BACHELOR THESIS

THE CONCEPT OF CREATIVITY AND ITS SYNONYMS AND ANTONYMS RETRIEVED BY A FREE ASSOCIATION STUDY

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1. Abstract

As part of the EU project *Concept Creation Technology* we want to investigate the concept of creativity, because it is still unclear what creativity really means and how it can be evaluated in computer systems. Jordanous (2012) has made an attempt to analyze the concept of creativity in the scientific literature and to evaluate it. The result of her research was a list of 694 words which might be related to creativity. This study investigates to what extent people associate a selection of 32 words from her list and words from this study back to creativity. 50 students took part in a free association study, where the synonyms and antonyms of the words also had to be named. 29 words have been associated with the concept of creativity, seven of those words have been only mentioned by Jordanous (2012). We also found that demographic variables influence the answers on the synonyms. In the end a proposal for how to evaluate creativity in computer systems is given.

2. Introduction

There is a growing interest in more creative computer systems: According to Gelderen (2007) innovation and creativity are strongly related. If one wants to design an innovative computer system, one has to use creative processes for achieving that (Mattia, 2013). Because of the competitive character of the market this is an important issues for businesses. If one wishes to design creative computer systems, one must be able to evaluate its creativity in order to compare it to other systems in the same field and to improve it (Jordanous, 2012). The EU project *Concept Creation Technology* wants to stimulate more research on creative problem solving and its implementation on computers (Concept Creation Technology, 2014). As part of this project, this paper will try to give an answer to the following questions: What is creativity in general and how can you evaluate it?

In the time of the antique philosopher Plato, people believed that a creative person is filled with inspiration by a god. With this he was able to give form to outstanding products. Later, Freud suggested that creativity is maintained by "unconscious wishes", which are becoming visible in a socially acceptable form (Sternberg, 1999). In the 21st century, Hennessey and Amabile (2010) said that creativity is "the generation of products or ideas that are both novel and appropriate". It is obvious that the concept of creativity has changed a lot during the history of mankind.

Jordanous (2012) states that more and more creative computer systems are being developed, but that there is "an evident lack of systematic evaluation of the creativity of these systems in the literature". The reason for this might be a missing general definition for the concept of creativity, because one has to know what he wants to evaluate. As a solution to this problem Jordanous (2012) investigated different systems measuring creativity, designed a concept of creativity according to the scientific literature and developed the *Standardised Procedure for Evaluating Creative Systems* (SPECS) based on her findings from the first two studies.

Because of doubts on how the concept of creativity has been analyzed, this study wants to test to what extent the terms as found by Jordanous (2012) are related to creativity. This will be done with a free association test. In addition, a proposal for how to design a standardized system for evaluating creative computer systems will be made.

2.1. Overview on the research on creativity in different disciplines

In their review, Hennessey and Amabile (2010) summarized the most important findings about creativity of different psychology fields as follows: Creative thinking is promoted by positive affect, feeling of safety, intrinsic motivation and flexible thinking. Feeling safe is correlated with positive affect, which in return is correlated with intrinsic motivation. Once in this state flexible thinking is supported, which most of the time results in creativity (Hennessey & Amabile, 2010). Also, Svensson et al. (2002, as cited in Hennessey & Amabile, 2010) found that groups are more creative in solving problems, but that individuals are higher in fluency. According to them, individuals are better at creative problem solving than groups. Kurtzberg and Amabile (2001) pointed out the fact that cognitively diverse groups may be more creative, but that diversity correlates negatively with "team satisfaction, affect, and members' impression of their own creative performance". If one wishes to stimulate creativity, one has to be conscious of this problem. In the cognitive psychology, Marupaka, Iyer & Minai (2012) supposed that creative thinking is supported by a different way of knowledge organization with "differences in modulating factors such as inhibition, emotion, etc.". Beside the fact that the concept representation is strongly associated with other concepts, it promotes creative thinking (Schilling, 2005).

In addition, some models of creativity have been constructed in the last years. The four P's take the whole environment into account, which supports creativity: "the creative Person, the generated Products, the creative Process and the Press/ Environment hosting and influencing the creativity" (Jordanous, 2012). Boden (2004, as cited in Jordanous, 2012) makes a difference between P- and H- creativity. P-creativity "is novel at personal level" and H-creativity "is historically novel".

Summarized, every discipline has its own definition of creativity and approaches it in different ways. They do not always exclude each other, but it would be easier for the general understanding and for further research if there would be one definition of this concept, which would take different disciplines into account (Jordanous, 2012).

2.2. Review on the research on creativity by Jordanous (2012)

The goal of evaluating systems is to be able to compare them with each other and improve them. Jordanous (2012) says that "the evaluation process should be clearly stated, to be transparent and repeatable". Kaplan and Maxwell (2005) summarized which components

of a system have to be taken into account when evaluating it. With quantitative methods "costs and benefits, timeliness, completeness, error rates, retrievability, usage rates, [and] user satisfaction" can be highlighted. Furthermore, qualitative methods can be used for investigating among other things "what might be important to measure" and how the system is functioning (Kaplan et al., 2005). This paper will focus more on what has to be measured to determine the creativity of a system. Therefore the concept of creativity has to be investigated.

Jordanous (2012) has already made an attempt of defining creativity and evaluating it. First of all, she compared the papers about creative computer systems with each other. Her conclusion was that there is no standardized manner of evaluating them. Because of this she decided to design such a method. Using statistical methods she analyzed the used words in papers about creativity of different academic disciplines against those words used in papers which were unrelated to this topic. She found 694 words which were used significant more in the articles about creativity (see Appendix A for the list). With linguistic analysis she divided these words in groups with the similar meaning, which in return have been clustered in 14 themes describing creativity. Her resulting components are shown in Table 1.

Table 1. *14 Key Terms of Creativity Defined by Jordanous (2012)*

The 14 components describing *creativity*	
• active involvement and persistence	• originality
• dealing with uncertainty	• progression and development
• domain competence	• social interaction and communication
• general intellect	• spontaneity/ subconscious processing
• generation of results	• thinking and evaluation
• independence and freedom	• value and variety
• intention and emotional involvement	• divergence and experimentation

Her results are more a cluster of key themes describing something about the creative process. Although she used standardized methods analyzing the texts it is not certain that all the themes found are really about creativity. It is possible that she included words in her analysis that are representative for the disciplines of creativity research and not for creativity itself. In the list there are words like *refrigerator* and *neuroscience* (see Appendix A for the

list by Jordanous (2012)), which have no apparent relation with the concept. Because of this there is a need for a definition of the concept, which does not result from investigating the concept in the scientific world, but in the human mind. This concept has to be verified by many people, so that there are no words unrelated to the concept. Hopefully a model like this will help to understand the concept of creativity more.

