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Examining mental simulations of uncertain events

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Abstract

A great deal of research into the experiential nature of language has demonstrated that our understanding of events is facilitated through mental simulations of the described linguistic input. However, to date little is understood about how contextual uncertainty about the described event might influence the content and strength of these mental representations, or the cognitive effort involved. In this paper, we report a single experiment, where participants read sentences, such as “The old lady [knows/thinks] that the picnic basket is open”. Following a delay of 250ms or 1500ms, they responded to pictures that varied in the physical form of the target object (matching *vs.* mismatching). Results revealed an expected facilitation effect for matching images, but more importantly they also showed interference effects (longer reaction times) at the shorter ISI (250ms), following the uncertain verb ‘thinks’ compared to the certain verb ‘knows’. At the longer ISI, this effect was no longer present. This suggests that at the short ISI, uncertain conditions required extra time to construct and map a simulation of events onto the available image. Results are discussed in terms of the mechanisms involved in representing possible events and with reference to related literature on perspective-taking.

Key words: Situation model, language comprehension, uncertainty

Introduction

The ability to communicate and understand information regarding not only the present, but also the past, future and even the impossible is an important feature of human language (Hockett, 1960). It has been suggested that such processes are facilitated in language users through the construction of mental representations, which depict the described events and set up expectations about forthcoming referents (Zwaan, 2004). Despite over a decade of research that has evaluated the structure and content of such mental representations for understanding concrete language, none so far has considered how they are affected by uncertainty. Therefore, the current study attempts to examine the way that readers represent described events under varying levels of certainty (by comparing ‘knows’ *versus* ‘thinks’).

The idea that readers construct a mental representation of linguistic information is commonly referred to as a *situation model* (Glenberg, Meyer, & Lindem, 1987; Graesser, Millis, & Zwaan, 1997; Zwaan & Radvansky, 1998). According to this model, mental simulations are experiential in nature as they implicate embodiment and are assumed to be grounded in perception and action. Thus, understanding language entails recapitulating motor or perceptual activity as a ‘simulation’ of the language input. A number of findings have been produced over the last decade, using various different tasks, to demonstrate the validity of this mental-simulation view (e.g. Martin & Chao, 2001; Pecher, Zeelenberg, & Barsalou, 2003; Pulvermüller, 1999; 2002; Spence, Nicholls & Driver, 2001; Spivey, Richardson, Tyler, & Young, 2000). In this paper we will concentrate on those studies that have exploited the link between linguistic input and experimental task and have shown reliable facilitation/interference effects using different language structures (e.g. Glenberg & Kaschak, 2002; Zwaan, 2004; Zwaan & Yaxley, 2003b).

One popular version of this paradigm is the sentence-picture verification task. Here, participants read sentences such as, ‘The ranger saw an eagle in the sky’, then subsequently respond

(mentioned/not mentioned) to an image that depicts the eagle in a matching physical form (i.e. an eagle with its wings outstretched), or a mismatching physical form (an eagle with folded wings). Response times reveal facilitation effects (shorter reaction times) when the depicted object's shape and orientation matches information implied in the preceding sentence, and interference effects (longer reaction times) when these two sources of information are in conflict (Zwaan, Stanfield & Yaxley, 2002).

Interestingly, the degree of facilitation/interference that readers experience during comprehension is also influenced by the wider sentence context. Using the sentence-picture verification task described above, Yaxley and Zwaan (2007) presented participants with sentences that either set up a high level of visual resolution such as, 'Through the clean goggles, the skier could easily identify the moose', or a low level of visual resolution such as, 'Through the fogged goggles, the skier could hardly identify the moose'. Results revealed faster responses when the visual resolution of the subsequent picture matched that described in the preceding sentence, suggesting that contextually-defined visual properties of an object are encoded into the mental representation. Similar effects have been reported when the context modifies other perceptual aspects of an object (e.g. direction of motion and orientation; see Stanfield & Zwaan, 2001; Zwaan, Madden, Yaxley, & Aveyard, 2004). Clearly then, understanding language involves representations driven by both the described state-of-affairs and inferences from the wider context.

