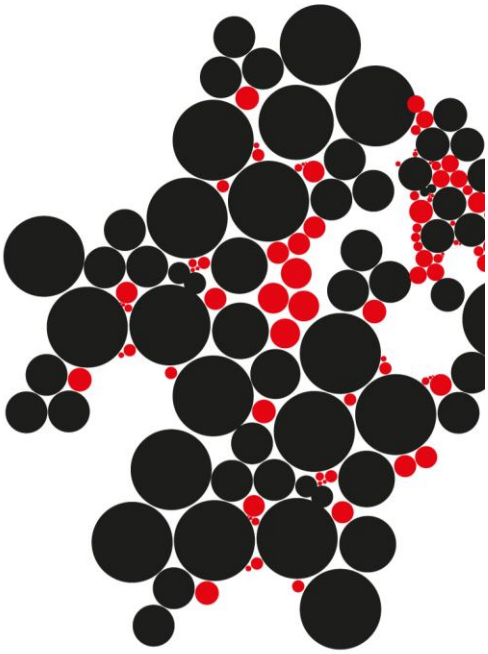

PROCESSING OF METAPHORS IN THE CONTEXT OF BILINGUALISM: AN EVENT-RELATED POTENTIAL STUDY

Bachelor Thesis

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Abstract

The processing of literal, novel metaphorical and semantically anomalous expressions in native Dutch speakers and German Dutch learners was examined using event-related potentials. The N400 component was determined for expressions which were formulated in an “A is a B” form and varied in their degree of figurativeness. A three-choice task was used in which the participants had to decide whether an expression is literal, metaphorical or anomalous. An increase in negativity for the N400 was found in the Dutch group, being less negative for literal expressions, more negative for novel metaphors and most negative for anomalous expressions. For German participants, this pattern was different, as anomalous expressions could not be distinguished from metaphorical expressions. Metaphorical and anomalous expressions both evoked a greater N400 component than literal expressions. The results were interpreted to indicate that the N400 component is a representation of semantic astonishment with less expected expressions resulting in the greatest N400 components. This was supposed to be similar for the first and second language.

Keywords: language, nominal metaphor, ERP, bilingualism, N400

Samenvatting

De verwerking van letterlijke, novel metaforische en semantisch anomale expressies door Nederlanders en Duitsers met Nederlands als tweede taal werd onderzocht door middel van event-related potentials. De N400 component werd bepaald voor expressies met een “A is een B” vorm die varieerden in hun mate van figuurlijkheid. Een drie-keuze taak werd gebruikt waarin deelnemers moesten beslissen of een expressie letterlijk, metaforisch of anomaal is. Bij de Nederlandse deelnemers werd voor de N400 een toename in negativiteit gevonden. Minst negatief waren letterlijke expressies, gevolgd door novel metaforen en anomale expressies. Bij de Duitse deelnemers was het patroon anders: anomale expressies waren niet te onderscheiden van metaforen. Metaforen en anomale expressies riepen wel allebei een negatievere N400 op dan letterlijke expressies. De N400 component werd als een representatie van onverwachtheid geïnterpreteerd, zodat minder te verwachten expressies een grotere N400 component oproepen. Er werd ervan uit gegaan dat dit proces gelijk is voor de eerste en tweede taal.

Processing of Metaphors in the Context of Bilingualism: An Event-related Potential Study

Figurative expressions color our language, but the way they are processed is quite controversial. This topic has been an item of research in linguistics, cognitive linguistics and psychology for several decades. Conceptual metaphor theory stated 30 years ago that metaphor was not just an aspect of language but a fundamental part of human thought (as cited in Gibbs, 2011). This was a starting point to metaphor research and made clear how challenging metaphors were to understand. The question to be raised, however, is whether metaphors are qualitatively different from literal expressions and whether there is a qualitative difference between metaphor processing in native speakers and second language learners.

A metaphor is a figure of speech that establishes an analogical relationship between two concepts: a source (or vehicle) concept and a target (or topic) concept (Yang, Bradley, Huq, Wu & Krawczyk, 2013). In the metaphorical sentence “Life is a journey”, the features of journey (source) are thus projected to the concept of life (target). If as in this case the metaphorical term is a noun, it is called a nominal metaphor in contrast to verbal (here, the metaphorical term would be a verb, e.g., “I see your point.”) and qualifying (the metaphorical term would be an adjective or adverb, e.g., “She sings blindly.”) metaphors. Metaphors are further distinguished into conventional and novel. The difference is the degree of familiarity with novel metaphors as being less familiar. With respect to this variety of metaphors, there was the idea that “different theoretical accounts may be needed to explain various kinds of metaphorical language” (Gibbs & Matlock, 2008, p. 165). The present study focused explicitly on novel nominal metaphors.

In addition to the long standing tradition of linguistic reasoning and the reaction time (RT) paradigm about metaphor processing, recent studies also considered non-linguistic data gathered in psycholinguistic experiments (Kertész, Rákosi, & Csatár, 2012). Event-related potentials (ERPs) formed part of those non-linguistic data and provided important results to further understand the underlying processes of metaphor processing. ERPs are derived from electroencephalographic (EEG) measures and describe the electrophysiological activity resulting from motor, sensory and cognitive events at a given moment, e.g., stimulus onset (Ibáñez et al., 2010). EEG is an adequate measure for language experiments as it has an eminent temporal resolution. Other methods, in contrast, cannot adequately capture the quick processes in language usage.

With regard to metaphor processing, one ERP component proved to be very important: N400. The N400, a negative amplitude peaking at around 400 ms post stimulus onset, is one of the most established language-related ERP components (Lai, Curran, & Menn, 2009). It was considered to be related to semantic unexpected components in sentence comprehension and has been reported in several ERP studies concerning figurative language (Arzouan, Goldstein, & Faust, 2007; Coulson, & Van Petten, 2002; Iakimova, Passerieux, Laurent, & Hardy-Bayle, 2005; Pynte, Besson, Robichon, & Poli, 1996; Tartter, Gomes, Dubrovsky, Molholm, & Stewart, 2002).

To examine metaphor processing, Arzouan, Goldstein and Faust (2007) used two-word expressions conveying literal, conventional metaphoric, novel metaphoric or no meaning (unrelated). Participants performed a semantic judgment task in which they decided whether a two-word expression was meaningful. Arzouan et al. (2007) compared the N400 amplitude and found an increase as a function of expression type. Literal expressions elicited the smallest N400, followed by conventional metaphors, novel metaphors and unrelated two-word expressions, in order. The graded N400 component was interpreted as an indication of a more demanding retrieval process of conceptual knowledge concerning novel metaphors in contrast to literally related words. That is, the retrieval of the stored conceptual knowledge related to novel metaphors is more demanding than the retrieval of knowledge related to literal expressions or conventional metaphors. The meaning making process however was supposed to be similar. They assumed a quantitative in contrast to a qualitative difference in the processing of metaphorical and literal expressions. Kazmerski, Blasko and Dessalegn (2003) similarly found an increase in N400 from literal to metaphorical to scrambled (meaningless) expressions, but interpreted the result as dependent on the degree of semantic relatedness between the source and the target.