2.3. Semantic networks, concepts and free association

This paper will investigate the relationship between the key themes from Jordanous (2012) by free association. Before the method of free association will be explained, the cognitive background of it will be discussed. In the cognitive psychology, word meanings are represented in a semantic network, which is based on perceptual and functional information. For example, a *computer* is represented by its colors and forms, but more importantly by its functions at work or at home. The meaning of a word is also influenced by the context of use. There is another representation of the word *computer* in the context of writing a mail than in the context of programming. Words, which share the same information, are connected more strongly and are members of one category (Smith & Kosslyn, 2009). Concepts can be close or distant to each other. Budanitsky and Hirst (2006) suggested that *close* words are "organized into networks of synonym sets (synsets) that each represent one underlying lexical concept and are interlinked with a variety of relations". On the other hand, antonyms are *distant* words. They are not similar, but still "strongly related semantically" to each other, because they are describing the opposite mostly in the same context (Budanitsky et al., 2006). The assumption is that a thought is always associative. A word or an idea is followed by other ideas, which are directly connected with each other. Watts (1999) (as cited in Marupaka et al., 2012) introduced the *small-world networks*, which are characterized through "a high clustering coefficient, C, but low mean shortest path length (MSPL), L, between node pairs" (Marupaka et al., 2012). C expresses "that the direct neighbors of two directly connected nodes are also directly connected" (Marupaka et al., 2012). The lower L, the stronger the nodes are connected. An example of a semantic network is shown in figure 1.

Each node represents a concept (Marupaka et al., 2012). According to Rodgers (1989) there are different views of a concept. The *entity views* say that a concept is "some type of entity or 'thing', such as an abstract mental image or idea, a word with a specific grammatical function, an external unitary form, or an element in a system of formal logic" (Rodgers,

1989). According to the *dispositional views* concepts describe more a procedure, "such as specific mental or physical acts or the capacity for word use" (Rodgers, 1989). The *positivism view* supposes that there have to be clear boundaries between two concepts, so that it is for sure that they are describing different things. The *static view* defines concepts as stable over time and different contexts. Finally, Rodgers (1989) introduced the *evolutionary view* which considers the concept with different attributes that are defining it. Its definition is also dependent on context and time. In this paper the static view of concepts will be used, because the goal is to find a definition of creativity in no special context, but it will be applied on computers later. For this, a concept is needed which is stable over time and different contexts.

Concepts that are connected to each other "represent *directed associations*" (Mapuraka et al., 2012). Free association is "a task that requires participants to produce the first word to come to mind that is related in a specified way to a presented cue" (Nelson, McEvoy, & Dennis, 2000). A strong connection between two concepts is related with a higher chance that the other concept will be named during free association. When a word is associated more often with an item, its strength increases (Nelson et al., 2000). With the results of a free association test a semantic network of a concept can be designed.

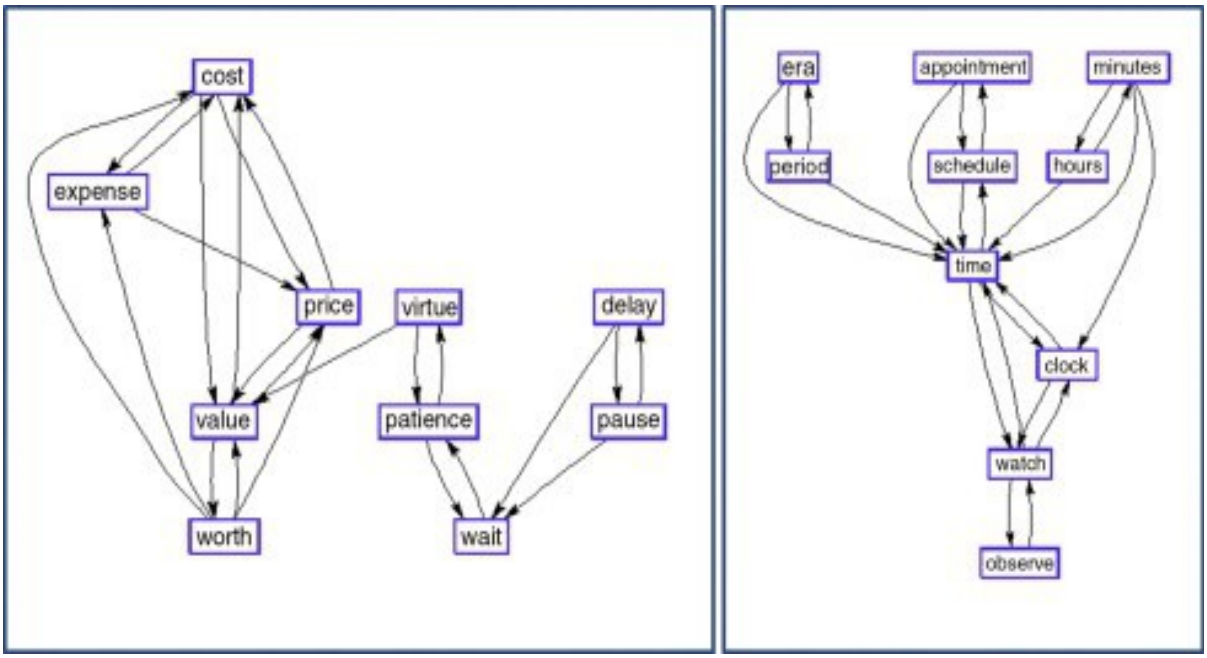

Fig. 1. Two examples of a semantic network (Marupaka et al., 2012).

2.4. Designing an experiment for exploring the colloquial concept of creativity

Rodgers (1989) developed a method for concept analyzing, which is used in analyzing

the conceptual understanding of the scientific world (for example used in: Holland, Middleton, & Uys, 2012; Smith, 2012) . Although this is a quite common method in analyzing a concept, it is not used in this paper. Jordanous (2012) has already analyzed the scientific understanding of creativity. Because of this, a different method has been chosen to investigating the colloquial understanding of creativity.

In this research project we will investigate if the words, which Jordanous (2012) got through her analysis, are really related to creativity (see Appendix A). This will be achieved by an association test. The idea is that the stronger the strength is between creativity and another word, the higher the chance will be that a word will be named. In addition, words related to creativity will be added, which have been named by participants in a first study. The goal is to investigate to what extent the words from the list from Jordanous (2012) and the ones from our first study are associate back to creativity and to come to a colloquial concept of creativity.

The study was divided into two sub-studies. The first study provided the word list with colloquial terms associated with creativity. The second study consisted of a free association test, and a part where the participants had to name the synonyms and antonyms of the words of the "creativity word pool". The following two sections describe the two studies in more detail.

3. Study 1

Goal of the first study was to design a word list with words which are associated with creativity. This list of words can be used in study 2 for further investigation of the concept of creativity. The main question of this section is more descriptive: How many words about creativity can be gathered during a free association test which have not been already mentioned in the word list by Jordanous (2012)?

3.1. Methods

3.1.1. Participants

The members of the general population that added their words to the 'creativity word pool' were Dutch or German. 36 people between age 16 and 59 (m=25,47; sd=8,93) have been interviewed. Of these people, 29 were Dutch and 7 German and 16 were men and 20 were women. All of them were from the direct environment of the researchers.

3.1.2. Procedure

The method of gathering a satisfactory sample of words related to creativity consisted of two parts. For the first part, the list of words taken from the work of Jordanous (2012) were used. From this list, three independent researchers removed all the words that in their view did not relate to creativity. The lists made by the three researchers were compared, and only words that were deemed to be related to creativity by all three researchers were kept, resulting in a list of 32 out of the original 694 words.