The Current Study

This paper attempts to extend these findings by examining how contextual uncertainty about the state of an object (e.g. whether someone knows *vs.* thinks that an eagle is flying) influences the content and strength of subsequent mental representations. Uncertainty is a pervasive component of everyday language, however it remains largely neglected in the psychological research literature. In speech,

uncertainty is typically communicated to others through prosodic cues (see Pon-Barry & Schieber, 2011), but choice of words provides the strongest indicator of the degree of certainty afforded to an utterance (e.g. conditional terms such as, *some, most, maybe, often, perhaps, likely, unlikely, typically, usually, possibly*, etc). Given that most previous studies of experiential language have examined the mental representations underlying concrete statements (but see de Vega & Urrutia, in press), it is important to understand how these representations are influenced (if at all) by a context that implies uncertainty. Moreover, given evidence that in everyday language production, adults tend to focus on past or potential future events, rather than on ongoing events in their immediate environment (Tomasello & Kruger, 1992), it is crucial to know how language listeners construct mental models of uncertain events. For example, are we less likely to set up mental representations of events when they are described as being uncertain?

Moreover, understanding uncertainty is likely to involve the production and storage of multiple representations of the world, since comprehenders need to accommodate all the possible permutations of described events. For example, saying (1) implies that both the described (i.e. *the picnic basket is open*) and the alternative (*the picnic basket is closed*) states of the world are possible. In contrast, following a definite statement such as (2), only the described state is deemed plausible.

(1) The old lady *thinks* that the picnic basket is open.

(2) The old lady *knows* that the picnic basket is open.

The construction of such ‘multiple-worlds’ is a common feature in other language constructs, such as conditionals and negation (e.g. Ferguson & Sanford, 2008; Ferguson, Sanford, & Leuthold, 2008; Ferguson, Scheepers, & Sanford, 2010), where it has been associated with higher levels of cognitive effort. Indeed, numerous investigations of negation (e.g. ‘the eagle is not in the nest’) have used the sentence-picture verification task to reveal that mental representations of both the factual and negated forms of an utterance are set up during comprehension (Kaup, Lüdtkke, & Zwaan, 2006;

Kaup, Yaxley, Madden, Zwaan, Ludtke, 2007; Ludke, Friedrich, De Filippis, Kaup, 2005; but see Tian, Breheny, & Ferguson, 2010). Interestingly, these studies also demonstrate a delay in comprehension due to the process of constructing and selecting appropriate ‘multiple worlds’, with the ‘negated state’ being available at short inter-stimulus intervals (ISIs, 250ms), and the alternative state only becoming available with an ISI of 1500ms. Furthermore, representing uncertainty is likely to share many processing steps with Theory of Mind (ToM) understanding. Research on ToM commonly emphasises the need to hold two mental representations in mind when carrying out a false belief task (i.e. one’s own true belief and someone else’s false belief), which naturally incurs a degree of working memory load (e.g. Apperly, Back, Samson & France, 2008; German & Hehman, 2006; Lin, Keysar, & Epley, 2010; McKinnon & Moscovitch, 2007, but see also Ferguson & Breheny, 2011; 2012). Similar to the work on negation, much of this work has found a delay in making reality and belief judgments, when the two are in conflict, suggesting that representing multiple perspectives of the world engages more effortful cognitive processes relative to other inferences that only elicit a single representation.