Although ERP research is established for language experiments concerning native speakers (L1), it was rarely used to consider second language (L2) processing (Hahne, 2001). Examining L2 learners means manipulating the automaticity of language processing and the familiarity with expressions. This could reveal relevant information to analyze metaphor processing in detail. Before EEG was introduced as research method in metaphor studies, Johnson and Rosano (1993) concluded that there was no difference between L1 and L2 speakers concerning the interpretation of metaphors. That is, that second language learners are able to interpret metaphors as good as native speakers. Early EEG research about L2 learners, in contrast, well stated a difference between L1 and L2. Here, however, the attention was directed to the neuronal processing of metaphors instead of the interpretation thereof.

Perani et al. (1996) indicated that low-proficient L2 speakers used different brain areas to process L1 or L2, but high-proficient L2 learners used the same region for both languages. Furthermore, the comparison of high-proficient L2 learners and native speakers concerning semantic processing while reading, got Ardal, Donald, Meuter, Muldrew and Luce (1990) to the result that the N400 amplitude was detected in every participant, but that the latency was 40 ms delayed in L2. They interpreted this time delay as dependent on the timing of an automatic word-identification process which preceded the N400 component. The slowdown of this process suggested a reduction in automaticity in L2, according to Ardal et al. (1990).

Hahne (2001) compared auditory sentence comprehension of German sentences in native Germans and native Russians whose second language was German. Semantic violations were reflected in the N400 component and these violations evoked different patterns in native speakers and second language learners. Here, the N400 effect was 100 ms delayed in the L2 learners and the N400 component was less pronounced in L2 due to more negative ERPs of literal expressions. A comparable delay was also found by Weber-Fox and Neville (1996) and Ojima, Nakata and Kakigi (2005). Weber and Lavric (2008) similarly found a N400 negativity elicited by final words containing semantic or syntactic violations in L2 learners and they interpreted the effect as a sign of increased integration demands.

There are a vast number of different metaphor theories, trying to explain the underlying processes and to integrate the research findings. One of the first theories, the traditional pragmatic model, gave new insights into the processing of metaphors by its falsification. This view was developed by Grice (1975) and Searle (1979) and based on the idea that metaphor processing has three stages. First, when a person gets in contact with a non-literal expression, she tries to understand it literally. Detecting that this is not possible or logical (second), the person tries to interpret the expression in a non-literal way (third). In this theoretical approach, literal and non-literal processing are said to be qualitatively different processes. One of the strongest counter-arguments against this idea was considered by Glucksberg (2003). He came to the conclusion that people could not ignore metaphors when they were expected to concentrate solely on the literal meaning of an expression. In his experiment, people had to judge whether sentences were literally true or false. If people were able to ignore the metaphorical meaning of a sentence, the metaphors should not have taken more time to be rejected than non-metaphoric literally false sentences. However, rejecting metaphors as literally false was difficult for the participants. This means, metaphoric interpretation was not optional and literal meaning had no priority. This was at odds with the traditional pragmatic model as it predicted that non-literal interpretations are not activated

when a literal interpretation is possible. Glucksberg challenged this assumption and concluded that “there is a consensus in the field that literal meaning does not have unconditional priority. Metaphor comprehension can be as easy as literal” (Glucksberg, 2003, p. 92).

In his theoretical approach, Glucksberg (2008) stated that metaphors are understood as categorical class-inclusion assertions. This means, metaphors are not understood by comparison but exactly as they appear. Saying that a surgeon is a butcher means that the surgeon belongs to the category of persons who behave the way a butcher does. To understand the relationship between the source and the target of an expression, people are expected to identify the closest superordinate category that encompasses the two concepts. Then, this category is used to compare them. For novel metaphors, the category has to be created and for conventional metaphors, the category is said to preexist. Glucksberg argued that literal and metaphorical expressions are processed in parallel and equally quickly. Novel metaphors are, according to this view, more difficult to integrate because the common superordinate category of the source and the target domain first has to be created. This would predict a greater N400 component for novel metaphors in contrast to literal expressions. Furthermore, the processing of anomalous expressions should be even more difficult and therefore result in an even greater N400, as a common superordinate category cannot be constructed. Since it should be more difficult to identify a superordinate category in L2, Glucksberg’s theory would moreover predict a greater N400 component for L2 learners.

A related metaphor theory is the graded salience hypothesis (Giora, 2003), which assumes two distinct mechanisms that run parallel: one stimulus driven (salience sensitive) bottom-up process and one context dependent top-down process. Giora (2008) argued against the literal/non-literal distinction as a qualitatively processing difference and supported the idea of a salient-nonsalient continuum. That is, that meanings are accessed according to their salience rather than according to whether they are literal or non-literal (e.g., metaphoric). If a word is frequently used in its metaphorical meaning, this meaning will be more salient than its literal meaning. Although, even if these supposed underlying processes differ from Glucksberg’s theory, the predictions made by the graded salience hypothesis with respect to the present question would not differ from Glucksberg’s predictions.

Another related metaphor theory is the predication model for simple metaphors by Kintsch (2008). He argued that one first has to represent human knowledge to be able to model the process of understanding metaphors and suggested a computational model using latent semantic analysis (LSA). LSA is a mathematical method encouraging relationships of

words through their co-occurrence in a large body of text (Wolff & Gentner, 2011). Kintsch (2008) insisted that literal and metaphorical comprehension (for simple metaphors) entail the same psychological processes. According to his model, to understand the expression "life is a journey", the parts of life which are related to journey are emphasized and the unrelated parts are deemphasized, that is, creating a contextualized vector in a map of meaning which represents *life-which-is-a-journey*. The model is closely related to Glucksberg's theory, but describes the processes in more detail (Kintsch, 2008). The N400 component should, according to this model, decrease with a higher degree of semantic relation. Again, assuming a different underlying process still yields the same predictions as Glucksberg's theory does. For that reason, the current study focused exclusively on the metaphor theory by Glucksberg.

In the present study, ERPs were used for the purpose of investigating whether the electrophysiological correlates of metaphoric processing were modulated by language group (native speakers vs. second language learners). Metaphoric processing was examined through the comparison of literal, metaphorical and semantically anomalous expressions and these three expression types were presented to native Dutch speakers and German Dutch learners. The study thus contrasted the L1 processing and the L2 processing of expressions, differing in their degree of figurativeness.

