

Conceptual Metaphor Theory (CMT; Lakoff & Johnson, 1980) argues that metaphors reflect underlying conceptual mappings between source domains—rooted in bodily and sensory experience—and target domains of abstract thought. For instance, spatial orientation provides a source domain for understanding status: "high status" and "low status" map vertical elevation onto social hierarchy (Kövecses, 2002). Empirical support for CMT comes from psycholinguistic experiments: Glenberg and Kaschak's (2002) Action–Sentence Compatibility Effect (ACE) demonstrated that comprehending sentences implying motion (e.g., "He handed you the book") is faster when the physical response direction matches the implied action. Neuroimaging studies further reveal that reading action verbs activates corresponding motor cortex regions (Pulvermüller, 2005). These converging lines of evidence confirm that metaphoric mappings are not arbitrary linguistic devices but are grounded in embodied simulation processes that recruit the same neural and motor systems engaged during real-world perception and action (Gallese & Lakoff, 2005). Thus, CMT

provides a robust framework for understanding how bodily experience structures abstract thought.

Metaphors of Time and Space

Within CMT, spatial experiences constitute a primary source domain for conceptualizing time and emotion. English speakers say “look forward to tomorrow” because they metaphorically map forward motion onto future events, while “leave the past behind” uses backward motion to signify the past (Lakoff & Johnson, 1980). Similar spatial–emotional mappings appear in expressions like “cheer up” (positive emotion as upward movement) and “fall into despair” (negative emotion as downward movement). These metaphors are cross-culturally pervasive, suggesting that sensorimotor experiences of gravity and verticality underpin how humans universally structure temporal and affective concepts (Pitt & Casasanto, 2022). Experimental work shows that participants respond faster to positive words presented in upper screen locations and to negative words in lower locations, providing behavioral evidence for these mappings (Meier & Robinson, 2004). Together, research on time and space metaphors illustrates how fundamental bodily interactions—such as moving up or down—become entrenched in the conceptual system to organize complex, abstract domains.

Challenges and Research Gaps

Although extensive research has validated embodied cognition and conceptual metaphor mappings in English, significant gaps remain concerning Mandarin spatial metaphors. First, most Chinese studies employ reaction-time or compatibility tasks (e.g., Yang et al., 2021), which capture automatic, early-stage processing but do not reveal how participants consciously interpret and evaluate metaphoric sentences. Second, prior work has focused

almost exclusively on explicit motor compatibility (e.g., button-press directions) without examining the impact of more subtle, implicit spatial cues such as the vertical arrangement of response options. Third, cross-dialectal variation within Mandarin—potentially affecting metaphor interpretation—has not been systematically explored. Finally, existing research rarely contrasts explicit cues (e.g., arrows) with implicit spatial layouts, leaving open the question of which form of spatial prompt more strongly influences metaphor comprehension. To address these limitations, the present study implements two offline rating tasks: (1) a relatedness judgment with explicit arrow cues and (2) a comprehensibility rating with vertically arranged response options. By comparing these conditions, we aim to clarify how embodied experience shapes conscious metaphor evaluation in Mandarin and to fill a critical cross-linguistic and methodological gap in the literature.

Methods

To examine whether real-world spatial configurations influence Mandarin speakers' processing of space-related metaphors, we conducted two offline rating tasks: (1) a relatedness judgment pairing arrow cues with sentences, and (2) a sentence comprehensibility judgment using vertically arranged scales.

Experiment 1: The Offline Relatedness Rating Task

Experiment 1 tested whether explicit vertical cues (upward vs. downward arrows) influence Mandarin speakers' processing of space-related metaphors. Participants rated how well each arrow–sentence pair matched on a 5-point Likert scale (1 = "completely irrelevant," 5 = "highly related").

Materials

Stimuli comprised 32 experimental sentences and 8 filler sentences. Experimental sentences were evenly divided into four types: literal (i.e., 他的收入非常低。*tā de shōu rù fēi cháng dī* "His income is very low."), metaphorical (i.e., 他的情商非常低。*Tā de qíng shāng fēi cháng dī* "His emotional intelligence is very low."), anomalous (i.e., 他的日常非常低。*tā de rì cháng fēi cháng dī* "His daily life is very low.") and control (i.e., ○○○○○○非常低。○○○○○○ *fēi cháng dī* "○○○○○○ is very low."). Control sentences used nonsensical subjects to serve as a baseline comparison. Filler sentences (i.e., 這台手機非常貴。*zhè tái shǒu jī fēi cháng guì* "This smartphone is very expensive.") contained no spatial terms and masked the experiment's focus on vertical metaphors. Examples of the literal, metaphorical, anomalous, and control sentences are presented in Table 1.

Each experimental sentence was paired with one of two arrow cues: an upward arrow (signifying "high") or a downward arrow (signifying "low"). Arrow–sentence pairings were counterbalanced across four lists, ensuring that each sentence appeared equally often in both consistent (e.g., "high" + up arrow) and inconsistent (e.g., "high" + down arrow) conditions. Figure 2 shows examples of the upward and downward arrows used as spatial cues in Experiment 1.

a. Upward arrow showing "high"	b. Downward arrow showing "low"
	

Figure 2. The Sample Pictures in Experiment 1

Table 1. The Sample Sentences of Stimuli in Experiment 1

Category	Examples
Literal spatial sentences	他的收入非常低 *tā de shōu rù fēi cháng dī* "His income is very low."
Metaphorical spatial sentences	他的情商非常低 *tā de qíng shāng fēi cháng dī* "His emotional intelligence is very low."
Anomalous spatial sentences	他的日常非常低 *tā de rì cháng fēi cháng dī* "His daily life is very low."
Control sentences	○○○○○○非常低 ○○○○○○ *fēi cháng dī* "○○○○○○is very low."
Filler sentences	這台手機非常貴 *zhè tái shǒu jī fēi cháng guì* "This smartphone is very expensive."

Participants

Thirty-four native Mandarin–speaking undergraduates (18 females, 16 males) from National Chiayi University participated in Experiment 1. Their ages ranged from 20 to 28 years (M = 21.4, SD = 2.1).

