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Different but the Same: Mental Representations of Negated Similes

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ABSTRACT

When people comprehend language, they mentally represent object shape. Previous research has shown that objects that are mentioned in a simile construction (X is like Y) are represented as similarly shaped. The present study examined object shape in mental representations of *negated* similes (X is NOT like Y). In our experiment participants read negated similes or control sentences without a comparison structure. After having read the sentence, they judged whether two presented objects, which were either similarly or dissimilarly shaped, were previously mentioned. Our findings showed that for the negated similes, verification latencies were shorter for similarly shaped than for dissimilarly shaped objects. This shows that the expected situation (without the negation marker), rather than the actual situation is represented. For the control sentences, we did not find such an effect of similarity in shape. We discuss our findings in the light of processing theories of negation and comparison.

Introduction

Perceptual Symbol theory assumes that during language processing people activate perceptual symbols of concepts expressed. These are mental representations about perceptual features of the referent, like its orientation, color, and shape (Barsalou, 1999). Transformations of the referent expressed in language cause analogous transformations of the mental representations. For example, if we talk about seared rather than raw steak, the color of the steak in the mental representation will be adjusted (Connell, 2007; but see also Richter & Zwaan, 2009). Likewise, if we talk about a flying bird, the perceptual symbol of the shape of the bird will be matched to that situation (Zwaan, Stanfield, & Yaxley, 2002). Experimental evidence supporting the perceptual symbol hypothesis has hitherto focused largely on the representation of concrete objects, such as a seared steak or a flying bird. But do people also construct perceptual symbols for higher order information, like *similarity* between two objects (e.g., *"A forklift is like an elephant"*) and, if so, what do such perceptual symbols look like? In an earlier study (Van Weelden, Schilperoord, & Maes, 2014), we demonstrated that comparison statements indeed affect perceptual symbols. When two objects are described as being similar, people verify pictures of those objects faster when they have similar shapes than when they have different shapes. In the present study we elaborate on this work by focusing on the perceptual representation of another type of higher order information: negation. In particular, we investigate the perceptual symbol of similarity in mental representations of *negated* comparisons (e.g., *"A forklift is not like an elephant"*).

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Shape and Perceptual Symbols

Zwaan et al. (2002) were among the first to demonstrate that a perceptual symbol of object shape is activated during language processing. In their experiment participants read sentences like "The ranger saw the eagle in the sky" or "The ranger saw the eagle in its nest," after which they had to verify a line drawing of the described eagle. These drawings depicted the eagle either with outstretched or with folded wings. Verification times were faster if the implied shape of the object description matched with the shape of the object in the drawing.

Van Weelden et al. (2014) investigated the perceptual symbols of object shape when people process similes, which are comparisons between two concepts from disparate domains, (e.g., *"A forklift is like an elephant"*). It was hypothesized that when similes are processed, people's perceptual symbols of the compared entities represent them as having a similar shape. The reasoning behind this prediction was as follows. When people interpret (metaphoric) relations between entities, they have a preference for conceptual similarities over perceptual similarities (Gentner & Clement, 1988). At the same time, there is a robust relationship between perceptual and conceptual features of objects. That is, conceptually similar objects are expected to look similar as well (Desmarais, Dixon, & Roy, 2007; see also Ortiz, 2010; on *"The nature of an entity is its shape"*). In addition to this, evidence suggests that the reverse holds as well. When two objects have similar shapes, people tend to judge them to be conceptually similar (Van Weelden, Maes, Schilperoord, & Cozijn, 2011; Van Weelden, Maes, Schilperoord, & Swerts, 2012).

To test the hypothesis, Van Weelden et al. (2014) had participants read sentences that either invited them to compare two objects (i.e., "An X is like a Y") or described a non-comparing, locational relation between the same objects (i.e., "An X is in front of a Y"). After having read the sentence, participants were presented with two pictures of objects and were asked to verify whether those were the two objects that were mentioned in the preceding sentence. The depicted objects either had similar or dissimilar shapes. For comparison statements, verification latencies were found to be shorter for similarly shaped objects than for dissimilarly shaped objects while no such effect was found for the location sentences. These findings are taken as evidence for the activation of a perceptual symbol of similarly shaped objects when processing similes. In the present study, the question is addressed whether this perceptual symbol of shape is also activated when people process similes that explicitly deny two objects being "like" each other (e.g., "An X is NOT like a Y").