Method

Participants

The L1 group consisted of 18 native Dutch speakers (M_{age} = 23.83 years, SD = 7.09, age range: 17–49 years, 11 women) and the L2 group consisted of 18 native German speakers (M_{age} = 21 years, SD = 1.53, age range: 19–24 years, 15 women) whose second language was Dutch. One L1 participant was 49 years old, causing the deviating descriptive values. Excluding this participant from the L1 group yielded a mean age of 22.35 years (SD = 3.39, age range: 17–28 years). Most participants were students of the Faculty of Behavioral Sciences of the University of Twente in Enschede, the Netherlands, and one female native speaker was an employee of the University of Twente. All participants had normal or corrected to normal vision and hearing, did not suffer from dyslexia, neurological or psychiatric disease and used no legal or illegal drugs. 94.44% of the participants were right-handed (one left-handed person in each group). The students received participant credits based on the time spent as part of their academic study. 25.00% of the participants took part without compensation. The participants took part in the experiment after providing informed

consent and the procedure was accorded by the ethical committee of the University of Twente.

The German participants' language proficiency was tested through the on-line diagnostic language assessment system DIALANG (Alderson & Huhta, 2005) which is based on the Common European Framework of Reference (CEFR; Council of Europe, 2001) for languages. The CEFR defines 6 proficiency levels: A1 and A2 (basic user), B1 and B2 (independent user) and C1 and C2 (proficient user). The median of reading proficiency of the L2 group was C2 (ranging from A2 to C2) and the median of vocabulary proficiency was B2 (ranging from A1 to C2). The average age of acquisition of Dutch for the German participants was 19.56 years (SD = 1.04, age range: 18–22 years).

Stimuli

In the experiment, 93 sentences in an "A is (a) B" form were used. The B term was manipulated to create three conditions: literal, metaphorical and anomalous (total of 279 sentences). For an example see Table 1. In the anomalous condition, the B term was expected to be semantically unrelated to the A term. In the literal condition, the B term made a categorical inclusion and in the metaphorical expression, the B term was expected to be interpreted as figuratively related to the A term. The B term was monosyllabic with 3 to 6 letters in all conditions. There were no significant differences concerning the word frequency of the B terms between the three conditions ($F(2,276) = 2.32$, $p = .10$). The expressions were presented in a random sequence with 18 different random versions generated. Each version was made by one participant of the L1 group and one participant of the L2 group. The metaphorical expressions used in this study were supposed to be novel metaphors, as they were expected to be less familiar but still interpretable for the native speakers.

Table 1. *Examples of Expression Types with Approximate Literal Translation in Parenthesis*

Expression type	
Literal	Liefde is een staat. (Love is a state.)
Metaphorical	Liefde is een spel. (Love is a game.)
Anomalous	Liefde is een kip. (Love is a chicken.)

Procedure

Participants were seated in a comfortable chair, sitting upright with a distance of 60 cm from their eyes to the monitor (17"-CRT-screen). They were instructed to use exclusively the right index finger and to move as little as possible. A pre-test was taken while

the participant kept the eyes open and fixed on one point for 30 seconds and then closed for 30 seconds. Afterwards, the presentation of the stimuli was started (Presentation, Version 11.0). A short written introduction explained the structure of the experiment and which key to use to indicate whether an expression is literal, metaphorical or anomalous.

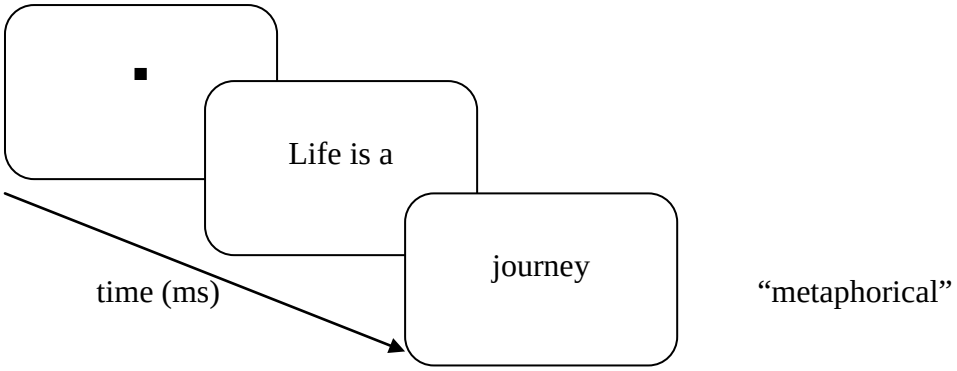

Figure 1. Schematic of the stimuli presentation during the experiment. The ocular fixation “■” appeared for 500 ms. The A term expression (Life is a) was presented for 1800 ms, followed by a white screen for 500 ms. The B term (journey) appeared for 300 ms followed by a white screen until the reaction (e.g., “metaphorical”) was given.

The assignment of the keys (left, right and upward arrow key of a standard QWERTY keyboard) was counterbalanced for the 18 versions of the experiment. The space bar could be used if a participant did not know the vocabulary. The participants first saw the sentence base and then the B term. Trials were intermittent by an ocular fixation “■” (see Figure 1). The stimuli were presented in a black font (size 23) on a light-grey background. During the measurement, the room was dark and quiet and after 15 minutes, a break of several minutes was held. At the end of the experiment, a post-test was taken (cf. pre-test).

Recordings

The EEG was acquired using Brain Vision Recorder (Version 1.10, Brain Products GmbH; installed on a separate acquisition computer) and a 72 channels QuickAmp (Brain Products GmbH) amplifier with the ground electrode placed on the forehead. The amplifier had a built-in average as reference. 61 passive Ag/AgCl ring electrodes were placed on the scalp (see Figure 2) with an elastic cap (Braincap, Brainproducts GmbH), two bipolar Ag/AgCl electrodes on the outer canthi of both eyes (horizontal electrooculogram, hEOG), two bipolar Ag/AgCl electrodes supra- and infraorbitally on the left (vertical electrooculogram, vEOG) and two bipolar Ag/AgCl electrodes on the right forearm (electromyogram, EMG; placed on the caput ulnae and the musculus extensor carpi ulnaris). Electrode impedance was kept below 10 kΩ. The signals were sampled at a rate of 500 Hz. In

addition to the EEG, EOGs and EMG, key presses and digital codes related to the presented stimuli were registered.