Procedure

Participants completed an online questionnaire via Google Forms. First, they read brief instructions and provided consent. Next, They then completed three practice trials to familiarize themselves with both consistent and inconsistent arrow–sentence pairings. In the

main phase, each trial began with an arrow cue (upward or downward) presented at the top of the screen, immediately followed by a Mandarin sentence beneath it. Participants used a five-point Likert scale (1 = "completely irrelevant," 5 = "highly related") to indicate how well the arrow and sentence matched. The 32 experimental trials comprised equal numbers of consistent pairings (e.g., 高 + up arrow; 低 + down arrow) and inconsistent pairings (e.g., 高 + down arrow; 低 + up arrow). Eight filler trials (containing no spatial terms) were interspersed to mask the study's focus. Trial order was randomized for each participant, and the session took approximately 10 minutes. Figures 3 and 4 provide representative examples of consistent and inconsistent arrow–sentence pairings, and the overall sequence is illustrated in Figure 5.

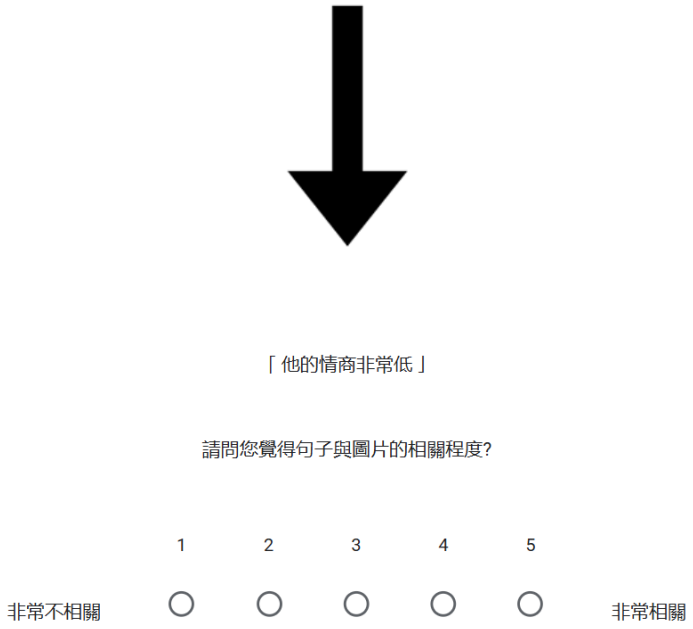

Figure 3. A Sample Question (consistent combination) of the Experiment 1

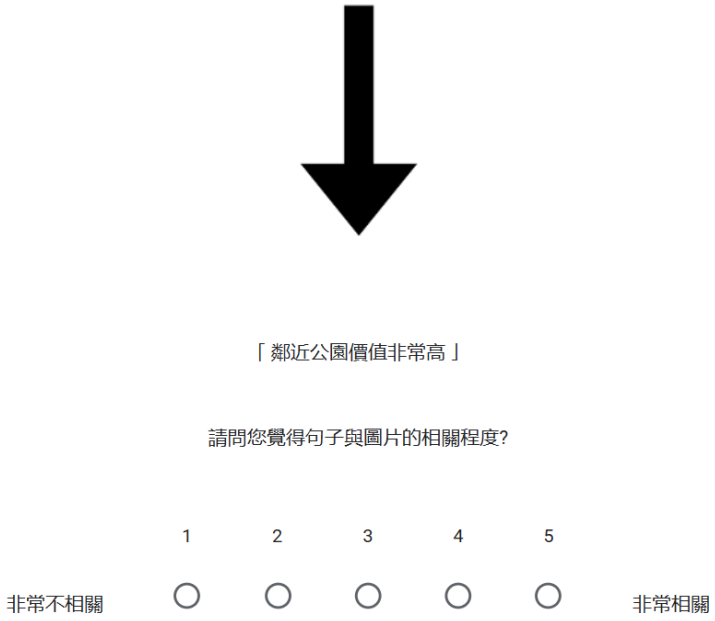

Figure 4. A Sample Practice Question (inconsistent combination) of the Experiment 1

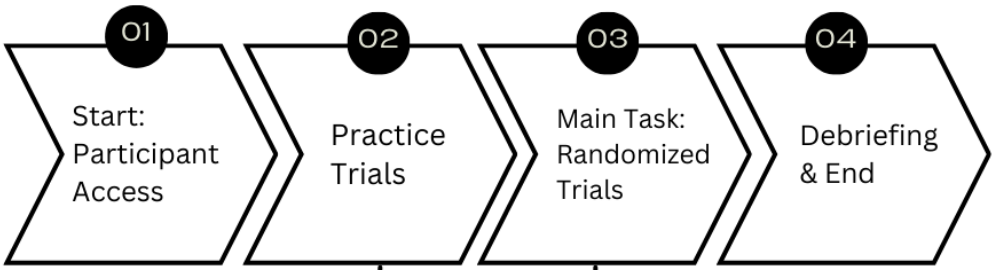

Figure 5. Flowchart of Experiment 1 procedure.

Experiment 2: The Offline Sentence Comprehensibility Judgement Task

Experiment 2 tested whether implicit spatial cues—vertical arrangement of the rating scale—affect how Mandarin speakers judge the comprehensibility of space-related sentences.

Materials

The same 32 experimental sentences (8 each of literal, metaphorical, anomalous, and control) and 8 filler sentences from Experiment 1 were used. No arrow images were shown. Instead, the five-point comprehensibility scale was presented in a vertical column, with the topmost label "非常不容易理解" ("very difficult to understand") and the bottommost label "非常容易理解" ("very easy to understand"). By positioning the "非常容易理解" label at the top versus the bottom, we created an **implicit "up" or "down" cue**: participants would implicitly associate the top-aligned "very easy to understand" option with the notion of "high" and the bottom-aligned "very easy to understand" option with "low."

Participants

Thirty-two undergraduates (M= 21.1, SD = 1.7; range = 20–27; 17 females) from National Chiayi University participated in Experiment 2. All were native Mandarin speakers with normal or corrected vision. None of these participants took part in Experiment 1, ensuring two independent samples.

Procedure

Participants accessed the experiment via Google Forms and first read instructions and provided consent. They then completed three practice trials—each presenting a different sentence—to become familiar with both orientations of the vertical comprehensibility scale.

Following practice, participants moved on to the main phase, in which each trial began by displaying a Mandarin sentence at t Table 2 he top of the screen and then presenting a vertically aligned five-point scale below it, labeled from “非常不容易理解” at one end to “非常容易理解” at the other. Participants indicated their level of understanding by clicking the label that best reflected how easily they comprehended the sentence.