Negation

Both the ubiquity and expressive potential of negation warrant addressing the question how negation affects perceptual symbols, for example in cases denying similarity between concepts. Semantically, negation is an operator marked by lexical items like "no," "not," "never," "without," "neither—nor," which reverses a statement's truth value (e.g., "I have read Franzen's new novel" vs. "I have NOT read Franzen's new novel"). Pragmatically, negation is invaluable. Without it, we would not be able to perform the speech acts of denying and refuting, and engage in communications as diverse as arguing, advising, warning, forbidding, or instructing. Negation is also the conveyor of the subtle semantics of irony and euphemism, and helps us to determine which information is to be extracted from statements and the implications to be drawn from them, like denying presuppositions (e.g., "John stopped smoking." "No, he did not, he never smoked.") or implicatures (e.g., "Some men are chauvinists." "No, all men are chauvinists.").

Crucially, despite its pragmatic diversity, negation always implies communicating some *deviation from expectancy* (Giora, 2006; Kaup, Lüdtke, & Zwaan, 2006). That is, the idea that a particular situation or state is opposed to what is or might be believed, implied, or expected. Therefore, a statement like "I haven't read Franzen's new novel" represents two states, which we shall refer to as the *actual* state and the *expected* state. The actual state captures what the speaker actually is saying: "I have NOT read Franzen's new novel," while the expected state captures what he or she expects his or her interlocutor believes to be true: "I HAVE read Franzen's new novel."

With regard to the perceptual symbol of object shape for negated similes ("An X is *not* like a Y"), this analysis gives rise to two opposing expectations. The perceptual symbol either represents the actual state or the expected state. According to the former, one would expect negated similes to activate perceptual symbols of objects that *differ* in shape. On the other hand, according to the latter, one would expect negated similes to be represented just like their affirming counterparts (i.e., to activate perceptual symbols of objects that are *similar* in shape).

The first hypothesis is in line with the so-called suppression hypothesis regarding negation (Hasson & Glucksberg, 2006), according to which the "X is like Y" similarity should be suppressed and be replaced by the actual situation: X IS [NOT LIKE Y]. Under this view, the prediction is that people, after reading negated similes, will verify dissimilarly shaped objects faster than their similarly shaped counterparts.

The second hypothesis is in line with the so-called retention hypothesis (Giora, Heruti, Metuki, & Fein, 2009), which predicts the expected situation to be retained. In this case, the presence of the negation marker does not result in the representation of the actual situation; NOT [X IS LIKE Y]. Under this view, the prediction is that people, after reading negated similes, will verify similarly shaped objects faster than their dissimilarly shaped counterparts.

Support for the second hypothesis comes from a study of Kaup, Yaxley, Madden, Zwaan, and Lüdtke (2007) in which it was investigated what perceptual symbol of shape is activated when a situation is negated. Results showed that after reading a sentence like "There was *no* eagle in the sky" participants verified a picture of the eagle faster if it had its wings outstretched than if it had its wings folded. This finding shows that the negation marker did not prevent that the expected (i.e., NOT [EAGLE IS IN THE AIR]), rather than the actual situation (i.e., EAGLE IS [NOT IN THE AIR]) was mentally represented.