To add a colloquial sample of words, the general public was asked to provide some words by means of free association. People participated individually. First, the participant was explained that the goal of the study was to get associations for a later named word. When instructions were clear, the participant was posed a single question: "Can you please give three words that you closely associate with the term creativity?" These terms were written down and processed for further use in the study 2. While Nelson, McEvoy and Schreiber (2004) note the risk implicit in continuous association over discrete association, compromises had to be made. Since each participant was required to be made aware of the study he or she participated in, it would have been too time-consuming to ask participants for only one word. When the results were in, three researchers once again judged the words given by the populace, removing words that were not judged by all three to bear a relation to creativity, for example *socks*. By adding each unique word to the list of 32, a broad and varied sample of terms related to creativity was created (see Appendix B for the list of words).

3.1.3. Materials

For the addition of words to the 'creativity word pool', materials were pen and paper to write the words down. When administering the test, participants received the word *creativity* in their mother tongue. Afterwards the word pool has been translated into English, Dutch and German.

3.1.4. Analysis

The words which have been gathered from the word list by Jordanous (2012) and from this study were compared to each other. We investigated how many words were named in both word lists. Because three researchers selected only 32 out of the 694 words from Jordanous (2012), we investigated if the participants named words which are also in the word list from

Jordanous (2012), but which have not been selected by the researchers.

3.2. Results

A list of 80 words was gathered during this study (see Appendix B for the list of words). Of those, 32 words were selected from the word list by Jordanous (2012) and 58 words were gathered during the first study. Ten words were found in both word lists. Both lists of words have the same ten words. Also, eight words have been named during the study, which are also in the list by Jordanous (2012), but which have not been selected by the three researchers.

3.3. Conclusion

The goal of this study was to get more words for the 'creativity word pool'. Because we want to investigate the colloquial concept of creativity, it was important to get words which have not been named by Jordanous (2012). 48 additional words have been found, of which eight words have been named by Jordanous (2012), but they were not selected by the three researchers. In conclusion: 40 words have been found which have not been mentioned in Jordanous (2012). Maybe the colloquial concept of creativity differs slightly from the scientific one.

This list of words can be used for a free association study, in which we investigate how many of the words, which have been associated with creativity, are also associated back to creativity. With this words are gathered which have a strong relationship with the concept of creativity.

4. Study 2

With study 2 we want to investigate to what extent the words provided by study 1 are associated back to creativity and what the synonyms and antonyms of those words are. The goal is to explore the semantic network of the concept of creativity. First of all, the results of the words which have only be named in the word list from Jordanous (2012) are compared to the words which have only been named during study 1. For this the following hypothesis is set up:

1. There is no significant difference ($\alpha = 0{,}05$) in how often the words from Jordanous (2012) and the words from our first study are associated back to creativity.

After the association test, the participants have to think of a synonym and an antonym for each word from the word list. We will test if demographic variables such as nationality, gender and field of study have an influence on the results. Because this is a pilot study, possible differences in the answers can be taken into account with the composition of a good sample next time.

For the question if demographic variables influence the answers on the synonyms the following hypotheses will be tested:

2. There is no significant difference (α= 0,05) in the named synonyms between the Dutch and German participants.
3. There is no significant difference (α= 0,05) in the named synonyms between the social sciences/ music and engineering students.
4. There is no significant difference (α= 0,05) in the named synonyms between the female and male participants.

For the question if demographic variables influence the answers on the antonyms the following hypotheses will be tested:

5. There is no significant difference (α= 0,05) in the named antonyms between the Dutch and German participants.
6. There is no significant difference (α= 0,05) in the named antonyms between the social sciences/ music and engineering students.
7. There is no significant difference (α= 0,05) in the named antonyms between the female and male participants.

Furthermore, we will investigate if the results can be useful for evaluating creative systems.

4.1. Methods

4.1.1. Participants

In the second study, only participants who did not participate in the first study could participate. The participants were drafted through the University of Twente, since there are plenty of both Dutch and German students available for participation. Participants must have either Dutch or German as their mother language, because of some issues with second

language association. Paul Meara (1983) noted that there is a large difference in the words recalled by second language speakers when compared to native speakers. The associations produced by native speakers have their basis in the semantic relations between words, whereas participants associating in a language that is not their mother tongue, are more likely to produce so-called “clang associations”, similar-sounding words.

In this study 50 people between age 19 and 27 (m=22,06; sd=1,963) took part. Of those 29 were Dutch and 21 German and 24 were men and 26 were women. 25 study social sciences or music and 25 Engineering. Five of them were found through a ´participants pool´ of the University of Twente, while the rest was from the direct environment of the researchers. In Table 2 the distribution of the Dutch and German participants is shown. In the Dutch sample, there are more engineering students and in the German sample, there are more females and social studies and music students.

Table 2. *Distribution of the Dutch and German Participants in Field of Studies and Gender*

	Gender		study		
	female	male	social studies / music	engineering	age
Dutch	11 (37,9%)	18 (62,1%)	7 (24,1%)	22 (75,9%)	22,03
German	15 (71,4%)	6 (28,6%)	18 (85,7%)	3 (14,3%)	22,1
TOTAL	26 (52%)	24 (48%)	25 (50%)	25 (50%)	22,06

4.1.2. Procedure

Because the participants were not to know that the study is focused on creativity, they were simply told that the study is designed to investigate the concept of free association. After the debriefing, the participant was asked to take place in the cubicle. The computer program responsible for taking the test was started when the participant took his seat. The computer administered the test by presenting a participant with a single word, randomly selected from the definitive list. The participant then typed in one word that he closely associated with the presented word. The administration of the test lasted until every word from the definitive word list had been associated exactly once. After a five- minute break, the participant was asked to combine every presented word with its synonym. This time, too, the words were presented singularly and randomly. Lastly, the procedure was repeated with the same words,

but this time the participant was asked to give antonyms to the presented words. Afterwards the participant had to fill in a questionnaire (see Appendix C). In the end, the participant was told that the main goal of the study was to analyze the concept of creativity.

4.1.3. Material

A secluded cubicle provided with a computer was used, which reduced the effects of participant priming to a minimum. The computer was supplied with a self-developed test program, which presented the words from the list which has been designed in study 1 in a random order in the three parts associations, synonyms and antonyms. Because of the random presentation of the words, the effect that previous words have on the results should be minimized across the group of participants. The association test was presented in the first part, because the participant had to respond spontaneously and was not allowed to know the words. During the second and third part, knowing the words had no influence on the synonyms and antonyms. In the end they had to fill in a questionnaire, which was about their demographic variables and what they thought the research was about (see Appendix C for the questionnaire).

4.1.4. Analysis

This research project investigates more part two and three with the synonyms and antonyms. The association test from part one has been analyzed by Roppelt (2014). Her results are used in this analysis.

Before the hypotheses could be tested, the data had to be prepared for the analysis: First of all, the Dutch and German synonyms and antonyms were imported in excel files separately. The answers to the words, which have been associated back to the creativity words *creative, creativity* and *to create* (Roppelt, 2014), were analyzed, for which the following rules were formulated: When the answer was the same word as the cue, it was deleted. Furthermore, it was checked if the words were Dutch or German using the Duden or Van Dale, which are recognized dictionaries in those countries. When a word was not named in the dictionaries, it was deleted. The same answers were summarized and counted and the demographic variables of each respondent was recorded. When a word was named in the form of a subjective, adverb or adjective, the most common form of the set was used. In addition, when two words were named as a synonym, only the first one has been used, e.g. *Fotos oder*

Gemälde. Sometimes the synonym of a word was more a definition than a synonym, for example *geest* was described as *het 'ik' zijn* and *genie* as *de beste in zijn soort*. Those answers were deleted. Also spelling and grammatical errors were corrected, e.g. *Kreierer* was changed to *Kreator*. After this procedure there were four files (synonyms and antonyms in Dutch and German) with the cue on the left side and synonym/ antonym with its frequency of occurrence. Besides, it was noted how many of the respondents were studying social sciences/ music or engineering, if they are Dutch or German and what their gender is.