Half of the experimental sentences appeared with the “非常容易理解” endpoint at the top (implicit “up” cue, expected consistent for “high” sentences) and half with it at the bottom (implicit “down” cue, expected consistent for “low” sentences), counterbalanced across participants. Representative examples of consistent and inconsistent spatial cue configurations are shown in Figure 6 and Figure 7, respectively. To obscure the study’s focus on spatial language, eight filler sentences without any spatial terms were interspersed among the experimental trials. The entire session lasted approximately 10 minutes. The overall flow of Experiment 2 is shown in Figure 8.

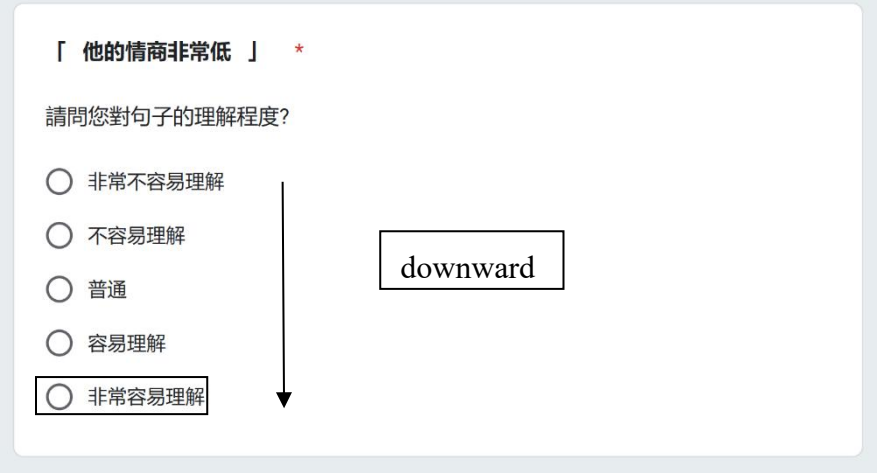

Figure 6. A Sample Question (consistent combination) of the Experiment 2

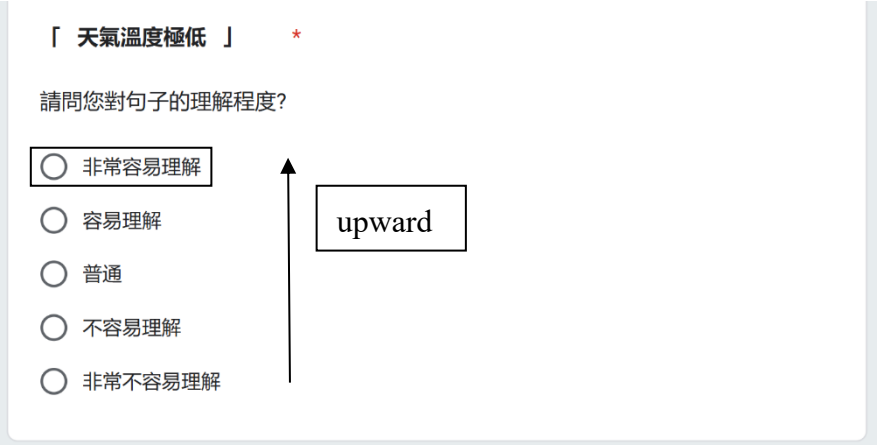

Figure 7. A Sample Question (inconsistent combination) of the Experiment 2

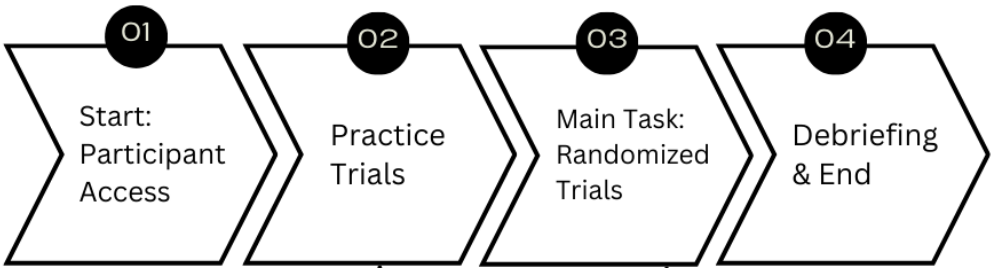

Figure 8. Flowchart of Experiment 2 Procedure

Results and Discussion

Experiment 1

Descriptive statistics (Table 2) revealed that participants gave higher relatedness ratings to consistent sentence pairs across all types. In the Consistent condition, the mean ratings were highest for Control sentences (M = 4.35, SD = 0.73), followed by Metaphor (M = 4.24, SD = 0.89), Literal (M = 4.03, SD = 1.00), and Anomalous (M = 3.76, SD = 1.23). In contrast, under the Inconsistent condition, all sentence types received notably lower ratings: Metaphor (M = 1.29, SD = 0.46), Literal (M = 1.38, SD = 0.78), Control (M = 1.44, SD = 0.82), and Anomalous (M = 1.44, SD = 0.56).

Table 2. Descriptive Statistics by Condition (Experiment 1)

Consistency	Sentence_Type	Mean_Rating	Std_Deviation	N	Std_Error
Consistent	Anomalous	3.765	1.232	34	0.211
Consistent	Control	4.353	0.734	34	0.126
Consistent	Literal	4.029	1.0	34	0.171
Consistent	Metaphor	4.235	0.89	34	0.153
Inconsistent	Anomalous	1.441	0.561	34	0.096
Inconsistent	Control	1.441	0.824	34	0.141
Inconsistent	Literal	1.382	0.779	34	0.134
Inconsistent	Metaphor	1.294	0.462	34	0.079

A two-way ANOVA revealed a significant main effect of Consistency (Figure 9), $F(1, 264) = 703.56$, $p < .001$. No significant main effect of Sentence Type was found (Figure 10), $F(3, 264) = 1.45$, $p = .229$, and the interaction effect between Consistency and Sentence Type was not significant (Figure 11), $F(3, 264) = 1.98$, $p = .117$.

The results of Experiment 1 highlight the strong effect of space-word consistency on relatedness judgments. Participants gave much higher ratings to matching pairs in every sentence category, showing that semantic coherence is the main factor guiding their responses. Sentence type itself made little difference, which suggests that consistency can take priority over smaller, less noticeable differences in sentence structure. These findings underscore how aligning context drives meaning integration, consistent with prior work on coherence-based comprehension.