There may, however, be a catch. According to Giora (2006), processing negation involves two stages: (1) an initial, comprehension stage, which is insensitive to negation and (2) a subsequent, interpretation stage, which involves the representation of the actual situation. In the Kaup et al. (2007) study pictures were presented very shortly after the offset of the sentences. Their recognition task thus may have informed only about the initial stage of processing, and have failed to tap into the interpretation of the negation. In an earlier study, Kaup et al. (2006) actually hypothesized, congruent with Giora's (2006) two-stage view, that a representation involving negation is formed *after* the initial representation, that is, the one representing the expected situation. In this study participants read both affirmative and negative sentences, such as "The door is/is not open" and subsequently received a picture naming task. Pictures of the mentioned object either matched or mismatched with the object's properties (e.g., an open door or a closed door). The pictures were presented with a short (i.e., 750 msec) or a long delay (i.e., 1,500 msec). Results indicated that in the short delay conditions, naming was faster for matching pictures as compared to mismatching pictures, but only for affirmative sentences (e.g., "The door is open"). The exact opposite effect was found for the long delay condition. For negated sentences (e.g., "The door was not open") naming was faster for matching pictures than for mismatching pictures, whereas this effect was absent for the affirmative sentences. Under the present terminology, the findings of Kaup et al. (2006) indicate that when processing negation statements, comprehenders represent both the expected and the actual situation, but they first focus their attention on the expected situation (i.e., the open door) and then on the actual situation (i.e., the closed door).

The time course of processing negation was also studied by Hasson and Glucksberg (2006), this time focusing on processing metaphorical statements and their negated counterparts. Participants read sentences like *"This kindergarten is a zoo"* and *"This kindergarten isn't a zoo."* A lexical decision task was used to investigate how the two types of sentences were mentally represented. Target words were either related to the affirmation (the expected state; e.g., *noisy*) or the negation (the actual state; e.g., *calm*). Furthermore, the delay between the prompt and target word varied. Results showed that in early processing (i.e., after 150 and 500 msec delay) both affirmative and negated metaphors facilitated naming affirmative target words (i.e., noisy). After 1,000 msec, however, affirmative metaphors kept

facilitating the naming of affirmative-related target words, whereas the negated metaphors did not. Yet there was also no facilitation of the negative-related words for the negated metaphors, at this later stage. It is therefore unclear whether the latter results disproof Giora's two-stage view or whether it reflects difficulties in disentangling the two processing stages. Either way, more insight is needed into how people represent negated metaphors *after* the initial processing stage.

Present Study

In the present study, we focus on the way people mentally represent negated similes. In line with Zwaan et al. (2002) and Van Weelden et al. (2014), we are interested to see whether a perceptual symbol of object shape is activated when processing negated similes. We present participants with negated similes (e.g., "*A forklift is not like an elephant*") and negated location sentence (e.g., "A forklift was not located in front of an elephant"). Subsequently, participants are presented with two pictures of objects, either having similar or dissimilar outlines, that were mentioned in a preceding sentence. The participants' task is to verify whether these objects were shown in the previous sentence.

Considering the time course of the interpretation of negations, our focus is on the "later" stage of processing because in this stage the interpretation of the sentences is expected to include negation. Therefore, the delay between the offset of the sentence and the presentation of the pictures was set at 1,500 msec. If negation is part of the predicate: X IS [NOT LIKE Y] (i.e., if the two entities are represented as the actual state), then verification latencies are predicted to be shorter for dissimilarly shaped objects (Hypothesis 1). If, on the other hand, negation is not part of the predicate: NOT [X IS LIKE Y] (i.e., the expected state is represented), then verification latencies are predicted to be shorter for similarly shaped objects (Hypothesis 2). The latter outcome would indicate that people represent the objects as similar, but somehow label this representation as not true. This labeling is then not included in the mental representation, or at least not in the shapes of the objects in the representation. Finally, as in Van Weelden et al. (2014), we expect to find none of these effects for negated location sentences with the "An X is not in front of a Y" structure (Hypothesis 3). The predictions and previous findings are summarized in Table 1.

Method

Participants

Fifty Tilburg University (Tilburg, The Netherlands) undergraduates (33 women and 17 men) participated in this study for course credit. Their mean age was 21.5 years, ranging from 18 to 28.

Materials

We based our materials on a subset from the materials used in Van Weelden et al. (2014). In total, we used 12 negated similes, 12 negated location sentences (see Appendix A for the Dutch sentences and English translations) and 24 filler sentences (i.e., 12 negated similes and 12 negated location fillers). Each of the different types of sentences involved a target (X) and a base term (Y).