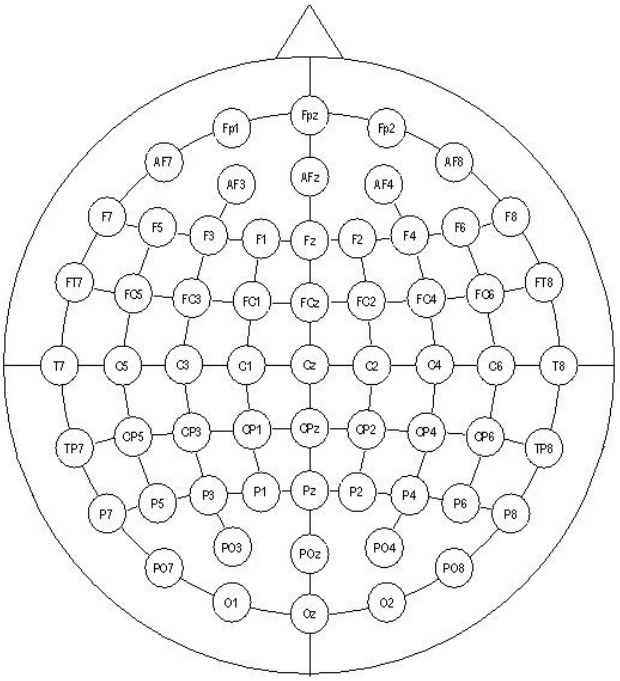

Figure 2. The configuration of recording electrodes viewed from the top of the head.

Data processing

Behavioral measures

RT was defined as the time period between the onset of the B term and the pressing of a key. Reactions faster than 400 ms and slower than 3000 ms were excluded from RT analysis. For each participant, the average RT per expression type was calculated. Furthermore, the percentage of congruent and incongruent judgments per expression type and participant was considered. That is, for instance, how many metaphors were rated as metaphorical, literal or anomalous. To analyze the RTs, repeated measures analyses of variance (ANOVAs) were conducted with language group (L1, L2) as between-subject factor and expression type (metaphorical, literal, anomalous) as within-subject factor. Interactions were further analyzed separately with independent sample *t*-tests and paired sample *t*-tests.

The judgments of the participants were analyzed through repeated measures ANOVAs with language group (2) as between-subject factor, and expression type (3) and judgment (congruent, incongruent (2)) as within-subject factor. Congruent judgments (CJ) were defined as reactions of the participant that were congruent with the expression type and incongruent judgments were thus defined as reactions that were incongruent with the expression type. Two kinds of incongruent judgments were possible as, for instance, a literal expression could

be categorized as metaphorical or anomalous, both being incongruent. Then, the three expression types were separately analyzed by means of repeated measures ANOVAs with judgment (3) as within-subject factor and language group (2) as between-subject factor. Significant effects were further analyzed by means of paired sample *t*-tests, separated for L1 and L2, and independent sample *t*-tests, separated for the expression types. The proportion of CJs was additionally analyzed with a repeated measures ANOVA with factors expression type (3) and language group (2). Further analysis was done with independent sample and paired sample *t*-tests. All statistical analysis was done with IBM SPSS Statistics 21.0. The confidence level was never chosen below 95.00 %.

EEG measures

The EEG data were analyzed with Brain Vision Analyzer 2.0 (Brain Products GmbH, 2012). Activity from -200 to 800 ms relative to the B term onset (stimulus-locked) was analyzed. The -200 to 0 ms interval was taken as baseline. Segments with eye movements (values of > 150 µV for the vEOG in the 0-200 ms interval) and EEG artifacts (parietal electrodes > 100 µV, central electrodes > 125 µV, frontal electrodes > 150 µV; gradient criterion: 100 µV / ms; low activation criterion: 0.1 µV / 50 ms) were excluded from further analyses. After inspection of the grand means, appropriate time windows were determined to analyze the N400 component as follows: 340 to 380 ms, 380 to 420 ms and 420 to 460 ms. Cz was used for analysis as the N400 component is a centro-parietal negativity (Arzouan et al., 2007; Hahne, 2001; Lu & Zhang, 2012). Obtained averages per individual were subjected to repeated measures ANOVAs with factors expression type (3), language group (2) and time window (340-380 ms, 380-420 ms, 420-460 ms). Next, the three windows were analyzed separately by means of repeated measures ANOVAs with expressions type (3) as within-subject factor and language group (2) as between-subject factor. Significant interactions were analyzed through paired sample *t*-tests for L1 and L2, respectively.

Results

Behavioral data

Reaction times

RTs differed across expression types ($F(2,68) = 51.73$, $p < .0005$) and language group ($F(1,34) = 9.40$, $p = .003$). Furthermore, a significant interaction between expression type and language group was found ($F(2,68) = 6.18$, $p = .004$). Planned comparison of the two groups yielded that participants in the L2 group needed significantly more time than L1 participants. This pattern was found for all expression types separately (metaphorical ($t(34) = 2.45$,

p = .02), literal (t(34) = 2.35, p = .025), anomalous (t(34) = 4.10, p < .0005)). Comparing the three expression types in the L1 group revealed that reactions to anomalous expressions were faster than reactions to literal expressions and both faster than to metaphorical expressions (anomalous vs. literal: t(17) = -5.13, p < .0005; anomalous vs. metaphorical: t(17) = -9.33, p < .0005; literal vs. metaphorical: t(17) = -6.27, p < .0005). For the L2 group the pattern was different. There was no difference detected between the RTs of literal and anomalous expression types (t(17) = .06, p = .95), but both were faster than metaphorical expressions (literal vs. metaphorical: t(17) = -5.74, p < .0005; anomalous vs. metaphorical: t(17) = -4.34, p < .0005). For the average RTs across expression types see Table 2.

Table 2. *Reaction Times (RTs) across Expression Types Differentiated for Language Groups*

	L1	L2
Expression type	M (SD)	M (SD)
Metaphorical	1338.70 (287.87)	1583.21 (310.99)
Literal	1191.16 (271.51)	1414.08 (296.85)
Anomalous	1042.67 (215.93)	1416.71 (321.02)

Note. L1 = native speakers, L2 = second language learners, M = mean, SD = standard deviation.

Judgments

For the 36 participants, the distribution of congruent and incongruent judgments (see Table 3) differed significantly across the three expression types (F(8,27) = 173.94, p < .0005) and between language groups (F(1,34) = 12.93, p = .001). A significant interaction of expression type and language group was also yielded (F(8,27) = 3.84, p = .004). The further analysis was done individually for the three expression types.