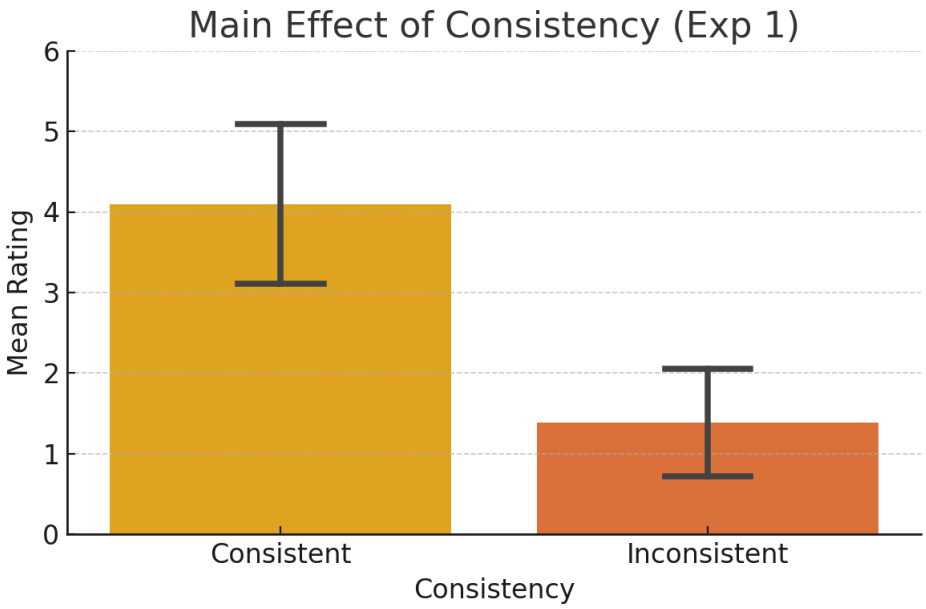

Figure 9. Main Effect of Consistency (Experiment 1)

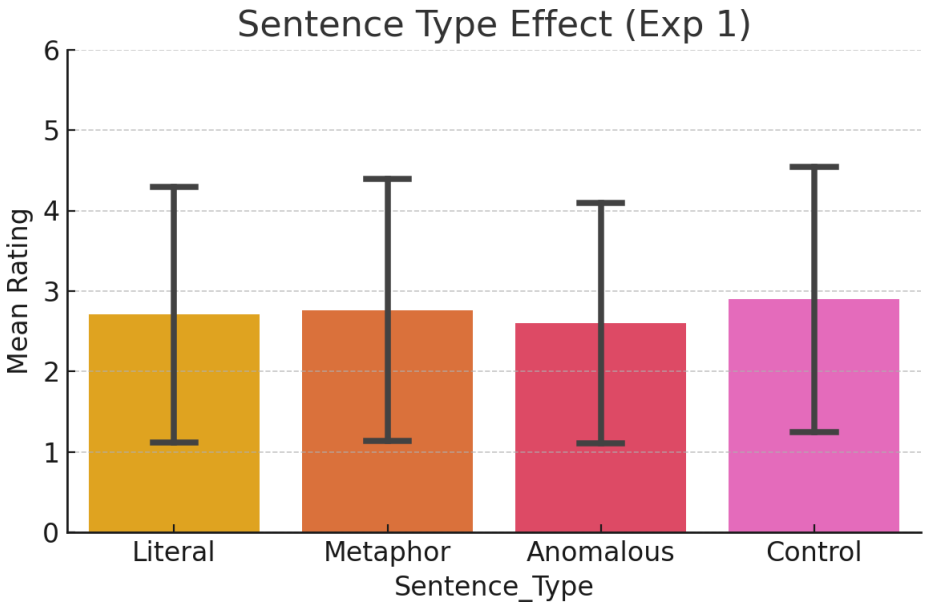

Figure 10. Sentence Type Effect (Experiment 1)

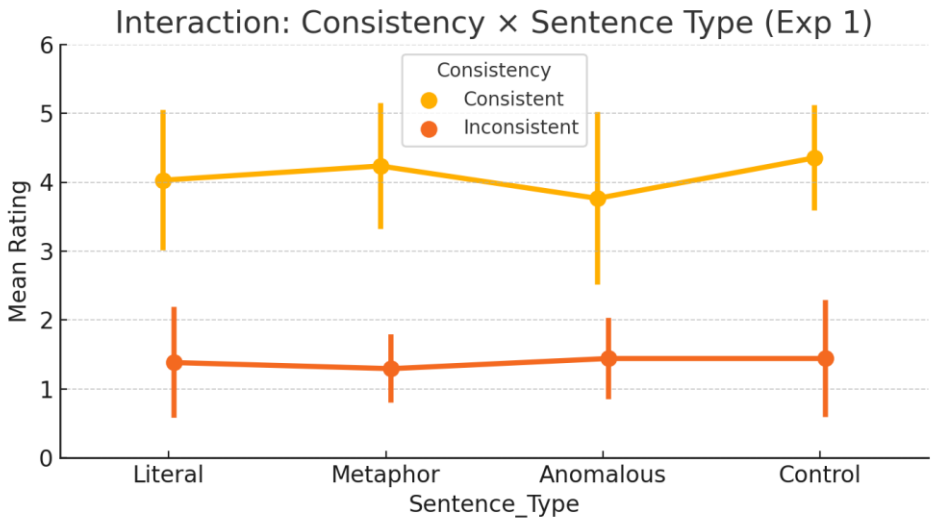

Figure 11. Interaction: Consistency × Sentence Type (Experiment 1)

Experiment 2: Comprehensibility Ratings

Table 3 shows that in the Consistent condition, participants gave the highest ratings to Literal sentences (M = 4.42, SD = 0.92), followed by Metaphor (M = 4.29, SD = 1.10), Control (M = 3.00, SD = 1.10), and Anomalous (M = 2.29, SD = 0.94). In the Inconsistent condition, Literal again received the highest ratings (M = 4.32, SD = 1.25), followed by Metaphor (M = 3.42, SD = 1.36), Control (M = 3.03, SD = 1.20), and Anomalous (M = 1.77, SD = 0.76).