Table 1. Overview of previous findings and hypotheses for present study.

Type	Meaning	Hypothesis	Picture verification time
Similes	*Affirmative*	(Van Weelden et al., 2014)	Similar shape < dissimilar shape
	Negated	H1, present study	Dissimilar shape < similar shape
		H2, present study	Similar shape < dissimilar shape
Location	*Affirmative*	(Van Weelden et al., 2014)	Similar shape = dissimilar shape
	Negated	H3, present study	Similar shape = dissimilar shape

The negated similes had an "X is not like Y" construction (1). The negated location sentences negated a spatial relation between the two entities (2). In these control sentences, the target and base term were mentioned but the construction of the sentence did not invite to compare the two in any way. Based on the presented objects, the experimental sentences required a "yes" response, while the filler sentences required a "no" response.

(1) Een heftruck is niet als een olifant.
A forklift is not like an elephant.
(2) Een helikopter zweefde niet boven een libel.
A helicopter did not hover above a dragonfly.

For each of the target and base term combinations, Van Weelden et al. (2014) created a picture set. Each picture set consisted of a target object and two base objects (see Appendix B). The shape (i.e., outline) of the base object was depicted either similar (+Shape) or dissimilar (−Shape) to the target object, see Figure 1. The 200 × 200 pixel pictures were simple black-and-white line drawings.

We performed two pretests on the visual materials, which are also described in Van Weelden et al. (2014). The manipulations of object shape were pretested by subjective ratings of shape similarity. Seventeen participants were presented with the 40 experimental picture pairs and were asked to rate their perceptual similarity by moving a slider along a track from 0 (not similar) to 1 (similar) to indicate their judgment about the shape similarity of the object pairs. The test showed a significant difference between the ratings for the +Shape (.63) and the −Shape pairs (.26); $t(16) = 12.16$, $p = .001$. The prototypicality of the shape of objects was pretested through a test in which 10 participants were instructed to read a presented word, imagine what the object described by the word would look like, and then, from two objects, pick the object that provided the closest match to their imagined object. A chi-square analysis did not reveal a difference between the prototypicality of the +Shape (54.3%) and −Shape (45.7%) base pictures; $\chi 2$ (1, $N = 200$) = .50, $p = .48$.

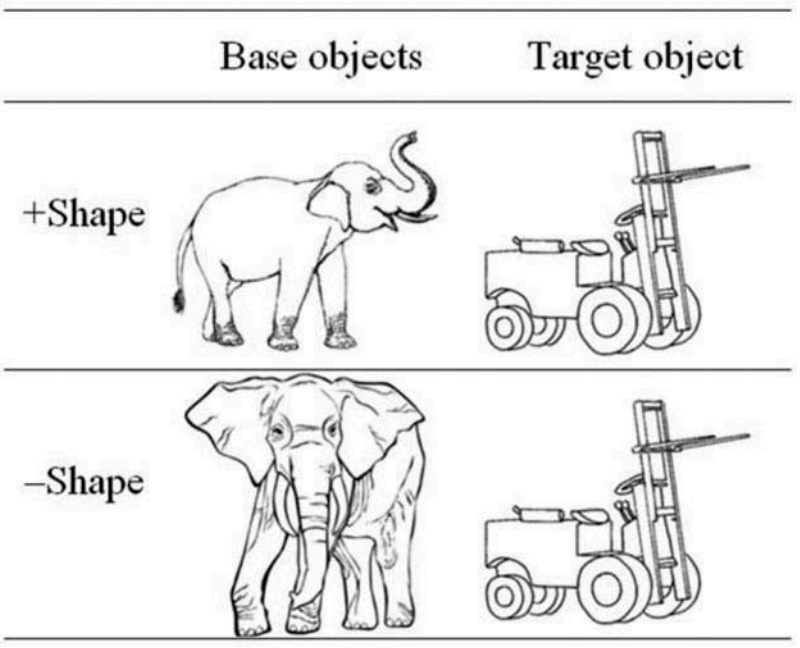

Figure 1. Example picture set with two picture pairs: +Shape and −Shape.