With regard to the metaphorical expressions, a main effect of judgment (F(2,33) = 432.43, p < .0005) and a main effect of language group (F(1,34) = 10.71, p = .002) was found. Planned comparison of the judgments revealed that no significant difference was yielded between metaphorical and anomalous judgments (t(35) = -.18, p = .86), but well for the other differences. Metaphorical expressions were more often judged as metaphorical than literal (t(35) = 13.89, p < .0005) and they were more often judged as anomalous than literal (t(35) = 14.91, p < .0005). No differences were found between L1 and L2 for metaphorical expressions judged as metaphorical, literal or anomalous (all ts(34) < 1.40, all ps > .18)

As regards the literal expressions, a main effect of judgment (F(2,68) = 249.13, p < .0005), a main effect of language group (F(1,34) = 7.09, p = .01) and an interaction effect

($F(2,68) = 7.00$, $p = .002$) were detected. In the L1 group, literal expressions were more often judged as literal than as metaphorical ($t(17) = 12.15$, $p < .0005$) and as anomalous ($t(17) = 15.54$, $p < .0005$). No difference was found between the frequency of literal expressions being judged as metaphorical or anomalous ($t(17) = 2.33$, $p = .03$). In the L2 group, this pattern was similar, with literal expressions being more often judged as literal than metaphorical ($t(17) = 12.17$, $p < .0005$) and anomalous ($t(17) = 11.52$, $p < .0005$) and with no detected difference between literal sentences being judged as metaphorical or anomalous ($t(17) = -.41$, $p = .69$). Members of the L1 group judged literal expressions more often as literal than L2 group members ($t(34) = 3.56$, $p = .001$) and less often as anomalous ($t(34) = 2.26$, $p = .03$). Although, no significant difference was found between L1 and L2 concerning literal expressions judged as metaphorical ($t(34) = .62$, $p = .54$).

Table 3. *Mean Percentages of Congruent and Incongruent Judgments across Expression Types and Language Groups*

	Judgment					
	L1			L2		
Expression type	Metaphorical	Literal	Anomalous	Metaphorical	Literal	Anomalous
Metaphorical	**46.66**	5.61	44.99	**39.83**	4.36	43.19
	(15.59)	(4.76)	(13.48)	**(13.93)**	(4.49)	(16.93)
Literal	17.48	**69.11**	10.79	15.73	**56.87**	17.00
	(8.32)	**(11.32)**	(7.12)	(8.57)	**(9.17)**	(9.25)
Anomalous	7.90	1.86	**88.97**	8.90	4.09	**72.73**
	(8.17)	(2.49)	**(10.07)**	(7.76)	(7.40)	**(15.57)**

Note. Standard deviations are indicated in parenthesis. Congruent judgments are shown in bold. Other responses (too fast, too slow, spacebar for unknown vocabulary) are not shown. L1 = native speakers; L2 = second language learners.

For the anomalous expressions, a main effect of judgment ($F(2,33) = 440.80$, $p < .0005$), a main effect of language group ($F(1,34) = 15.86$, $p < .0005$) and an interaction effect ($F(2,33) = 6.18$, $p = .005$) were found. In the L1 group, anomalous expressions were more often judged as anomalous than metaphorical ($t(17) = 19.00$, $p < .0005$) and literal ($t(17) = 30.71$, $p < .0005$). Furthermore, anomalous expressions were more often judged as metaphorical than as literal ($t(17) = 3.77$, $p = .002$). In the L2 group, this was different. Anomalous expressions were more often judged as anomalous than as metaphorical ($t(17) = 13.54$, $p < .0005$) and literal ($t(17) = 15.42$, $p < .0005$), but no difference could be

found between the frequency of judging an anomalous expression as metaphorical or literal ($t(17) = 1.80$, $p = .09$). Members of the L1 group judged more anomalous expressions as anomalous ($t(34) = 3.71$, $p = .001$) than members of the L2 group. No significant differences were found for the frequency of judging an anomalous expression as metaphorical ($t(34) = .37$, $p = .71$) or as literal ($t(34) = 1.21$, $p = .24$).

Finally, according only to the CJs, the main effect of language group ($F(1,34) = 26.12$, $p < .0005$) and expression type ($F(2,33) = 45.49$, $p < .0005$) remained. With regard to the independent sample *t*-test, L1 group members had significantly more percent of CJs than L2 group members ($t(34) = 5.11$, $p < .0005$). Both groups had most CJs for anomalous expressions, followed by literal expressions and less congruent judgments were made for metaphorical expressions (anomalous vs. literal: $t(35) = 7.57$, $p < .0005$; anomalous vs. metaphorical: $t(35) = 9.52$, $p < .0005$; literal vs. metaphorical: $t(35) = 6.82$, $p < .0005$).

ERP data

Of the final dataset, 5.76 % of the trials were rejected because of eye movements and artifacts. At least 71.33 % of the trials remained for each participant. The rejection rate did not differ for the three expression types ($F(2,68) = 1.84$, $p = .17$) and the two language groups ($F(1,34) = .08$, $p = .78$). Grand-averaged ERPs elicited by the three different expression types in the two groups are presented in Figure 3. At Cz, a clear N400 component could be seen for all participants. A repeated measures ANOVA was conducted and yielded a main effect of time window ($F(2,33) = 25.82$, $p < .0005$), a main effect of expression type ($F(2,33) = 27.26$, $p < .0005$), an expression type x language group interaction ($F(2,33) = 3.40$, $p = .046$) as well as a window x expression type x language group interaction ($F(4,31) = 3.92$, $p = .01$). No significant main effect of language group was revealed ($F(1,34) = .19$, $p = .67$) as well as no interaction effect between language group and window ($F(2,33) = .20$, $p = .82$). Due to the interaction effects, the data were separately further analyzed.

Window 1: 340-380 ms

Analysis of the first time window revealed a main effect of expression type ($F(2,68) = 28.17$, $p < .0005$) and a significant interaction of expression type x language group ($F(2,68) = 6.82$, $p = .002$). Separately analyzed, different patterns were discovered for L1 and L2 participants. In the L1 group, the main effect of expression type ($F(2,34) = 33.75$, $p < .0005$) was further investigated through paired sample *t*-tests. They revealed in the L1 group that the amplitude of literal expressions was significantly less negative than the amplitude of metaphorical expressions ($t(17) = 6.09$, $p < .0005$), literal expressions evoked less negativity than anomalous expressions ($t(17) = 7.23$, $p < .0005$), and the amplitude of

metaphorical expressions was less negative than the amplitude of anomalous expressions ($t(17) = 2.93$, $p = .009$). In sum, this yielded the result that anomalous expressions evoked the highest negativity, metaphorical expressions less and literal expressions least.