Thereafter, the files were summarized, so that further analysis with a bigger group was possible. The German synonyms and antonyms have been translated into Dutch. We chose Dutch, because it was not always possible to get good English translations for the Dutch and German words. *Kunstenaar/ Künstler* and *artiest/ Artist* are both translated as *artist*, which would make differentiating between them impossible. The synonyms and antonyms had to be named at least ten times before they have been named in the matrix. Hereby it was guaranteed that the answers are really the synonyms and antonyms of the words. The frequency of occurrence has been replaced by the response probability, which is also the strength of an item (Nelson et al., 2004).

Roppelt (2014) summarized in her bachelor thesis which words of this research have been associated with the words *creative*, *creativity* and *create*. We investigated how many participants have associated the words which have only been mentioned by Jordanous (2012) back to creativity and how many have associated the words which have only been named by the participants in study 1 back to that. Using the Chi-square we tested if there is no significant difference ($\alpha = 0{,}05$) between those two groups. With this it can be said in what extent the words of Jordanous (2012) are really related to creativity.

Using the Chi-square test, we investigated if there is no significant difference ($\alpha = 0{,}05$) in the answers on the synonyms and antonyms of the Dutch and German participants, the social sciences/ music and the engineering students and the male and female students.

Also, the Pearson correlation of the frequencies of the demographic variables of the respondents, who gave a strong synonym or antonym, has been calculated. With this the relationship of nationality, field of study and gender of the respondents was investigated, so that a possible interaction effect could be detected.

4.2. Results

4.2.1. Words associated back to creative, creativity and to create

Table 3. *Words Associated with Creative, Creativity and To Create and Their Strength of Association (Roppelt, 2014)*

Word	Creative	Creativity	To Create	Total Strength
Resourceful^	0,3			0,3
Artist*^	0,2	0,02		0,22
creation^	0,14	0,02		0,16
artistic*^	0,12			0,12
invent*	0,04	0,02	0,06	0,12
inspiration*^	0,04	0,06	0,02	0,12
originality*	0,12			0,12
To design^	0,08		0,04	0,12
innovative*	0,1			0,1
To make^			0,08	0,08
To inspire*	0,04	0,02		0,06
crafts^	0,04		0,02	0,06
Graphic design^	0,06			0,06
idea*^	0,06			0,06
original^	0,06			0,06
To craft^	0,06			0,06
To paint^	0,04		0,02	0,06
Out of the box^	0,04			0,04
imagination*^		0,04		0,04
To create^	0,04			0,04
creative^	0,02			0,02
art*^	0,02			0,02
Free thought^	0,02			0,02
imaginativeness^		0,02		0,02
innovation*	0,02			0,02
musical*	0,02			0,02
spontaneous*	0,02			0,02
theater^	0,02			0,02
To knit^	0,02			0,02
Total Strength	1,74	0,2	0,24	2,18

Note: * The words have been gathered from the word list by Jordanous (2012). ^ The words have been gathered from study 1.

First of all, the results of the first part, the association study, will be discussed: Roppelt (2014) investigated in her bachelor thesis which words have been associated back to creative, creativity and to create during the second study. The results are shown in Table 3. Since the original list of the 'creativity words' has been translated by three researchers into English, Dutch and German, the results of the Dutch and German participants could be summarized in English.

Only 32 out of the 694 original words by Jordaous (2012) have been seen as related to creativity by three independent researchers. During this study only 13 of those words have been associated back to creativity by the participants. In the first study 40 words have only been mentioned by the participants, of which 22 words have been associated back to creativity later. Six words of which have been associated back to creativity have been named by Jordanous (2012) and the first study. None of the eight words, which have not been selected by the three researchers from the list by Jordanous (2012), but which have been named during study 1, have been associated back to creativity. Summarized, 29 words have been associated back to a creativity word during this study.

The strength of association represents the response probability (Nelson et al., 2004). The total strength shows how often the word has been associated with another word. Nine words have a total strength of more than 0,1, the other 20 words have a weak relationship with creative, creativity and to create. Creative has with 1,74 the highest total strength. In Appendix D the results of the association study of the Dutch and of the German participants are shown separately.

The first hypothesis said that there is no significant difference ($\alpha = 0,05$) on how often participants associated a word from Jordanous (2012) or from our first study with creativity. However, using the Chi- Square test a significant difference between those groups was found ($p = 0,000$; $df = 21$). The participants associated the words from the first study more often back to creativity than the words from Jordanous (2012).

4.2.2. Synonyms

After presenting the results of the free association test, the results of the synonyms and the influence of the demographic variables on them will now be discussed. In Appendix E it is shown how many of the respondents to the synonyms had which nationality, study field and gender. With those data the hypothesis of this section are tested. Table 4 shows the words,

which have been associated back to *creative*, *creativity* or *to create* and for which a synonym has been found. Also, the synonyms and antonyms of the first synonyms are illustrated with their strength of association (StoA). For 18 out of the 29 words a synonym was found.

Table 4. *The Synonyms and Antonyms of the Synonyms of the Words, Which Have Been Associated Back to Creative, Creativity or To Create*

	Association	**StoA**	**1st synonym**	**StoA**	**2nd synonym**	**StoA**	**2nd antonym**	**StoA**
Creatief	artiest	0,06	kunstenaar	0,62	artiest	0,54		
	artistiek	0,12	kunstzinnig	0,54				
	creëren	0,04	maken	0,6	creëren	0,38		
	grafisch design	0,06	ontwerp	0,24				
	handvaardigheid	0,04	knutselen	0,3				
	idee	0,06	ingeving	0,26	idee	0,64		
			gedachte	0,28	idee	0,34		
	innovatie	0,02	vernieuwing	0,4				
	innovatief	0,1	vernieuwend	0,46	innoverend	0,52	verouderend	0,52
	inspiratie	0,04	idee	0,24	ingeving	0,26		
	kunstenaar	0,14	artiest	0,54	kunstenaar	0,62		
	origineel	0,06	uniek	0,14			hetzelfde	0,32
	schilderen	0,04	verven	0,36				
	uitvinden	0,04	bedenken	0,28				
	vindingrijk	0,3	creatief	0,48			oncreatief	0,22
creativiteit	inspiratie	0,06	idee	0,24	ingeving	0,26		
					gedachte	0,28		
	uitvinden	0,04	bedenken	0,28				
	verbeelding	0,02	fantasie	0,3				
Creëren	handvaardigheid	0,02	knutselen	0,3				
	inspiratie	0,04	idee	0,24	ingeving	0,26		
					gedachte	0,28		
	maken	0,08	creëren	0,38	maken	0,6	vernietigen	0,28
	schilderen	0,02	verven	0,36				
	uitvinden	0,06	bedenken	0,28				

Comparing of the Dutch and German results

The second hypothesis said that there is no significant difference ($\alpha = 0,05$) in the answers of the German and Dutch participants on the synonyms. Using the Chi- square test, a

significant difference was found in the synonyms (p= 0,000; df= 15).