Design

The experiment had a 2 × 2 × 2 design, with Type of Sentence (levels: Negated simile and Negated location) and List (levels: List 1 and List 2) as between-subjects factors and Shape (levels: +Shape and −Shape) as within-subjects factor. The two lists counterbalanced picture sets and shape condition.

Procedure

Participants' task was to read each sentence and subsequently decide if the objects that followed were mentioned in the preceding sentence. They were told that verification times were being measured and that it was important to make their decisions as quickly as possible. During each trial, participants first saw a fixation cross in the center of the screen for 1,000 msec. Then the sentence appeared, which either did or did not mention both objects presented subsequently. Participants were told to press the "yes" button when they had understood the sentence, after which another fixation cross appeared in the center of the screen for 1,500 msec. Then, the two object pictures were presented simultaneously. The target object was always presented on the left side and the base object on the right side. When the objects were presented on the screen, participants decided whether both objects were mentioned in the preceding sentence. They gave their response by pressing a key on a button panel. The "yes" response key was located on the dominant hand side of the participants. The trial ended with feedback indicating whether the answer was correct, incorrect, or given too late, that is, after more than 2 seconds. Directly following the feedback, the next trial started with a fixation cross on the screen.

Each participant saw 12 experimental trials (i.e., negated simile or negated location) requiring "yes" responses and 12 filler trials requiring "no" responses. The experiment started with five practice trials to familiarize the participants with the task. We used E-Prime software[1] to control the presentation durations of the fixation crosses and pictures, to randomize the sentence–picture pairs, and to collect the verification latencies.

Results

We conducted a 2 × 2 × 2 analysis of variance (ANOVA), with Type of Sentence (levels: Negated simile and Negated location) and List (levels: List 1 and List 2) as between-subjects factors and Shape (levels: +Shape and −Shape) as within-subjects factor, on the verification latencies. The analyses of the verification latencies focused on the latencies of the correct responses; 3% of the data was excluded for this reason. To control for outliers, we additionally discarded 3.5% of the data. We only included the latencies within a range of two standard deviations from the overall mean. We did not find an effect of List on the response latencies ($F_1 < 1$; $F_2 < 1$). Therefore, we excluded the factor List from the rest of the analyses.

There was an effect of Shape on the verification latencies for the analysis by subjects and a trend of an effect for the analysis by items, $F_1(1, 48) = 17.79$, $p = .000$, $\eta^2_p = .27$; $F_2(1, 10) = 3.60$, $p = .08$, $\eta^2_p = .26$. Responses were faster for objects that were similar in shape ($M = 769$ msec, $SD = 132$ msec) than for objects that were dissimilar in shape ($M = 820$ msec, $SD = 123$ msec). There was no effect of Type of Sentence for the analysis by subjects, but the analysis by items did show an effect, $F_1(1, 48) = 2.07$, $p = .16$; $F_2(1, 10) = 17.65$, $p = .002$, $\eta^2_p = .64$. Responses were faster for the negated location sentences ($M = 773$ msec, $SD = 72$ msec) than for the negated similes ($M = 817$ msec, $SD = 89$ msec). The analyses showed an interaction between the two factors, $F_1(1, 48) = 7.38$, $p = .009$, $\eta^2_p = .13$; $F_2(1, 10) = 9.23$, $p = .012$, $\eta^2_p = .48$, see Figure 2.