To investigate how contextual uncertainty influences the time course and strength of activation of mental representations, we compared performance on a sentence-picture verification task when the context depicted two levels of certainty about an object’s physical state (knows *vs.* thinks). In the experiment, participants read sentences like (1) and (2) above. Following a delay of either 250ms or 1500ms¹, they responded to pictures that varied in the physical form of the target object (matching *vs.* mismatching). Based on previous findings, we predicted faster response times when the shape of the depicted object matched, compared to when it mismatched, that described in the preceding target sentence. Regarding the novel certainty manipulation, we predicted that

¹ These two ISIs were chosen based on Kaup et al. (2007)’s previous work, to provide varying amounts of time for the multiple representations to be activated, if necessary.

uncertain events (described by the verb ‘thinks’) would slow down the construction of a mental simulation, possibly due to readers representing both the described and alternative states. This effect should lead to processing costs reflected in increased response times for ‘thinks’ *versus* ‘knows’, which elicits a single concrete representation of events. This prediction was tested against the null-hypothesis that comprehending uncertain events is no more effortful than certain events, meaning that there should be no difference in response times between certain (‘knows’) and uncertain conditions. This could be because readers do not activate an additional mental representation of the alternative state following an uncertain verb (‘thinks’), or simply that this process occurs rapidly. Examining effects at the different ISIs will allow us to explore this possibility. Finally, we tested the possibility that (un)certainty might influence the size of the mismatch effect emerging between these conditions. Such a difference in processing could be manifest as a *reduced* mismatch effect following ‘thinks’ if both possibilities are equally available for comparison.

Method

Participants

A total of eighty native English-speakers from the University of Kent took part in the study, either for course credits or for a small payment. Of these, 40 participants completed the task with a sentence-picture ISI of 250ms, and 40 completed the task with a sentence-picture ISI of 1500ms.

Stimuli and Design

Forty experimental sentences were created according to the form [*Character*] *knows/ thinks that the X is Y/Z*, where Y and Z describe opposing physical states of X. Prior to the main experiment, a pre-test was conducted to validate the binary status of the physical states described in these sentences.

Tenty participants (who did not take part in the main experiment) were presented with forty

truncated experimental sentences of the form, *The X is Y* in one of two lists (to test both states of X), and were asked to provide an alternative word for each item that described the opposite state to that described by the sentence final word (e.g. open/closed). This pre-test revealed a high overall probability of eliciting the desired alternative state across items (mean = 81%), which did not differ between the two state descriptions ($t(39) = 0.16, p > 0.88$).

For the main experiment, each sentence appeared in one of four forms: two *knows* and two *thinks* (e.g., *The old lady knows that the picnic basket is open*; *The old lady knows that the picnic basket is closed*; *The old lady thinks that the picnic basket is open*; *The old lady thinks that the picnic basket is closed*). Each experimental sentence was paired with one of two colour pictures (so eighty experimental pictures were used in total), with each version depicting object X in two different physical states, as described by the corresponding experimental sentence (see Table 1). The typicality of each picture was assessed in a pre-test, where twenty participants rated how well each image corresponded to how they would typically think of that object. Participants saw one version of each image pair, counterbalanced across two lists. Ratings were provided on a scale of 1-5, where 1 meant that the image was not at all similar to how they would typically think about this object, and 5 meant that the image was very similar to how they would normally think about this object. Typicality ratings across all pictures averaged 3.88 (SD = 0.39), with an average difference between alternate images of the same item of 0.11 ($t(39) = 0.52, p = 0.6$). As such, we can assume that our images are matched in typicality across (and within) items.

In addition, forty filler items were added to each list. These filler items included various verb structures (e.g. *saw, hopes, wishes, noticed*) and states (e.g. *alive, nervous, broken*). They all consisted of incorrectly matched picture-sentence pairings and were interspersed randomly among the forty experimental trials to create a single random order.

----- TABLE 1 ABOUT HERE -----

One version of each item was assigned to one of eight presentation lists, with each list containing forty experimental items. Each list contained one of the eight possible versions (4 sentence types x 2 picture types) of each item, presented in a fixed random order to ensure that they were evenly distributed. Each participant only saw each item once, in one of the eight conditions. Thus, half the experimental sentences were paired with a picture that matched the described physical state of object X and half were paired with a picture that mismatched the described physical state of X. All experimental trials required a ‘mentioned’ response and all filler trials required a ‘not-mentioned’ response.