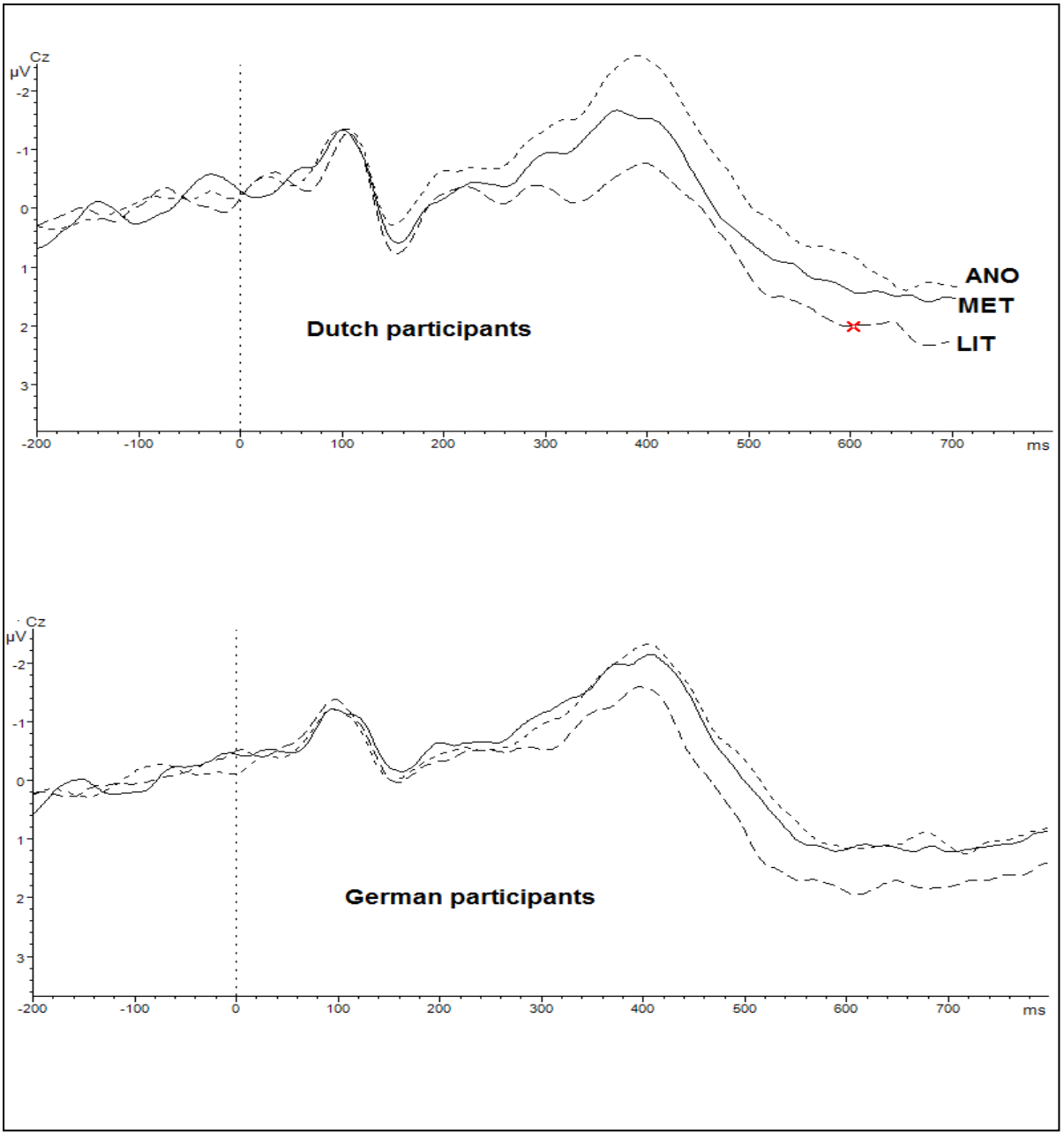

Figure 3. Event-related brain potential waveforms at Cz elicited by literal, metaphorical and anomalous expressions in native speakers (Dutch participants) and second language learners (German participants). Stimulus onset occurred at 0 ms. ANO = anomalous expression type; MET = metaphorical expression type; LIT = literal expression type.

For the L2 group, the effect of expression type ($F(2,34) = 3.84$, $p = .03$) showed another pattern. Literal expressions aroused less negativity than metaphorical expressions ($t(17) = 2.72$, $p = .015$) and marginally less negativity than anomalous expressions

($t(17) = 2.14$, $p = 0.048$). No difference was yielded for anomalous expressions versus metaphorical expressions ($t(17) = .08$, $p = .94$).

Window 2: 380-420 ms

As in the first time window, a main effect of expression type ($F(2,33) = 22.64$, $p < .0005$) and an interaction effect ($F(2,33) = 3.96$, $p = .03$) were found. Splitting the additional analyses with regard to language groups, yielded the same patterns as in the first window. For L1 participants ($F(2,16) = 24.53$, $p < .0005$), the amplitude of literal expressions was less negative than the amplitude of metaphorical expressions ($t(17) = 4.13$, $p = .001$), metaphorical expressions evoked less negativity than anomalous expressions ($t(17) = 4.41$, $p < .0005$) and the amplitude of literal expressions was less negative than the amplitude of anomalous expressions ($t(17) = 7.21$, $p < .0005$). Thus, anomalous expressions revealed most negativity, metaphorical expressions less and literal expressions least.

In the L2 group ($F(2,16) = 5.40$, $p = .02$), the results were similar to the results of the first window. Literal expressions evoked less negativity than metaphorical expressions ($t(17) = 3.36$, $p = .004$) and less negativity than anomalous expressions ($t(17) = 2.45$, $p = .03$). No significant difference was revealed for metaphorical expressions versus anomalous expressions ($t(17) = .80$, $p = .44$).

Window 3: 420-460 ms

In the third window, the pattern was different as no significant interaction effect between expression type and language group was found ($F(2,33) = 3.06$, $p = .06$). The main effect of expression type ($F(2,33) = 21.07$, $p < .0005$) was nevertheless separately further investigated. The effect of expression type in group L1 ($F(2,16) = 17.31$, $p < .0005$) revealed that the amplitude of literal expressions was less negative than the amplitude of metaphorical expressions ($t(17) = 2.73$, $p = .014$), literal expressions evoked less negativity than anomalous expressions ($t(17) = 5.83$, $p < .0005$) and metaphorical expressions evoked less negativity than anomalous expressions ($t(17) = 4.63$, $p < .0005$). In short, as in window one and two, in window three anomalous expressions revealed most negativity, metaphorical expressions less and literal expressions least, in the L1 group.