Comparing of the answers of the engineering and social sciences/ music students

The third hypothesis said that there is no significant difference (α= 0,05) in the answers on the synonyms of the engineering and the social studies/ music students. After testing this with the Chi- Square test, we found a significant difference (p= 0,002; df= 15) between those groups on the synonyms.

Comparing of the answers of the female and male participants

The fourth hypothesis said that there is no significant difference (α= 0,05) in the answers of the female and male participants. A significant difference has been found on the answers of the synonyms (p= 0,002; df= 15).

4.2.3. Antonyms

The influence of the demographic variables on the antonyms have been analyzed. In Appendix F it is shown how many of the respondents to the antonyms had which nationality, study field and gender. With those data the hypothesis of this section are tested. Table 5 shows the words, which have been associated back to *creative*, *creativity* or *to create* and for which a antonym has been found. For 5 out of the 29 words an antonym was found. For none of this antonyms a synonym or an antonym has been found during this study.

Table 5. The Antonyms of the Words, Which Have Been Associated Back to Creative, Creativity or To Create

	Association	**StoA**	**1st antonym**	**StoA**
Creatief	creatief	0,02	oncreatief	0,22
	creëren	0,04	vernietigen	0,28
	innovatief	0,1	oud	0,22
	muzikaal	0,02	onmuzikaal	0,28
	out of the box	0,04	in the box	0,28

Comparing of the Dutch and German results

The fifth hypothesis said that there is no significant difference (α= 0,05) in the answers of the German and Dutch participants on the antonyms. Using the Chi- square test, a

significant difference was found in the synonyms (p= 0,001; df= 4).

Comparing of the answers of the engineering and social sciences/ music students

The sixth hypothesis said that there is no significant difference (α= 0,05) in the answers on the synonyms of the engineering and the social studies/ music students. After testing this with the Chi- Square test, we found indeed no significant difference (p= 0,381; df= 4) between those groups on the synonyms.

Comparing of the answers of the female and male participants

The seventh hypothesis said that there is no significant difference (α= 0,05) in the answers of the female and male participants. Using the Chi- Square test, we found no significant difference on the answers of the antonyms (p= 0,405; df= 4).

4.2.4. Correlations between study, gender and nationality

Finally, the demographic variables of the respondents, who named a synonym or an antonym, were correlated to each other (see Table 6). It sticks out that being Dutch has a high correlation with studying Engineering (0,950) and being male (0,873). Also being German is highly correlated with studying social sciences or music (0,903) and being female (0,713). Studying Engineering is correlated with 0,869 with being male, studying social sciences or music has a correlation of 0,776 with being female.

Table 6. *Correlations Between Study, Gender and Nationality of the Respondents of the Synonyms and Antonyms*

	Engineering	**Social sciences/ Music**	**Male**	**Female**	**Dutch**	**German**
Engineering	1,000	0,000	0,869	0,272	0,950	-0,324
Social/ Music	0,000	1,000	0,046	0,776	-0,231	0,903
Male	0,869	0,046	1,000	0,134	0,873	-0,223
Female	0,272	0,776	0,124	1,000	0,102	0,713
Dutch	0,950	-0,231	0,873	0,102	1,000	-0,510
German	0,000	0,903	-0,223	0,713	-0,510	1,000

4.3. Conclusion

4.3.1. Discussion about the concept of creativity by Jordanous (2012)

After presenting the results, the conclusions of the association test will be discussed. One purpose of this study is to investigate to what extent the 'creativity words' by Jordanous (2012) are associated back to the concept of creativity. 24,1% of the backward associated words are just from Jordanous (2012), 55,17% are from the first study and 20,68% of the words have been retrieved from both studies. One has to be careful with the results, because only 32 out of the 694 words from Jordanous (2012) have been selected for this study. More words from Jordanous (2012) could have been associated back to creativity, if the participants would have had the chance to do that. Because this study would have been to time-consuming with more than 700 words in the "creativity word pool", a selection has been made.

The first hypotheses said that there is no significant difference ($\alpha = 0,05$) in how often the words from Jordanous (2012) and from our first study are associated with creativity. This hypothesis has to get rejected, because a significant difference between those two resources has been found.

Those results support partly the doubt about the research methods used by Jordanous (2012) as mentioned in the introduction. Comparing the words used in the creativity literature against those used in unrelated fields may not just result in creativity words, it also may bring up unrelated words. Also, the low recurrence of the words could mean that the concept of creativity in the scientific world differs slightly from the colloquial concept. It is better not to mix up a scientific and a colloquial concept in one concept, because they are describing different things.

4.3.2. The influence of demographic variables on the named synonyms and antonyms

The second and third part of study 2 consisted of thinking of a synonym and an antonym for each word of the word list. The influence of demographic variables on the results has been investigated. The second, third and fourth hypotheses suggested that there is no significant difference ($\alpha = 0,05$) in the given answers of Dutch and German participants, social studies/ music and engineering students and the female and male participants on the synonyms. Here, significant differences were found in all three groups. The fifth, sixth and seventh hypotheses said that the demographic variables have no significant influence on the answers of the antonyms. Only the Dutch and German participants differed significantly in

their answers, the other groups showed no significant difference. Because of this, only the fifth hypothesis is rejected. With the results of the tests on the antonyms one has to be careful, because the sample consisted just of five antonyms. Therefore, only the results of the synonyms will be further discussed.

Language, field of study and gender interact with the kind of synonyms participants gave during the experiment. Possibly, those variables influence the kind of semantic representation people have of creativity. German, female and social studies/ music are highly correlated to each other as is Dutch, male and engineering. It is not possible to say if the language, the gender or the kind of study is influencing the results more. On the one hand German people might have another representation of this concept in their language than Dutch people, on the other the field of study or the gender can also be related to different views.

For further investigation on this issue it is recommended to perform both studies on a Dutch and German sample, where in both populations gender and field of study is better represented than in this study. In this case, the results could be better compared to each other and a possible causality could be detected. After those pilots a good sample can be designed, which can be used for a bigger study. The gathered colloquial concept of creativity can be used for the development of a method for evaluating it as proposed next.

5. Discussion

5.1. A proposal for evaluating creativity in computer systems

The goal of this research was not just to explore the concept of creativity and its synonyms and antonyms, but also to design a method for evaluating creativity in computer systems. In this section, a proposal will be made using the *Evaluation Guidelines for Computational Creativity (Jordanous, 2011)* and the method Laugwitz, Held and Schrepp (2008) used for designing the *User Experience Questionnaire (UEQ)*.

Evaluation Guidelines for Computational Creativity (Jordanous, 2011)

Jordanous (2011) designed the *Evaluation Guidelines for Computational Creativity* which task it is to “identify in what areas we are achieving creative results and what areas we should focus more research attention on.” Every item shall be discussed and eventually a proposal on how to do it with this data will be given. The guideline consists of the following three items:

1.“Identify key components of creativity that your system needs if it is to be considered creative.

a) What does it mean to be creative in a general context, independent of any domain specifics?

b) What aspects of creativity are particularly important in the domain your system works in (and conversely, what aspects of creativity are less important in that domain)?

2.Using step 1, clearly state what standards you use to evaluate the creativity of your system.