Comprehension questions followed half of the trials (20 experimental, 20 filler). These questions required a binary ‘true/false’ or ‘yes/no’ response and tested participants’ memory of the preceding sentence or picture (e.g. ‘Did the old lady have a picnic basket?’).

Procedure

The experiment was run on a PC using e-prime 2.0 Professional software (Psychology Software Tools, Pittsburgh, PA). Each trial began with the presentation of a single sentence in the centre of the screen. Participants read this sentence for understanding and pressed spacebar to proceed. A fixation point then appeared in the centre of the screen for either 250ms or 1500ms (depending on the experimental group), followed by the target picture (200x200 pixels). Participants then had to decide whether that object had been mentioned in the preceding sentence or not, by pressing ‘*m*’ for mentioned and ‘*n*’ for not-mentioned. Participants were told to respond as quickly and as accurately as possible throughout the task.

The experiment began with 10 practice trials and participants completed the remaining 80 experimental trials in two short blocks. Comprehension questions followed half of the trials (20 experimental, 20 filler).

Results

Main analyses

Reading times for the target sentences averaged 1987ms and 2003ms for sentences containing ‘knows’ *versus* ‘thinks’ respectively (both $F_s < .26$), with no difference between ISI conditions (both $F_s < .27$). Overall, participants averaged 79% accuracy on the comprehension questions that followed half the items and none responded at lower than 65%. As such, it appears that there was no initial comprehension advantage between the different levels of certainty. Further, picture verification accuracy on the ‘not mentioned’ filler trials averaged 98%.

The main analyses focused on participants’ accuracy and reaction times in the sentence-picture verification task. Mean accuracy data are shown in Figure 1. Prior to analysis, any reaction times less than or longer than 2.5 standard deviations from the mean reaction time for each participant were removed. This eliminated 5.4% of the data. Only correct picture verification responses were included in the reaction time analysis. Mean reaction times are shown in Figure 2.

----- FIGURE 1 ABOUT HERE -----

----- FIGURE 2 ABOUT HERE -----

For statistical analysis, we calculated an average accuracy and reaction time for each condition, allowing generalization to participants (F_1 ; in which participants are seen as a random factor and items as a fixed factor) and items (F_2 ; in which items are seen as a random factor and

participants as a fixed factor). Significance on both these tests was examined to ensure generalizability of the results across the different participants and experimental items. Strength of association is reported in terms of partial eta-squared ($p\eta^2$). Analyses were conducted using a mixed 2(250ms ISI vs. 1500ms ISI) x 2(Knows vs. Thinks) x 2(Match vs. Mismatch) x 8(List) ANOVA, with ISI and list as the between-subjects factor and knows/thinks and match/mismatch as the repeated-measures factors. List did not significantly interact with any other variables (all $F_s < 1.52$).

Statistics on the accuracy data revealed a main effect of match/mismatch [$F_1(1,78) = 19.71, p < 0.001, p\eta^2 = 0.2$; $F_2(1,78) = 49.75, p < 0.001, p\eta^2 = 0.39$], reflecting higher accuracy on match trials compared to mismatch trials. No other effects or interactions reached significance (all $F_s < 1.94$).

Statistical analyses on the reaction time data revealed faster overall responses to the image when the physical state of the depicted object matched, compared to when it mismatched, that described in the preceding sentence [$F_1(1,78) = 48.52, p < 0.001, p\eta^2 = 0.38$; $F_2(1,378) = 78.1, p < 0.001, p\eta^2 = 0.5$]. There was also a main effect of ISI [$F_1(1,78) = 4.02, p < 0.05, p\eta^2 = 0.05$; $F_2(1,78) = 10.67, p = 0.002, p\eta^2 = 0.12$], with faster responses to the picture at the shorter ISI (250ms), compared to the longer ISI (1500ms). Results also revealed a significant interaction between ISI and knows/thinks [$F_1(1,78) = 6.86, p < 0.01, p\eta^2 = 0.08$; $F_2(1,78) = 3.63, p = 0.06, p\eta^2 = 0.05$]. In order to examine the underlying effects further, we ran separate 2(Knows vs. Thinks) x 2(Match vs. Mismatch) ANOVAs for each ISI condition.