Again, the pattern of the L2 group was different to the pattern of the L1 group. The main effect of expression type ($F(2,16) = 14.09$, $p < .0005$) was further analyzed and yielded that literal expressions elicited less negativity than metaphorical expressions ($t(17) = 5.46$, $p < .0005$) and less negativity than anomalous expressions ($t(17) = 3.30$, $p = .004$). The difference between metaphorical and anomalous expressions was again not significant ($t(17) = .52$, $p = .61$).

Discussion

The present study used ERP data to examine the effect of language group (L1 vs. L2) on the electrophysiological correlates of nominal metaphoric processing. With respect to the processing of literal, novel metaphorical and semantically anomalous expressions, the finding of a N400 component as a function of expression type that was clearly found in L1 and partially in L2, suggested a difference in the processing. This difference could be a quantitative difference which seemed to be equivalent for L1 and high proficient L2 speakers.

With regard to RTs, the pattern differed from the predictions of Glucksberg's theory. Although he thought literal and metaphorical expressions would be processed equally quickly, the RTs were different. In the L1 group, reactions to anomalous expressions were constantly the quickest, followed by reactions to literal and metaphorical expressions, respectively. In the L2 group, no difference was found between the RTs of literal and anomalous expressions. In any case, both were faster than the RTs of metaphors. This, however, was mainly due to the nature of the task. Arzouan et al. (2007) detected the fastest RTs in a semantic judgment task for literal two-word expressions, increasing for unrelated expressions and again increasing for novel metaphors. Another pattern was discovered by Lai, Curran and Menn (2009), who used a sensicality judgment task in which participants had to decide how much sense a sentence made. They found the fastest RTs for literal sentences, followed by conventional metaphors, again followed by anomalous sentences and novel metaphors. Between anomalous sentences and novel metaphors, no difference was detected. The quick reactions to anomalous expressions found in this study clearly differed from these findings just as the task differed. In the current study, a three-choice task was used in which participants had to decide for each expression whether its meaning was literal, metaphorical or anomalous. The present study replicated and extended the RT results of Hoorn (1997), who also used a three-choice-task and found the fastest RTs for anomalous expressions, followed by conventional metaphors and literal expressions. Nevertheless, many researchers questioned whether equivalent RTs at all represent equivalent cognitive effort (Arzouan et al., 2007; Coulson & Van Petten, 2002; Giora, 2008; Kutas, Van Petten, & Kluender, 2006). In line with this idea, it seemed interesting that L2 participants needed more time than L1 participants to react, but with respect to the N400, no latency difference was detected.

With regard to the N400 component, the findings seemed to be consistent with the theory of Glucksberg, at first sight. The theory predicted an increase in negativity from literal to metaphorical and again to anomalous expressions, which was detected in the L1 data. In the L2 group, however, this pattern was not confirmed. No constant difference could be

found between anomalous and metaphorical expressions. Furthermore, according to the L1 L2 difference, the model predicted a greater N400 component in L2. The current findings did not support this prediction, either. Thus, Glucksberg's theory could not be used to explain the present findings.

With respect to previous findings in metaphor research, the determined N400 components corresponded. In the current study, the N400 increased as a function of expression type for L1 across all time windows, replicating the results of Arzouan et al. (2007) and Kazmerski et al. (2003). The findings of Lai et al. (2009) were only partially replicated as they distinguished the N400 component in two time windows and found in the early window (320-440 ms) a difference between literal sentences to anomalous, novel metaphoric and conventional metaphoric sentences, which among one another did not show a reliable difference. In the late window (440-560 ms), the pattern changed and a difference was found between anomalous and novel metaphoric sentences to conventional metaphoric and literal sentences. One possible factor for the different pattern found in this study could be that the metaphors used by Lai et al. (2009) had another linguistic form than used in the current study.

De Grauwe, Swain, Holcomb, Ditman and Kuperberg (2010), in contrast, used the same linguistic form as in the current study for their conventional nominal metaphors, and used moreover literal sentences and anomalous sentences. Their findings were extended by the current study as they detected an increase in negativity in central regions from literal to conventional metaphoric to anomalous sentences in an early time window (350-400 ms). In a late window (400-500 ms), no difference was any longer found between conventional metaphors and literal sentences.

The second aspect of the present study was the examination of whether the processes differed for native speakers compared to second language learners. The findings only partially confirm previous research results. Hahne (2001) found a time delay for second language learners of 100 ms and a smaller N400 effect due to a larger negativity elicited by correct sentences. This pattern was not recognized in the current results. However, this time delay disappeared when analyzing semantically incorrect sentences. With regard to the behavioral data, the findings of Hahne (2001) were replicated with significantly longer RTs and more incongruent judgments in the L2 group. These results were in turn inconsistent with the results of Weber and Lavric (2008), who described a higher rate of congruent judgments for correct sentences than for semantically anomalous sentences for both groups. With respect to this, it is important to note, that due to the different natures of the tasks, as noted

earlier, the percentage of congruent or correct judgments needed to be carefully interpreted. In the current study, judgments were categorized as congruent or incongruent instead of correct or incorrect, as the figurativeness of an expression was a question of degree with respect to novel metaphors and anomalous expressions. It could, however, have had influence on the current results, that all expressions that were supposed to be metaphorical, were analyzed as metaphors regardless of the judgment of the participant. A general reference frame in metaphor research would be a great facilitation to be able to compare findings more effectively and to distinguish between different linguistic forms and experimental manipulations. For this study, it is important to note that all L2 participants had a homogeneously high reading ability while having learned the L2 after being 18 years old and that the sample's educational level was comparatively high. This constrains the external validity of the findings. The results of the current study, however, demonstrated that highly proficient L2 readers showed neural responses that were comparable to those of L1 speakers, extending the results of Ibáñez et al. (2010).

As the results of the current study were not consistent with Glucksberg's theory, other possible underlying processes were discussed. In line with previous ideas, a possible explanation of the findings could be that the N400 component represented the ease of semantic integration. Literal expressions and possibly also conventional metaphors (not investigated in the present study) were easiest to integrate. Novel metaphors were more difficult to integrate and anomalous expressions turned out to be the most difficult to integrate. This more demanding process could have evoked a greater negativity at 400 ms after stimulus onset (cf. Weber & Lavric, 2008). In the L2 group, less congruent judgments were given, which indicated that it was more difficult for L2 learners to identify the expression type than for L1 speakers. This could explain the slightly different pattern in ERPs with no constant difference between anomalous and metaphorical expressions. The categorization of the participants was namely not considered in the N400 analysis, as noted above.