Table 3. Descriptive Statistics by Condition (Experiment 2)

Consistency	Sentence_Type	Mean_Rating	Std_Deviation	N	Std_Error
Consistent	Anomalous	2.29	0.938	31	0.168
Consistent	Control	3.0	1.095	31	0.197
Consistent	Literal	4.419	0.923	31	0.166
Consistent	Metaphor	4.29	1.101	31	0.198
Inconsistent	Anomalous	1.774	0.762	31	0.137
Inconsistent	Control	3.032	1.197	31	0.215
Inconsistent	Literal	4.323	1.249	31	0.224
Inconsistent	Metaphor	3.419	1.361	31	0.244

A two-way ANOVA revealed a significant main effect of Consistency (Figure 12), $F(1, 240) = 6.83$, $p = .009$. There was also a significant main effect of Sentence Type (Figure 13), $F(3, 240) = 54.28$, $p < .001$. The interaction effect between Consistency and Sentence Type was not significant (Figure 14), $F(3, 240) = 2.20$, $p = .089$. Post-hoc Tukey HSD tests revealed

that both Literal and Metaphor sentences were rated significantly higher than Control and Anomalous sentences (ps < .001), while the difference between Literal and Metaphor was marginally non-significant (p = .051).

The results of Experiment 2 reinforce the crucial role of space-word consistency in shaping comprehensibility judgments. As in Experiment 1, participants gave higher ratings when the vertical scale layout matched the spatial words, demonstrating this consistency effect. We also found a significant main effect of sentence type: literal and metaphorical sentences were understood more easily than anomalous ones, even though they did not differ from each other. The non-significant interaction between consistency and sentence type suggests that each factor influenced comprehension independently and additively.

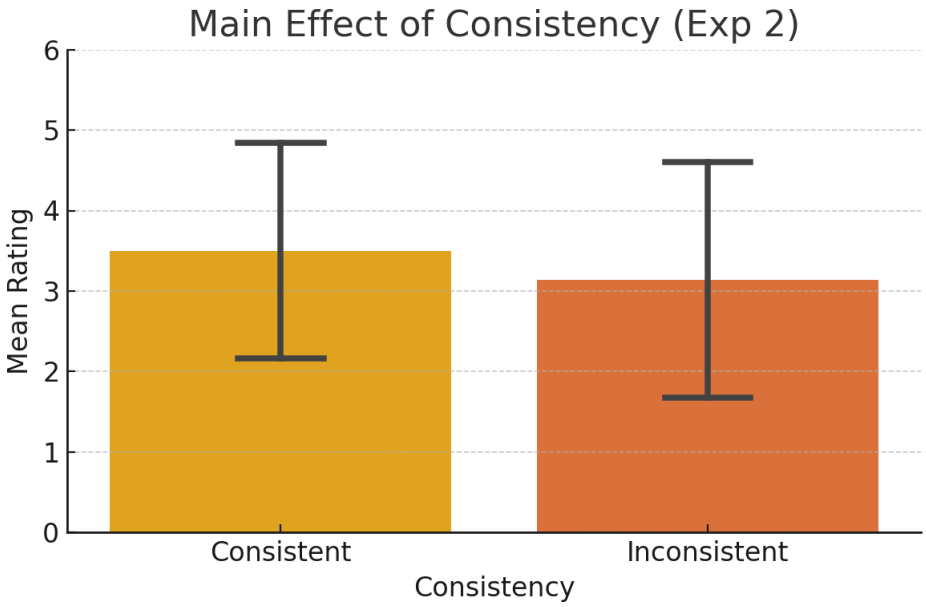

Figure 12. Main Effect of Consistency (Experiment 2)

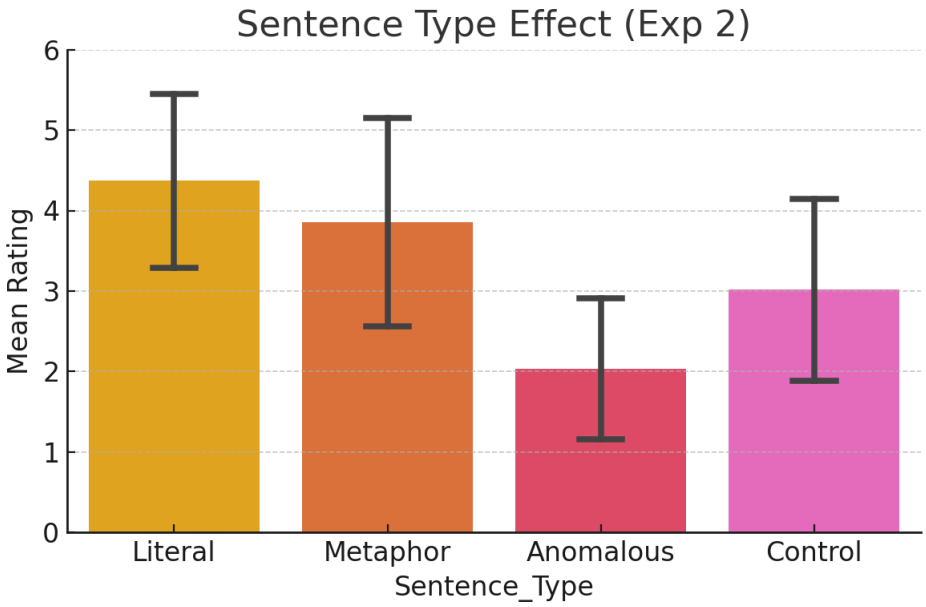

Figure 13. Sentence Type Effect (Experiment 2)

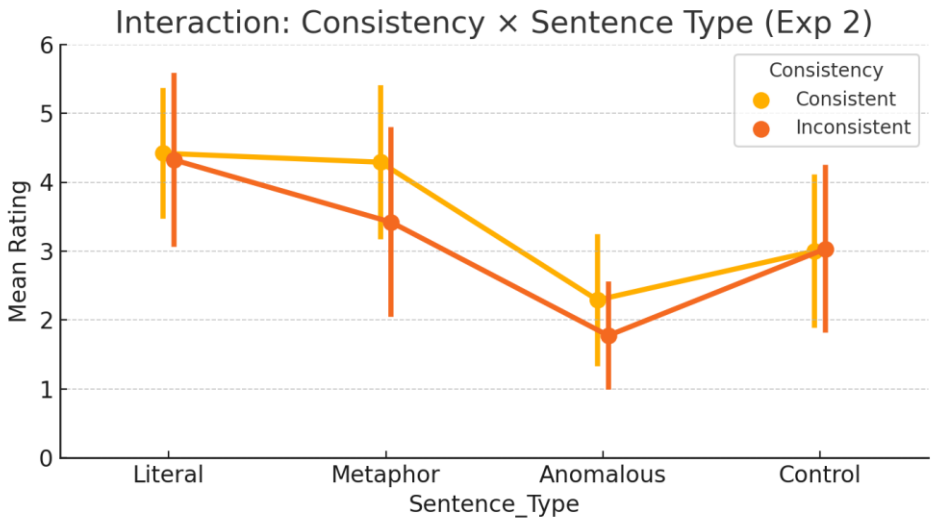

Figure 14. Interaction: Consistency × Sentence Type (Experiment 2)