250ms ISI: As in the overall ANOVA, statistical analyses for the 250ms ISI condition revealed a main effect of match/mismatch [$F_1(1,39) = 28.31, p < 0.001, p\eta^2 = 0.42$; $F_2(1,39) = 36.65, p < 0.001, p\eta^2 = 0.48$]. Analyses also revealed a main effect of knows/thinks at an ISI of 250ms [$F_1(1,39) = 4.27, p < 0.05, p\eta^2 = 0.1$; $F_2(1,39) = 3.27, p = 0.08, p\eta^2 = 0.06$], where reaction times were significantly faster when the preceding sentence included the definite verb ‘knows’ compared with

the uncertain verb ‘thinks’. The interaction between knows/thinks and match/mismatch was not significant ($F_s < 1$).

1500ms ISI: Once again, analyses revealed a main effect of match/mismatch [$F_1(1,39) = 23.47, p < 0.001, \eta^2 = 0.38$; $F_2(1,39) = 41.51, p < 0.001, \eta^2 = 0.52$]. In contrast, at this ISI of 1500ms, the main effect of knows/thinks was not significant [$F_1(1,39) = 2.88, p = 0.1, \eta^2 = 0.07$; $F_2(1,39) = 0.99, p = 0.33, \eta^2 = 0.03$], and in fact reflected a trend for faster responses following ‘thinks’ compared to ‘knows’. The interaction between knows/thinks and match/mismatch was not significant ($F_s < 1$).

The overall ANOVA showed no significant interactions for match/mismatch by ISI ($F_s < 1.31$), knows/thinks by match/mismatch ($F_s < 0.49$), or a three-way interaction for knows/thinks by match/mismatch by ISI ($F_s < 0.26$). As such, we can infer that responses to matching and mismatching images did not differ across the different levels of certainty.

Taken together, this data reveals that 250ms after the picture onset, the uncertainty associated with ‘thinks’, and potentially the multiple-representations that are activated, has interfered with readers’ representation of the described object, leading to a slow-down in responses. However, when participants are given longer to set up these mental representations (i.e. ISI 1500ms), this interference is removed.

Discussion

The purpose of this study was to investigate the time course and content of the mental representations that are activated by readers under varying levels of certainty (by comparing ‘knows’ *versus* ‘thinks’). Specifically, we were looking for evidence that uncertain contexts (e.g. ‘The old lady thinks that...’) delays readers’ mental representations of the world, possibly through the construction of multiple representations, and examined the degree of cognitive effort involved in

such processes. To this end, we compared performance of individuals on a sentence-picture verification task. Based on previous research with this task, we examined reaction times as a measure of the timing of representations and cognitive effort, with reduced reaction times revealing facilitation between described and depicted states of an object and increased reaction times demonstrating interference effects.

Results showed the expected mismatch effect, with responses to the picture-probe being significantly faster when the object's shape matched that described in the preceding sentence, compared to when it mismatched. This is in line with previous findings (e.g. Stanfield & Zwaan, 2001; Yaxley & Zwaan, 2007; Zwaan et al., 2002), and reflects the fact that comprehenders rapidly mentally represent the described physical state of the object when comprehending the sentence, which in turn facilitates their 'matching' response.

Crucially, the data also provide evidence for the use of different processing strategies following certain and uncertain utterances, which influenced the speed of responses differently at short versus long ISIs. Recall that at 250ms ISI, reaction times to the target image were significantly faster when the preceding sentence included the verb 'knows' compared to 'thinks'. This difference suggests that extra processing steps were required to construct and map a simulation of events onto the available image in the uncertain conditions, and that these processes had not yet been completed within the short ISI period. However, this difference in reaction times between 'knows' and 'thinks' disappeared when the ISI was extended to 1500ms. This suggests that when sufficient time was available to set up the appropriate mental representations, uncertain events were no more effortful to understand than certain events. Thus, the cognitive slow-down observed following 'thinks' could either be due to a delay in setting up these multiple representations, or a delay in accessing them for comparison with the target image.