3.Implement tests that evaluate your creative system under the standards stated in step 2.”(Jordanous, 2011)

Jordanous (2011) did not want the *Evaluation Guidelines for Computational Creativity* to be used for giving a system one grade of how creative it is. Her argument was that “Such a scenario is usually impractical for creativity, both human and computational. There is little value in giving a definitive rating of computational creativity, especially as we would be unlikely to encounter such a rating for human creativity”. She prefers giving rates on different categories, which can be compared with other systems. With this it is possible to improve the creativity of computer systems in a constructive way.

In the following proposal the method of Laugwitz et al. (2008), who have designed an evaluation method in another field of research, will be combined with the *Evaluation Guidelines for Computational Creativity* by Jordanous (2011). First, the method by Laugwitz et al. (2008) will be described.

The method of the development of the User Experience Questionnaire (UEQ)

Laugwitz et al. (2008) said that questionnaires “allow an efficient quantitative measurement of product features” and that they are widely used “for the user-driven assessment of software quality and usability”. Together with other experts, they developed the *User Experience Questionnaire* (UEQ), with which the user experience of a product can be measured. The method of how they developed it will be shortly described and applied on the development of a method of evaluating creativity.

Experts in the field of usability gathered words that were strongly associated

with usability and user experience. With those terms a questionnaire with 80 bipolar items was designed. After using it in some studies a factor analysis has been performed, which resulted in 26 items and 6 factors. In the end the reliability and validity has been tested (Laugwitz et al., 2008).

Usability research and creativity research are slightly different, but this method for designing a questionnaire about an abstract term can be used in both the disciplines. The goal of our evaluation system is not that the user has to do it, but different experts from different disciplines. Both populations have a lot of different people, who do not want to spend too much time on how to use the questionnaire. In the following proposal for how to develop an evaluation system for creativity in computer systems, the method of Laugwitz et al. (2008) will be combined with the *Evaluation Guidelines for Computational Creativity* by Jordanous (2011).

A proposal for a method for evaluating creativity in computer systems

1a) The concept of creativity in general

In this step, the colloquial concept of creativity has to get investigated. This has been done during this research project. 29 key terms with their synonyms and antonyms were gathered (see Table 6). We chose to investigate the colloquial concept of creativity, because creativity got a lot of different definitions by different research disciplines in the last years (Jordanous, 2012). This study has to get improved as described above. Afterwards, we might have one definition of creativity.

1b) The concept of creativity in the field of implementation

In addition to a colloquial concept, a concept which has been constructed by specialist in the field of creativity implementation on computer systems is needed. With specialists in the field we mean all the people who are related to the implementation of the creative computer system, such engineer, designer, and user. With this the specifications a creative system needs in this field can be collected. They could be asked to add adjectives with their synonyms and antonyms to the word list. Additional words, which have been named at least by 20% of the participants, will be recorded in the word list. 20 % is the same threshold used during the association study.

2) Standards that will be used for evaluating the system

Next, a questionnaire has to be developed with the gathered concept of creativity. For this the words from step 1 with their synonyms and antonyms are used for constructing bipolar items. Afterwards the questionnaire can be tested in the field of application by experts. The development of such a questionnaire has to be repeated whenever creativity systems are implemented in a new field, because every field has its own standards. Using a factor analysis on the results, categories and their weight can be found. With these, a new questionnaire can be developed.

3) Implementation of the test

After designing the questionnaire, it can be applied to evaluate different creative computer systems of one field. By using five experts for the rating, the inter-rater reliability can be tested. If it is not very high, the whole process has to be repeated.

5.2. Conclusion

The goal of this research project was to investigate to what extent the words from Jordanous (2012) are associated back to creativity, investigating the colloquial concept of creativity and make a proposal on how to evaluate creativity in computer systems.

The words which have been selected from the word list from Jordanous (2012) have been associated back significantly less to creativity than the words gathered from our first study. This can have two reasons: Either her used research methods as described in the introduction do not fully investigate the concept of creativity, or the scientific concept differs slightly from the colloquial concept of creativity. Furthermore, the synonyms and antonyms of the words which have been associated with creativity have been investigated. It was found that the demographic variables language, field of study and gender influence the results of the synonyms. At this moment it is not possible to see what causes what. The causality has to be examined in another study. With the results of the studies about the scientific and colloquial concepts and the demographic variables, a reliable research project on the colloquial concept of creativity with more than 100 participants can be designed. This concept can be used for the evaluation of creativity in computer systems.

Finally, a proposal on how to design a system for evaluating creativity in computer systems has been made using the *Evaluation Guidelines for Computational Creativity*

(Jordanous, 2011) and the method Laugwitz et al. (2008) used for designing the *User Experience Questionnaire* (UEQ). This method takes the colloquial concept and the concept of scientist in the field, where the creative computer systems gets implemented, into account. Using the gathered synonyms and antonyms a questionnaire with bipolar items can be constructed.

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Appendix A: Creativity words identified in Jordanous (2012)

"The following words were identified in Chapter 4 as *creativity words*, words which were found to occur significantly more often than expected when discussing the nature of creativity. There are 389 nouns (indicated with the suffix N), 72 verbs (suffixed V), 205 adjectives (suffixed J) and 28 adverbs (suffixed R).Words are listed in descending order of LLR score (see Chapter 4 Section 4.2),with a word's LLR score given in brackets after the word" (Jordanous, 2012).

- thinking N (834.55)
- process N (612.05)
- innovation N (546.2)
- artefact N (514.33)
- idea N (475.74)
- program N (474.41)
- domain N (436.58)
- cognitive J (393.79)
- divergent J (357.43)
- accomplishment N (355.35)
- openness N (328.57)
- discovery N (327.38)
- primary J (326.65)
- originality N (315.6)
- criterion N (312.61)
- intelligence N (309.31)
- ability N (299.27)
- knowledge N (290.48)
- individual N (243.34)
- human J (234.41)
- novelty N (232.72)
- conceptual J (232.58)
- art N (232.52)
- new J (227.61)
- production N (216.24)
- composition N (206.58)
- musical J (206.18)
- artistic J (205.1)
- thought N (202.08)
- activity N (197.17)
- concept N (189.9)
- artist N (188.4)
- personality N (175.19)
- transformational J (174.1)
- skill N (167.98)
- contribution N (162.4)
- talent N (162.17)
- motivation N (159.51)
- scientific J (157.51)
- genre N (152.63)
- intellectual J (149.37)
- typicality N (145.48)
- prefrontal J (140.77)
- insight N (139.65)
- vocational J (138.32)
- field N (137.17)
- potential N (136.14)
- sociocultural J (135.94)
- rating N (134.79)
- formal J (133.73)
- computational J (133.6)
- composer N (131.17)
- psychic J (131.17)
- associative J (121.53)
- brain N (118.04)
- novel J (117.68)
- fluency N (117.42)
- inspire V (116.06)
- facilitate V (116.04)
- generate V (115.89)
- chapter N (109.8)
- conscientiousness N (109.72)
- gene-culture N (109.7)
- novel N (108.39)
- quality N (106.85)
- flexibility N (106.34)
- scientist N (101.92)
- produce V (101.73)
- unconscious J (100.36)
- psychology N (99.91)
- science N (99.65)
- understanding N (99.49)
- poem N (99.13)
- remote J (98.09)
- painting N (97.78)
- productivity N (96.09)
- element N (94.42)
- endeavor N (93.82)
- minor J (93.23)
- primitive J (91.56)
- innovative J (91.39)
- output N (91.1)
- music N (90.79)
- structure N (90.77)
- gift V (90.62)
- market N (89.94)
- product N (89.44)
- faculty N (89.05)
- perhaps R (83.61)
- barren N (83.47)