Discussion

The present study set out to examine how individuals process both literal and metaphorical expressions of space in Mandarin, and how these processes correspond to real-world embodied experiences. By demonstrating robust *space-word consistency* effects across two tasks—one using explicit arrow cues and one using implicit vertical layouts—our findings not only corroborate embodied-cognition theories but also extend them by identifying boundary conditions related to cue salience and semantic abstraction. These insights deepen our understanding of how spatial metaphors integrate with cognitive mechanisms and suggest practical applications for designing multimodal educational materials and user interfaces that harness spatial alignment to enhance comprehension.

Across both experiments, space-word consistency emerged as the primary factor shaping participants' judgments. Explicit arrow cues in Experiment 1 produced strong consistency effects for literal, metaphorical, and anomalous sentences—while sentence type and its interaction with consistency remained non-significant—demonstrating that matching spatial terms with perceptual cues drives comprehension independently of structure. Experiment 2 confirmed this pattern using only the orientation of a vertical response scale: consistent layouts facilitated comprehension, particularly for abstract (metaphorical and anomalous) sentences, even though implicit cues exerted a weaker, more selective influence. The comparable ease of processing literal and metaphorical content under consistent conditions supports the view that figurative language, when contextually coherent, carries no additional processing cost.

Comparison with Previous Research

One prior study using online picture–phrase relatedness tasks found that literal and metaphorical spatial expressions were read significantly faster when paired with consistent images (Cheng, 2021). In contrast, another investigation employing a yes/no picture–sentence relatedness task observed no reliable embodiment effects on comprehension or reaction times (Wu, 2024). Our experiments reconcile these findings by demonstrating that both explicit arrow cues and implicit vertical-layout cues produce robust space-word consistency effects on relatedness and comprehensibility judgments, showing that spatial context reliably shapes both literal and figurative language processing when cue visibility or layout salience is sufficient.

Answers to the Research Questions

(1) Research question: Does spatial configuration in the real world affect the processing of space-related metaphors?

Answer: The results from Experiment 1 indicate that **explicit spatial cues significantly influenced judgments** of metaphorical, literal, and even anomalous sentences. These findings support the hypothesis that **real-world spatial consistency enhances sentence processing**, especially when directional cues are clear and congruent with the sentence content.

(2) Research question: Do consistent and inconsistent spatial cues influence participants' comprehension and interpretation of metaphorically space-related expressions in Mandarin?

The results from Experiment 2 demonstrate that **implicit spatial cues** (i.e., the orientation of response scales) had **selective effects**. Significant consistency effects were found for **metaphorical and anomalous** sentences, but **not for literal or control** sentences. This

suggests that abstract sentence types are more susceptible to disruptions in spatial alignment, whereas concrete meanings are more resilient to such subtle contextual changes.

Limitations and Future Directions

This study is limited in two major respects. First, reaction time (RT) data were not analyzed. Incorporating RT would provide valuable insight into the temporal dynamics of embodied language processing. Second, the physical properties of the spatial cues (e.g., arrow length, color) were held constant. Future studies could manipulate these visual features to explore whether perceptual salience modulates the embodiment effect. Additionally, utilizing interactive tools such as joysticks or motion-based inputs (e.g., E-Prime with joystick integration) may offer a richer understanding of real-time embodied responses.

Conclusion

The current findings highlight the interplay between spatial configuration and cognitive processing in language comprehension. While explicit cues reliably support metaphorical interpretation, implicit cues exert a subtler influence. These results offer empirical support for embodied theories of metaphor and provide practical insights for the design of multimodal communication, particularly in educational and user interface contexts. Although implicit cues exert a subtler influence, this effect may stem from the fact that participants require more salient or explicit spatial information to facilitate the activation of embodied mappings during abstract language comprehension. Further research will help clarify the boundaries of spatial metaphor processing and its implications for cognition and behavior.

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Appendix 1. Target Sentences for Experiment 1 and Experiment 2

	Literal	Metaphor	Anomalous	Control	Filler
1	職業球員身高相當高	職業球員興致相當高	職業球員宗教相當高	○○○○○相當高	大樓的牆面相當髒
2	鄰近公園樹木非常高	鄰近公園價值非常高	鄰近公園道德非常高	○○○○○非常高	這部影片非常爛
3	公司的地勢很高	公司的門檻很高	公司的靈魂很高	○○○○○很高	網際網路很慢
4	這座山海拔極高	這座山魅力極高	這座山意見極高	○○○○○極高	舞台燈光極亮
5	天氣溫度極低	天氣變化極低	天氣文筆極低	○○○○極低	這隻獅子很極胖
6	他的收入非常低	他的情商非常低	他的日常非常低	○○○○非常低	這台手機非常貴
7	政府的經費相當低	政府的效率相當低	政府的愛情相當低	○○○○○相當低	顧客的素質相當差
8	奶奶的血壓很低 8 c	奶奶的物欲很低	奶奶的思想很低	○○○○○很低	餐具的品質很好

Appendix 2. Questionnaire for Experiment 1

圖片和語句判斷調查

同學您好，

感謝您撥空填寫問卷。
本問卷主旨是為瞭解人們判斷圖片及句子的相關程度。
總共16題，每一題將會有一張圖片和中文語句，請仔細看圖片和句子。

接下來的任務如下:
判斷與語句和圖片相關之程度。若您覺得句子和圖片非常相關；請點選接近「非常相關 」的號碼；若您覺得完全不相關，請點選接近「非常不相關 」的號碼。