Interestingly, match/mismatch did not interact with knows/thinks in this study. This finding demonstrates that readers do not activate simultaneous multiple representations for uncertain events, which would have led to equal response times for matching and mismatching images in the ‘thinks’ condition. As such, we can infer that linguistic events preferentially elicit mental representations of the objects in their described form, regardless of whether they were described as certain (e.g. ‘The old lady *knows* that the picnic basket is open’) or uncertain (e.g. ‘The old lady *thinks* that the picnic basket is open’), as evidenced by facilitation effects for matching images in both cases. Thus, these results point to stronger activation of the described state, against which the target image is initially checked prior to considering the implied alternative state (i.e. *the picnic basket is closed*). Taken together, these effects and the lack of difference between knows/thinks conditions at longer ISIs, suggest that difficulties in accessing, rather than setting up, multiple versions of world are responsible for the increased processing time following ‘thinks’ at short ISIs.

This finding offers parallels with related research on ToM understanding. Both false belief tasks and the current task require comprehenders to construct and utilise a representation of events that differs from that of the actual/described events. Recent research has shown that considering an agent’s false belief is cognitively demanding and can lead to interference effects from one’s own true belief (e.g. Apperly, Samson, & Humphreys, 2009), leading to longer response times for judgements that involve conflicting perspectives. This disruption is often explained as a bias to initially map events onto one’s own knowledge and to only consider the other person’s perspective at some later stage (Birch & Bloom, 2007). The current data offers a wider potential explanation for this effect since under most circumstances, it can be assumed that we are more certain about our own knowledge than that held by others. Hence, it is possible that processing in both these types of task is influenced by the same bias to initially anchor our understanding of events onto *certain* information. This would suggest that understanding *uncertain* information about events or other peoples’

perspectives operates only as a subsequent and controlled checking mechanism, which may incur increased cognitive effort.

Identifying the source of the ‘costly’ cognitive processes involved in representing uncertain information- and their relation to other processes such as ToM- offers an interesting avenue for future research. For example, do other linguistic (and non-linguistic) cues about certainty elicit the same mental representations and cognitive demands as those found here? Systematically comparing how a speaker’s prosody and choice of language influences the speed and strength of mental simulations of uncertain events would help us gain a better understanding of how these cues can be used for effective communication about possible events, with obvious implications for individuals with communication disorders.

In sum, the current study supports previous findings in demonstrating that readers activate mental representations of described events during language comprehension. Further, it suggests that introducing uncertainty to a discourse (‘knows’ *versus* ‘thinks’) necessitates the activation of at least one additional representation- the object’s implied alternative form. The results reported here suggest that accessing these mental representations occurs as part of a time-consuming process, which maintains an advantage for the explicitly described events, over the possible-world alternatives. Thus, these results point to general cognitive difficulty in representing and manipulating uncertain, compared to certain, events.

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Appendix

Experimental items.

1.
The student knows/thinks that the textbook is closed.
The student knows/thinks that the textbook is open.
2.
The park ranger knows/thinks that the eagle is airborne.
The park ranger knows/thinks that the eagle is grounded.
3.
The chef knows/thinks that the egg has been fried.
The chef knows/thinks that the egg is in its shell.
4.
The farmer's wife knows/thinks that the wellies are clean.
The farmer's wife knows/thinks that the wellies are dirty.
5.
The coach knows/thinks that the hockey star is playing.
The coach knows/thinks that the hockey star is sat down.
6.
The clown knows/thinks that the balloon is burst.
The clown knows/thinks that the balloon is inflated.
7.
The biologist knows/thinks that the bat is flying.
The biologist knows/thinks that the bat is resting.
8.
Mrs Smith knows/thinks that her umbrella is closed.
Mrs Smith knows/thinks that her umbrella is open.
9.
The zoologist knows/thinks that the puffer fish is frightened.
The zoologist knows/thinks that the puffer fish is relaxed.
10.
The jockey knows/thinks that the horse is lying down.
The jockey knows/thinks that the horse is standing up.
- 11.