To get more insight in the effect of Shape for the different Types of Sentences, we performed post hoc analyses. These analyses revealed that for the negated similes the verification latencies were

[1]See http://www.pstnet.com/eprime/cfm

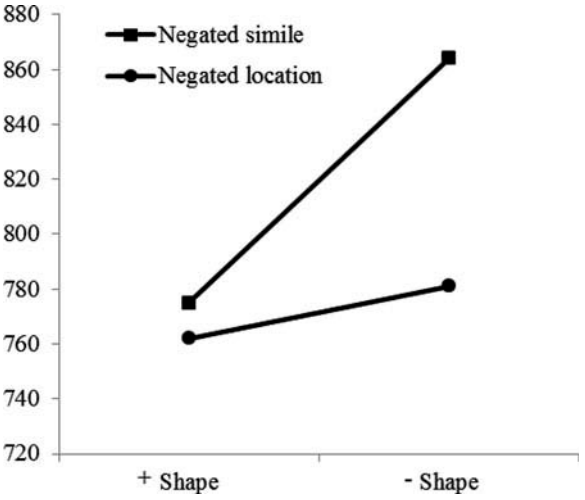

Figure 2. Interaction effect between Shape and Type of Sentence.

significantly faster for similarly shaped objects (M = 776 msec, SD = 141 msec) as compared to dissimilarly shaped objects (M = 864 msec, SD = 132 msec), $F_1(1, 22) = 22.46$, $p = .000$, $\eta^2_p = .51$, $F_2(1, 10) = 8.60$, $p = .015$, $\eta^2_p = .46$. For the negated location sentences, there was no difference between the response latencies to the similarly and dissimilarly shaped objects ($F_1(1, 26) = 1.22$, $p = .28$; $F_2(1, 10) = 1.014$, $p = .34$).

Discussion

The purpose of the present study was to examine the activation of the perceptual symbol of shape when processing negated similes (i.e., X is not like Y). Our earlier study showed that language comprehenders represent the objects that are mentioned in a simile (i.e., X is like Y) as similarly shaped objects (Van Weelden et al., 2014). The prediction of the present study was that under the suppression hypothesis, negated similarity would facilitate verification for objects with different shapes, whereas under the retention hypothesis, negated similarity would be represented like affirmative similes, hence facilitating verification for similarly shaped objects.

Our findings show that for negated similes the verification latencies were shorter for similarly shaped objects than for dissimilarly shaped objects. For negated location sentences no differences in verification latencies were found between similarly and dissimilarly shaped objects. These results thus suggest support for the retention hypothesis as in processing negated similes, people's perceptual symbols represent the expected situation in which an X is like a Y.

This finding corroborates with what we found in Van Weelden et al. (2014). In that study, the participants read sentences that were the same as the ones used in the present study except for the absence of a negation marker ("*A fork lift is like an elephant*" versus "*A fork lift is not like an elephant*"). These two studies together suggest that both the processing of similes and their negated counterparts give rise to a mental representation of similarly shaped objects.

To put these findings in further perspective, it is informative to compare the results for the negated similes in the present study to the results for affirmative similes of Van Weelden et al. (2014). The overall difference between affirmative and negated similes is considerable: 51 msec (725 msec and 776 msec, respectively) for similarly shaped objects and 107 msec (757 msec and 864 msec, respectively) for dissimilarly shaped objects. This surplus in RTs as compared to the previous study suggests that in the present study participants actually processed the negation—the only difference between the experimental sentences used here and in Van Weelden et al. (2014)—

instead of merely attending to the objects. That is, the increase in verification times for the negated similes as compared to the affirmative similes indicates that additional time was needed to process the negation marker and integrate it in the overall meaning of the sentences.

Although the results clearly support the retention hypothesis (Giora et al., 2009) and the findings of Kaup et al. (2007), they are less easy to explain in terms of the processing phases suggested by Giora (2006). That is, Kaup et al. showed faster recognition to objects if the shape of the objects matched the implied shape of the expected situation. The findings of the present study also show that the recognition to objects was faster if their shape matched the expected situation. So it seems that the negation was not part of the mental representation. However, the absence of the negation marker in mental representations found in Kaup et al.'s study can be explained by their experiment tapping into the initial stages of processing, which might be insensitive to negation. This explanation does not hold for the present study, which was designed to tap into later stages of processing, thereby allowing time to interpret the negation. Hence, our findings indicate that *negated* similarity lacks a perceptual representation in terms of object shape, even in the "later" stage of processing.