Another way to view the current results could be to interpret the N400 component as a reflection of semantic astonishment. That is, the more unexpected the critical word, the more negative the N400 component. Whereas the idea of the ease of semantic integration sounded plausible when considering only the N400 data, the RTs seemed to be at odds. Semantic integration, as an active process, should be time consuming. The RTs of anomalous expressions, which are supposed to be most difficult to integrate, were the fastest in L1 and faster than metaphors in L2. This indicates a less active process. Therefore, it seems more

likely that the N400 component represents an automatic process. Novel metaphors and anomalous expressions evoked a greater N400 component, as they are by definition less habitual in the daily language usage. In this context, the L2 results seemed reasonable, too. As mentioned in the introduction, exploring metaphor processing in L2 means manipulating language automaticity and familiarity. When you learn a language, you mainly learn literal expressions and conventional metaphors. Novel metaphors and anomalous expressions are similarly less frequent for L2 learners. Therefore, for L2 participants, it seems reasonable that literal expressions were less unexpected as reflected in the least negative N400 component and novel metaphors were more unexpected, resulting in a more negative N400. Possible explanations for the confused pattern of anomalous expressions could be that the L2 participants were uncertain about whether the expressions could probably have a metaphorical meaning. This explanation would be in line with the results, as (1) the RTs in L2 were slower for anomalous expressions which resulted in indistinguishable RTs for literal and anomalous expressions and (2) the N400 component was indistinguishable for novel metaphorical and anomalous expressions in all windows. Anomalous sentence final words could thus be seen as semantically unexpected for L2 participants and ambiguous to categorize by an automatic process.

Future research will have to explore the precise nature of metaphor processing in L1 and L2 and the special role of anomalous expressions therein. The issue of anomalous expressions should get more attention, as the focus of previous research lay mostly on the difference between literal and metaphorical expressions and the pattern of anomalous expressions seems to be important in this context. Moreover, the appropriate interpretation of RTs in the context of differing tasks should be clarified. Furthermore, norming studies should be done to evaluate the perceived figurativeness of the expressions. Further studies and elaborations of metaphor processing will be needed in order to determine the best interpretation of the current results. The question to be addressed is how metaphor processing takes place in detail and to develop a model which represents these processes adequately.

In conclusion, the present study found an increase in the N400 component as a function of semantic astonishment. In L1, a clear increase across the expression types was determined, but in L2, the pattern of metaphorical and anomalous expressions was indistinguishable. In general, the findings suggested a quantitative difference due to semantic astonishment between the processing mechanisms in L1 and L2 for expressions with varying degrees of figurativeness.

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Appendix

Table A1. *List of the Stimulus Materials*

A term expression	B term		
	Metaphorical	Literal	Anomalous
Een hond is een	vriend	dier	tuin
De tuin is een	droom	plek	mes
De hemel is een	huis	lucht	doek
De aarde is een	school	ding	pan
Vakantie is een	feest	tijd	dier
Ziekte is een	straf	staat	fiets
Een boek is een	vriend	ding	aap
Mijn baas is een	aap	mens	zaag
Mijn schoonmoeder is een	heks	vrouw	stoel
Mijn moeder is een	kip	vrouw	schoen
Mijn broer is een	beest	man	duik
Mijn zus is een	draak	vrouw	boom
Tijd is een	deur	duur	vaas
Liefde is een	spel	staat	kip
Mijn huisdier is een	ster	hond	bord
Mijn vriend is een	kei	man	stoel
Oorlog is een	hel	staat	voet
Vrede is een	kind	staat	want
Water is een	recht	stof	lamp
Mijn hart is een	kuil	spier	tas
Muziek is een	taal	klank	voet
De dood is een	reis	eind	bord
De ochtend is een	droom	start	darm
De avond is een	man	eind	kuil
De vrouw is een	gans	mens	duur
Mijn broer is een	rots	man	dag
De zon is een	vriend	ster	reis
De man is een	vos	vent	vork
Het verhaal is een	mes	boek	gans
De storm is een	kind	wind	tekst
Het vak is een	hel	deel	kind
Het gerecht was een	droom	gans	wind
De weg is een	boek	straat	gans
De arbeider is een	mier	knecht	boek
De lerares is een	slang	mens	reeks
De zangeres is een	lied	vrouw	kuil
Het gevoel is een	kleur	raad	kuil

(continued)

A term expression	B term		
	Metaphorical	Literal	Anomalous
Liefde is een	beest	staat	baard
Het leven is een	reis	tijd	voet
De held is een	vuur	man	roest
Woede is	gif	drift	tijd
Het hart is een	ster	spier	rest
Het gesprek is een	dans	zaak	ster
Het geheugen is een	zeef	plaat	spier
Vertrouwen is een	brug	wens	kip
Mijn dochter is een	lied	kind	zeef
Mijn werk is een	trog	taak	tros
Mijn opa is een	eik	knar	kans
Het leven is een	kans	duur	knar
Het strand is een	vloek	plek	vlok
Het bos is een	val	woud	zaak
De oase is een	drank	bron	kramp
De motie is een	dag	wet	boom
De dichter is een	koe	mens	kies
De dood is een	muur	eind	kien
Ons hart is ons	park	spier	zier
De haven is een	mond	oord	snars
De haven is een	tuin	plek	plop
Ons hoofd is een	berg	ding	gooi
Mijn hoofd is een	haan	deel	trant
De huid is een	vrouw	laag	taks
Hun huis is een	graf	pand	wrik
Het kind is een	maan	mens	slip
Zijn lach is een	lied	klank	plaat
Het leven is een	brood	feit	haan
De maan is een	dier	ding	piel
De mens is een	steen	soort	snap
Deze middag is een	mand	tijd	stoel
Je mond is een	huis	plek	tijd
De nacht is een	vrouw	tijd	soort
De poëzie is een	mens	tekst	brui
De stilte is een	brug	feit	baard
Mijn toekomst is een	hart	feit	kluts
Onze vrede is een	huid	recht	pats
De woede is een	slang	drift	zwik
De zanger is een	lied	mens	keer
De zee is een	buik	plek	gros

(continued)

A term expression	B term		
	Metaphorical	Literal	Anomalous
De zon is een	druif	ster	droom
Woede is	vuur	drift	stoel
Liefde is een	roos	staat	drop
De dood is een	nacht	eind	schoen
De kerk is een	vlucht	huis	dans
Mijn werk is een	hel	taak	kast
De koran is een	last	boek	stal
Sport is een	plaag	spel	druif
Ziekte is een	worm	plaag	spel
Geboorte is een	licht	start	plek
Oorlog is een	nacht	schijf	stoel
Vriendschap is een	ster	band	druif
Eten is een	drug	maal	park
Voetbal is een	boek	spel	ster
Het brein is een	spons	feit	doek
Mijn hoofd is een	huis	kop	balk