The shopkeeper knows/thinks that the wrapping paper is rolled up.
The shopkeeper knows/thinks that the wrapping paper is screwed up.

12.
The designer knows/thinks that the shirt is crumpled.
The designer knows/thinks that the shirt is hung up.

13.
The businessman knows/thinks that his phone is closed.
The businessman knows/thinks that his phone is open.

14.
The zookeeper knows/thinks that the snake is coiled up.
The zookeeper knows/thinks that the snake is stretched out.

15.
The gardener knows/thinks that the tomato is sliced.
The gardener knows/thinks that the tomato is whole.

16.
Mum knows/thinks that the loaf of bread is sliced.
Mum knows/thinks that the loaf of bread is whole.

17.
The politician knows/thinks that the flag is fluttering.
The politician knows/thinks that the flag is motionless.

18.
The hiker knows/thinks that his map is folded up.
The hiker knows/thinks that his map is open.

19.
The birdwatcher knows/thinks that the duck is in flight.
The birdwatcher knows/thinks that the duck is on the ground.

20.
The man knows/thinks that the shrimp is cooked.
The man knows/thinks that the shrimp is raw.

21.
The nanny knows/thinks that the pushchair is folded up.
The nanny knows/thinks that the pushchair is opened out.

22.
The cook knows/thinks that the spaghetti is cooked.
The cook knows/thinks that the spaghetti is raw.

23.

The camper knows/thinks that his sleeping mat is laid out.
The camper knows/thinks that his sleeping mat is rolled up.

24.

Andrew knows/thinks that the drawer is closed.
Andrew knows/thinks that the drawer is open.

25.

The mechanic knows/thinks that the tyre is inflated.
The mechanic knows/thinks that the tyre is punctured.

26.

The security guard knows/thinks that the gate is locked.
The security guard knows/thinks that the gate is unlocked.

27.

The housekeeper knows/thinks that the door is closed.
The housekeeper knows/thinks that the door is open.

28.

The athlete knows/thinks that his water bottle is empty.
The athlete knows/thinks that his water bottle is full.

29.

Mrs Green knows/thinks that the chocolate is melted.
Mrs Green knows/thinks that the chocolate is solid.

30.

Mary knows/thinks that the ice lolly is frozen.
Mary knows/thinks that the ice lolly is thawed.

31.

John knows/thinks that the tomato is dried.
John knows/thinks that the tomato is juicy.

32.

The old lady knows/thinks that the picnic basket is closed.
The old lady knows/thinks that the picnic basket is open.

33.

Granny knows/thinks that the wool is messed up.
Granny knows/thinks that the wool is rolled up.

34.

The holidaymaker knows/thinks that the deckchair is folded up.
The holidaymaker knows/thinks that the deckchair is opened out

35.

The schoolboy knows/thinks that the snail is inside its shell.
The schoolboy knows/thinks that the snail is out of its shell.

36.

The lady knows/thinks that her scarf is folded up.
The lady knows/thinks that her scarf is scrunched up.

37.

Mark knows/thinks that the tube of toothpaste is empty.
Mark knows/thinks that the tube of toothpaste is full.

38.

Amy knows/thinks that the Christmas cracker is pulled.
Amy knows/thinks that the Christmas cracker is whole.

39.

Sarah knows/thinks that the hot air balloon is deflated.
Sarah knows/thinks that the hot air balloon is inflated.

40.

Alison knows/thinks that the envelope is open.
Alison knows/thinks that the envelope is sealed.