- transformation N (81.62)
- artefact J (81.09)
- ideation N (81.09)
- melody N (81.09)
- phenotype N (81.09)
- capacity N (79.1)
- aesthetic J (78.7)
- avocational J (78.7)
- association N (78.08)
- semantic J (76.73)
- circuit N (75.88)
- emergence N (75.88)
- organisational J (74.12)
- epigenetic J (73.93)
- characteristic N (72.64)
- achievement N (72.3)
- analogy N (72.25)
- ego N (71.93)
- agreeableness N (71.55)
- am R (71.55)
- compositional J (71.55)
- domain-relevant J (71.55)
- framework N (69.95)
- consciousness N (69.76)
- combination N (69.76)
- interest N (69.62)
- influence N (68.39)
- evolutionary J (68.14)
- imagination N (65.75)
- environment N (65.56)
- secondary J (65.5)
- extrinsic J (64.46)
- danish J (64.39)
- invention N (62.43)
- ideational J (62.01)
- perceptual J (61.59)
- appropriateness N (61.19)
- unusual J (60.9)
- deliberate J (60.29)
- ai N (59.95)
- synthesis N (59.62)
- transmission N (59.14)
- notion N (58.9)
- mathematician N (58.8)
- abstract J (58.36)
- imagery N (58.01)
- productive J (57.83)
- hierarchy N (57.33)
- heterarchy N (57.24)
- listener N (57.24)
- assessment N (56.27)
- membership N (55.42)
- inspiration N (54.85)
- myth N (54.83)
- mutation N (54.18)
- organic J (52.47)
- iq N (51.9)
- rater N (51.87)
- perspective N (51.4)
- logical J (51.26)
- validity N (51.2)
- manifest V (50.29)
- possess V (50.29)
- genius N (50.08)
- empirical J (49.68)
- emergent J (49.04)
- spontaneous J (48.67)
- rate V (48.35)
- developmental J (48.08)
- welsh J (47.7)
- deem V (47.68)
- interest V (47.04)
- influence V (46.96)
- poetry N (46.81)
- quantity N (46.78)
- intrinsic J (46.71)
- career N (46.67)
- conceptualisation N (46.67)
- variation N (46.65)
- value V (46.6)
- drive N (45.97)
- repertoire N (45.97)
- blind J (45.47)
- habitual J (45.4)
- highly R (45.32)
- architect N (45.31)
- componential J (45.31)
- fine-tuned J (45.31)
- cortex N (45.16)
- psychoanalytic J (44.89)
- adjective N (44.52)
- peer N (44.52)
- schema N (43.67)
- lack V (43.54)
- genetic J (43.27)
- artificial J (43.03)
- locomotion N (42.93)
- pine N (42.93)
- heuristic N (42.82)
- keyword N (42.67)
- provincial J (42.67)
- judge N (42.07)
- receptivity N (40.54)
- contribute V (40.16)
- generative J (40.15)
- human N (39.94)
- implicit J (39)
- occupational J (38.56)
- rational J (38.42)
- possibility N (38.34)
- biological J (38.26)
- incubation N (38.16)
- reorganisation N (38.16)
- marginal J (37.16)
- compose V (36.69)
- story N (36.55)
- cognition N (36.3)

- external J (36.25)
- retention N (36.2)
- clarify V (35.92)
- hemisphere N (35.77)
- high-valued J (35.77)
- imaginative J (35.77)
- origence N (35.77)
- space-definition N (35.77)
- environmental J (35.65)
- recognise V (35.62)
- explicit J (35.55)
- evaluation N (34.89)
- observable J (34.88)
- culture N (34.67)
- discover V (34.51)
- conscious J (34.51)
- ambiguity N (34.42
- society N (34.23)
- enable V (34.16)
- writer N (34.07)
- joke N (33.55)
- routine J (33.54)
- configuration N (33.5)
- consequences N (33.39)
- examinee N (33.39)
- intellectence N (33.39)
- neo-pi J (33.39)
- psychoeconomic J (33.39)
- subnetwork N (33.39)
- uninspiration N (33.39)
- content J (33.33)
- economic J (33.26)
- protocol N (33.04)
- benefit N (32.69)
- selective J (32.33)
- valuable J (31.99)
- claim N (31.8)
- associate N (31.64)
- atom N (31.55)
- scoring N (31.55)
- appreciation N (31.37)
- medium J (31.37)
- allele N (31)
- divergent-thinking J (31)
- energistic J (31)
- interplay N (31)
- tat N (31)
- thinker N (31)
- uncreative J (31)
- workings N (31)
- language N (30.99)
- suitable J (30.82)
- psychologist N (30.57)
- link N (30.37)
- aptitude N (29.97)
- societal J (29.96)
- educational J (29.94)
- teacher N (29.94)
- generation N (29.6)
- gestalt N (29.2)
- literary J (29.2)
- prototype N (29.2)
- stochastic J (29.01)
- certainly R (28.96)
- collage N (28.62)
- fine-tuning N (28.62)
- innovator N (28.62)
- molecule N (28.62)
- node-link N (28.62)
- essential J (28.5)
- extraversion N (28.46)
- usefulness N (28.25)
- expert J (28.24)
- score V (28.07)
- enhance V (27.91)
- and/or N (27.68)
- direct V (27.5)
- linguistic J (27.05)
- prerequisite N (27.05)
- functional J (26.98)
- operational J (26.83)
- absorptive J (26.76)
- fuzzy J (26.76)
- genetics N (26.76)
- surprise N (26.29)
- aberration N (26.23)
- brainstorming N (26.23)
- buffer N (26.23)
- commonplace J (26.23)
- h-creativity N (26.23)
- historian N (26.23)
- innovativeness N (26.23)
- interrater N (26.23)
- intrapersonal J (26.23)
- noncomputational J (26.23)
- refrigerator N (26.23)
- stakeholder N (26.23)
- synonym N (26.23)
- intuition N (26.19)
- institutional J (25.8)
- wide J (25.46)
- abstraction N (25.24)
- merely R (25.22)
- conformity N (24.96)
- lifetime N (24.93)
- illogical J (24.9)
- dissociate V (24.52)
- interviewer N (24.52)
- neuroscience N (24.52)
- preference N (24.34)
- capable J (24.32)
- meaning N (23.95)
- associational J (23.85)
- basal J (23.85)
- disciplinary N (23.85)
- fuster N (23.85)
- genotype N (23.85)