若有任何問題或建議，請聯絡以下信箱，收信後會盡速聯絡。
學生: 游如茜
e-mail: p0926276239@gmail.com
嘉義大學外國語言學系

登入 Google 即可儲存進度。瞭解詳情

* 表示必填問題

1

年齡 *

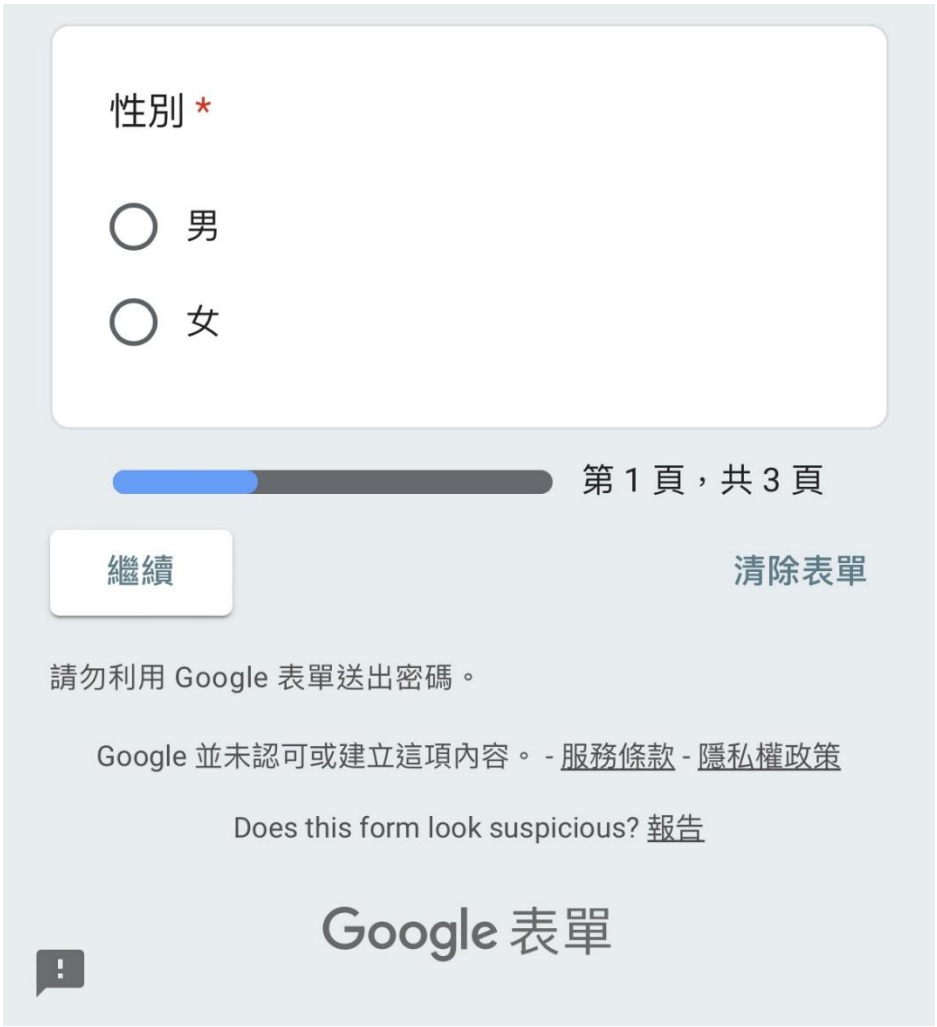
您的回答

母語 *

- [ ] 中文
- [ ] 英文
- [ ] 台語
- [ ] 客語
- [ ] 其他：

班級、姓名、學號 (例: 外語四 王小明 1110000) *

您的回答


性別 *
男
女
第 1 頁，共 3 頁
繼續
清除表單
請勿利用 Google 表單送出密碼。
Google 並未認可或建立這項內容。 - 服務條款 - 隱私權政策
Does this form look suspicious? 報告
Google 表單

範例問題

每一題將會有一張圖片和中文語句，請仔細看圖片和句子。

請仔細閱讀句子並對照圖片，判斷句子和圖片是否相關。若您覺得句子和圖片非常相關；請點選接近「非常相關」的號碼；若您覺得完全不相關，請點選接近「非常不相關」的號碼。

示範

「學校雜草高度相當低」

請問您覺得句子與圖片的相關程度?

	1	2	3	4	5	
非常不相關	○	◉	○	○	○	非常相關


示範
「○○○○○很低」
請問您覺得句子與圖片的相關程度?
1
2
3
4
5
非常不相關
非常相關

示範

「吧檯的民主極低」

請問您覺得句子與圖片的相關程度?

	1	2	3	4	5	
非常不相關	○	○	○	◉	○	非常相關

第 2 頁，共 3 頁

返回　繼續　清除表單

正式問卷填答(16題)