Interestingly, our findings suggest that interpreting statements that invite looking for differences between objects is tightly connected to and even dependent on the process of *finding similarities*. This conforms to Gentner's (1983) Structural-mapping theory, which models the process of comparison as a mentally performed structural alignment between two mental representations (Gentner & Markman, 1994; Markman & Gentner, 1993). When looking for commonalities between two objects, people attempt to find a structurally consistent match based on representations including these objects, their attributes, relations between objects, and relations between relations. Markman and Gentner (1993) showed that finding *differences* between objects also operates on (establishing) structural alignments. In their study, they asked participants to list commonalities and differences between pairs of words. While as expected participants produced more commonalities for similar objects (e.g., a yacht and a sailboat) than for dissimilar ones (e.g., an eggplant and a giraffe), they also produced *more differences* for similar objects than for dissimilar ones (see also Gentner & Markman, 1994). These differences were furthermore often related to what the objects structurally have in common. For example, because both a yacht and a sailboat move over water, it is relatively easy to find the difference that a yacht moves forward by a motor while a sailboat uses the wind. In other words, differences between objects may stand out because the objects *can* be structurally aligned. Thus, the process of structural alignment is driven by similarities, even when the task is to find differences, which in our case was induced by a negation marker. This might be a reason why we found mental representations that matched the representations of an affirmative simile.

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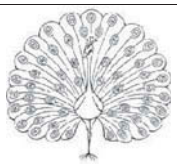
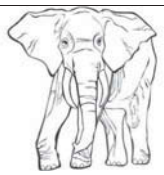
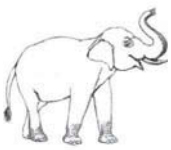
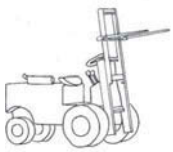
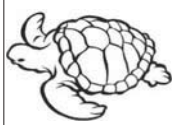
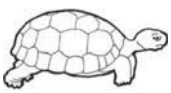
Appendix A

Set	Negated simile	Negated location
1	Een jeep is niet als een nijlpaard. *A jeep is not like a hippo.*	Een jeep bevond zich niet achter een nijlpaard. *A jeep was not located behind a hippo.*
2	Een waaier is niet als een pauw. *A fan is not like peacock.*	Een waaier lag niet voor een pauw. *A fan did not lie in front of a peacock.*
3	Een vuurtoren is niet als een giraf. *A lighthouse is not like giraffe.*	Een vuurtoren stond niet voor een giraf. *A lighthouse did not stand in front of a giraffe.*
4	Een heftruck is niet als een olifant. *A forklift is not like an elephant.*	Een heftruck bevond zich niet voor een olifant. *A forklift was not located in front of an elephant.*
5	Een caravan is niet als een schildpad. *A caravan is not like a turtle.*	Een caravan stond niet op een schildpad. *A caravan did not stand on top of a turtle.*
6	Een tol is niet als een ballerina. *A spinning top is not like a ballerina.*	Een tol stond niet achter een ballerina. *A spinning top did not stand behind a ballerina.*
7	Een klok is niet als de zon. *A clock is not like the sun.*	Een klok stond niet in de zon. *A clock did not stand in the sun.*
8	Een vlieger is niet als een meeuw. *A kite is not like a seagull.*	Een vlieger belandde niet achter een meeuw. *A kite did not land behind a seagull.*
9	Een helikopter is niet als een libel. *A helicopter is not like a dragonfly.*	Een helikopter zweefde niet boven een libel. *A helicopter did not hover above a dragonfly.*
10	Een bulldozer is niet als een mier. *A bulldozer is not like an ant.*	Een bulldozer stond niet op een mier. *A bulldozer did not stand on top of an ant.*
11	Een kantoorgebouw is niet als een bijenkorf. *An office building is not like a beehive.*	In een kantoorgebouw bevond zich geen bijenkorf. *'In an office building, a beehive was not located.'*
12	Een wekker is niet als een haan. *An alarm clock is not like a rooster.*	Een wekker stond niet achter een haan. *An alarm clock did not stand behind a rooster.*

Appendix B

Set	–Shape Base	+Shape Base	Target
1			
2			
3			
4			
5			
6