每一題將會有一張圖片和中文語句，請仔細看圖片和句子。

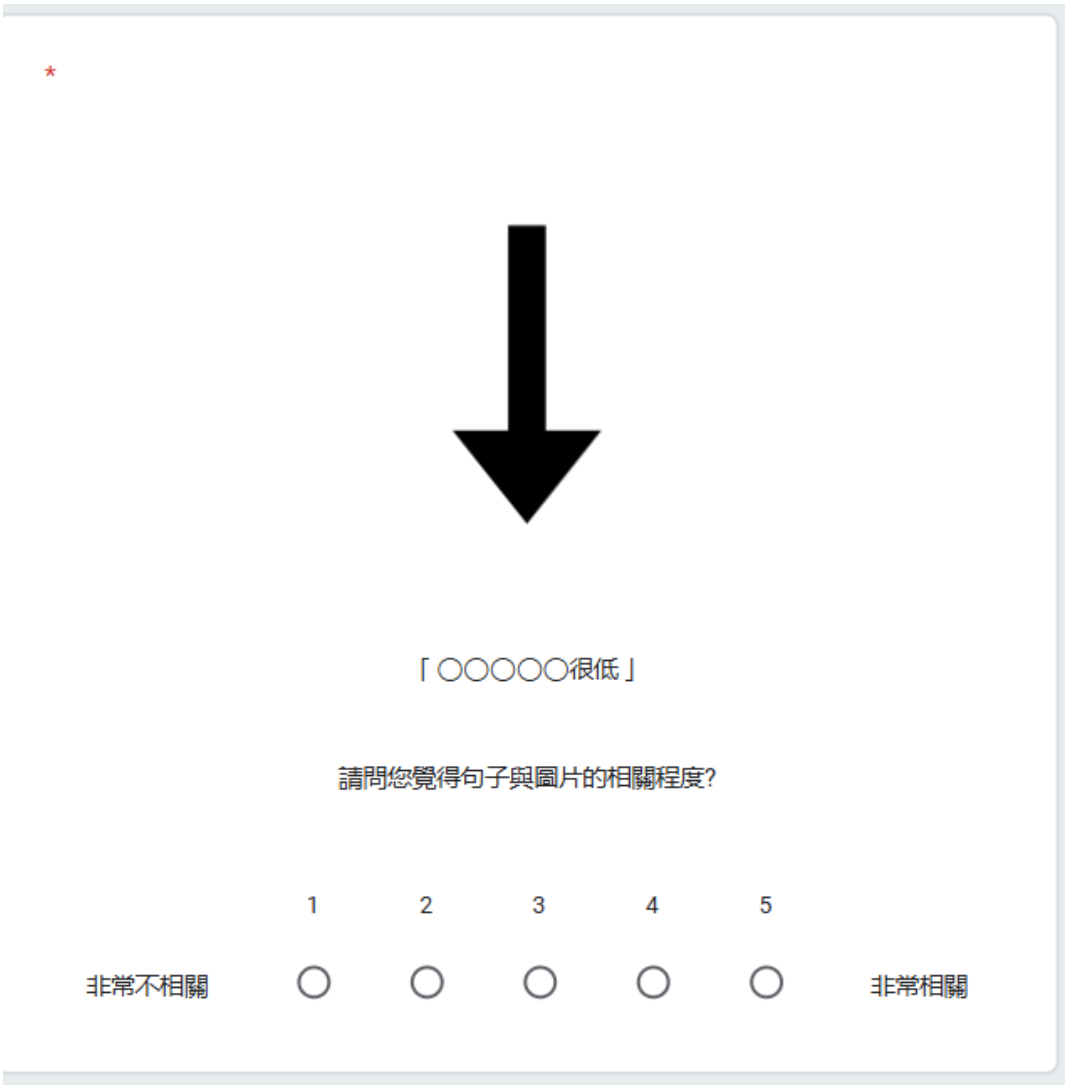
請仔細閱讀句子並對照圖片，判斷句子和圖片是否相關。若您覺得句子和圖片非常相關；請點選接近「非常相關」的號碼；若您覺得完全不相關，請點選接近「非常不相關」的號碼。

*

「鄰近公園價值非常高」

請問您覺得句子與圖片的相關程度?

	1	2	3	4	5	
非常不相關	○	○	○	○	○	非常相關



Appendix 3. Questionnaire for Experiment 2

語句理解度調查

同學您好，

感謝您撥空填寫問卷。
本問卷主旨是為瞭解人們對語句的理解度 。
總共16題，每一題將會有一段中文語句，請仔細閱讀句子。

接下來的任務如下:
判斷語句理解之程度，若您覺得非常容易理解，請點選「非常容易理解」；若您覺得非常不容易理解，請點選「非常不容易理解」。

若有任何問題或建議，請聯絡以下信箱，收信後會盡速聯絡。
學生: 游如茜
e-mail: p0926276239@gmail.com
嘉義大學外國語言學系

* 表示必填問題

年齡 *

您的回答

性別 *

○ 男

○ 女

班級、姓名、學號 (例: 外語四 王小明 1110000) *

您的回答

母語 *

☐ 中文

☐ 英文

☐ 台語

☐ 客語

☐ 其他：

第 1 頁，共 3 頁

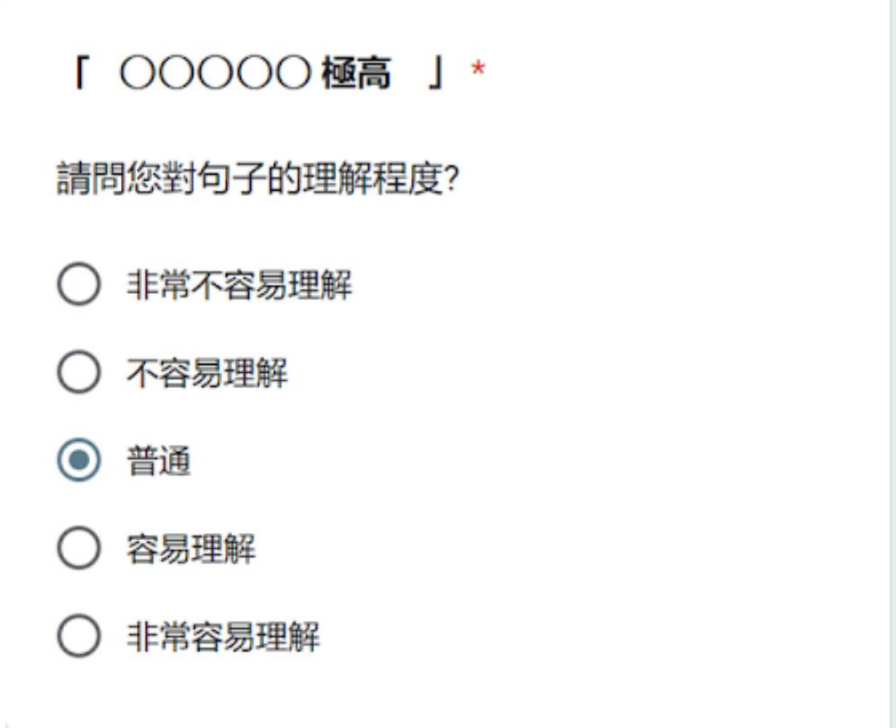
繼續

清除表單

範例問題

仔細閱讀句子，並判斷句子是否容易理解，然後勾選選項。

範例



範例

「 游泳池價值觀相當低 」 *

請問您對句子的理解程度?

- ○ 非常容易理解
- ○ 容易理解
- ○ 普通
- ◉ 不容易理解
- ○ 非常不容易理解

範例

「 學校雜草高度相當低 」 *

請問您對句子的理解程度?

- ○ 非常不容易理解
- ○ 不容易理解
- ○ 普通
- ◉ 容易理解
- ○ 非常容易理解

正式問卷填答(16題)

共16題，請仔細閱讀句子，並判斷句子是否容易理解

，然後勾選選項。

「 ○○○○○ **極高** 」 *

請問您對句子的理解程度?

- ○ 非常不容易理解
- ○ 不容易理解
- ○ 普通
- ○ 容易理解
- ○ 非常容易理解

「 **網際網路很慢** 」 *

請問您對句子的理解程度?

- ○ 非常不容易理解
- ○ 不容易理解
- ○ 普通
- ○ 容易理解
- ○ 非常容易理解