- h-creative J (23.85)
- informally R (23.85)
- inheritance N (23.85)
- lifespan N (23.85)
- morpheme N (23.85)
- multi-dimensional J (23.85)
- musician N (23.85)
- neurocognitive J (23.85)
- nominate V (23.85)
- nomination N (23.85)
- p-creativity N (23.85)
- tonal J (23.85)
- untypical J (23.85)
- harmony N (23.75)
- solver N (23.75)
- subsystem N (23.75)
- hierarchical J (23.35)
- logically R (23.28)
- informal J (23.26)
- rely V (23.11)
- chess N (22.99)
- testable J (22.99)
- male J (22.97)
- eminent J (22.78)
- generator N (22.78)
- mysterious J (22.78)
- transform V (22.59)
- judge V (22.54)
- gene N (22.46)
- structure V (22.45)
- curiosity N (22.29)
- domain-specific N (22.29)
- manifestation N (22.16)
- graduate N (22.01)
- logic N (21.92)
- cite V (21.76)
- loose J (21.72)
- triangle N (21.71)
- biocultural J (21.46)
- coevolution N (21.46)
- coevolutionary J (21.46)
- discoverer N (21.46)
- exceptional J (21.46)
- firstly R (21.46)
- five-factor N (21.46)
- fragmentation N (21.46)
- heterarchical J (21.46)
- hunch N (21.46)
- mentor N (21.46)
- metalevel N (21.46)
- o-node N (21.46)
- sensemaking N (21.46)
- superspace N (21.46)
- organise V (21.45)
- obvious J (21.19)
- proposal N (20.86)
- abstract N (20.67)
- internalise V (20.67)
- biology N (20.58)
- political J (20.34)
- acknowledge V (20.28)
- battery N (20.28)
- game N (20.28)
- neglect V (20.28)
- foundation N (20.2)
- corpus N (20.07)
- grader N (20.07)
- universality N (20.07)
- tentative J (19.95)
- disposition N (19.94)
- metaphor N (19.71)
- everyday J (19.62)
- detrimental J (19.11)
- anthropologist N (19.08)
- ativity N (19.08)
- avocational N (19.08)
- conspecific N (19.08)
- deterministic J (19.08)
- factual J (19.08)
- fascination N (19.08)
- feminine J (19.08)
- hoverfly R (19.08)
- hypnosis N (19.08)
- hypnotic J (19.08)
- image V (19.08)
- imposition N (19.08)
- infant N (19.08)
- innately R (19.08)
- interpreter N (19.08)
- melodic J (19.08)
- metaphorical J (19.08)
- mutant N (19.08)
- neo N (19.08)
- p-creative J (19.08)
- portrait N (19.08)
- psi N (19.08)
- sensibility N (19.08)
- stylistic J (19.08)
- well-formed J (19.08)
- positively R (19)
- guideline N (18.72)
- pitch N (18.72)
- peak N (18.6)
- grammar N (18.58)
- history N (18.53)
- break V (18.53)
- audience N (18.48)
- stereotype N (18.48)
- reality N (18.46)
- potentially R (18.46)
- conform V (18.41)
- expert N (18.41)
- mathematical J (18.39)
- designer N (18.34)
- pertain V (18.33)
- probably R (18.12)
- historical J (17.91)

- conducive J (17.87)
- dream V (17.87)
- insightful J (17.87)
- narrative N (17.87)
- synthesise V (17.87)
- apparent J (17.81)
- factorial J (17.73)
- title N (17.73)
- invest V (17.55)
- apparently R (17.48)
- dream N (17.21)
- realistic J (17.16)
- problem-solving N (17.1)
- educator N (17)
- inherent J (17)
- occupation N (16.74)
- survival N (16.72)
- benzene N (16.69)
- c.f. N (16.69)
- chapters N (16.69)
- chemist N (16.69)
- circularity N (16.69)
- eminence N (16.69)
- enquiry N (16.69)
- fertile J (16.69)
- focussing N (16.69)
- historic J (16.69)
- impossibilist J (16.69)
- intellect N (16.69)
- interestingness N (16.69)
- marvelous J (16.69)
- nominee N (16.69)
- non-involved J (16.69)
- officer N (16.69)
- patent N (16.69)
- poetic J (16.69)
- reality-oriented J (16.69)
- reentry N (16.69)
- results/results N (16.69)
- serendipity N (16.69)
- social-psychological J (16.69)
- tacitly R (16.69)
- tier N (16.69)
- tremendous J (16.69)
- universal N (16.69)
- warmup N (16.69)
- atypical J (16.63)
- supply V (16.63)
- phonological J (16.62)
- play N (16.62)
- progress N (16.61)
- open J (16.53)
- enhancement N (16.52)
- king N (16.52)
- radical J (16.52)
- real-life N (16.52)
- law N (16.24)
- heuristic J (16.14)
- actor N (16.12)
- ordinary J (15.9)
- exemplar N (15.78)
- perseverance N (15.78)
- blind N (15.69)
- criteria N (15.69)
- programmer N (15.69)
- relativity N (15.69)
- sudden J (15.69)
- syntax N (15.69)
- construction N (15.47)
- ball N (15.35)
- conjecture N (15.35)
- unconventional J (15.35)
- universe N (15.35)
- impose V (15.3)
- constrain V (15.14)
- articulate V (15.1)
- demand V (14.97)
- deny V (14.48)
- innate J (14.48)
- revision N (14.48)
- temporarily R (14.48)
- requisite J (14.4)
- archival J (14.31)
- artefact-set N (14.31)
- blindly R (14.31)
- blind-variation-and-selective-retention N (14.31)
- canalisation N (14.31)
- combinational J (14.31)
- concrete N (14.31)
- cough N (14.31)
- cross-cultural J (14.31)
- daydream N (14.31)
- deduction N (14.31)
- drive-related J (14.31)
- edition N (14.31)
- flexibly R (14.31)
- grade V (14.31)
- historiometric J (14.31)
- home-key N (14.31)
- imitate V (14.31)
- inflexible J (14.31)
- ingenuity N (14.31)
- intrapopulation N (14.31)
- jape N (14.31)
- mach N (14.31)
- mechanistic J (14.31)
- morphological J (14.31)
- psychoticism N (14.31)
- r.s. N (14.31)
- reputation N (14.31)
- script N (14.31)
- sims N (14.31)
- subjectivity N (14.31)
- submarket N (14.31)
- symphony N (14.31)
- talented J (14.31)

- tests N (14.31)
- trial-and-error N (14.31)
- verdict N (14.31)
- consumer N (14.1)
- constantly R (13.86)
- algorithmic J (13.84)
- claim V (13.84)
- overt J (13.66)
- biochemical J (13.52)
- camp N (13.52)
- funny J (13.52)
- inventive J (13.52)
- landscape N (13.52)
- meta-level N (13.52)
- nurture V (13.52)
- phenotypic J (13.52)
- redefinition N (13.52)
- roadblock N (13.52)
- senior N (13.52)
- substantiate V (13.52)
- transcend V (13.52)
- thesis N (13.52)
- aim V (13.51)
- climate N (13.51)
- conception N (13.49)
- criticise V (13.39)
- mathematics N (13.36)
- purely R (13.36)
- fundamentally R (13.35)
- whereby R (13.35)
- writing N (13.35)
- entity N (13.31)
- undertake V (13.31)
- field V (13.29)
- master V (13.29)
- preconscious J (13.29)
- old J (13.21)
- exploratory J (13.09)
- topic N (13.01)
- devise V (12.85)
- largely R (12.76)
- conceive V (12.61)
- pose V (12.61)
- integrative J (12.6)
- engine N (12.48)
- masculine J (12.48)
- debate N (12.39)
- leisure N (12.39)
- linkage N (12.18)
- independence N (12.09)
- appraise V (11.97)
- closure N (11.97)
- deliberately R (11.97)
- drawing N (11.97)
- self-confidence N (11.97)
- abstractly R (11.92)
- achiever N (11.92)
- acrobat N (11.92)
- aesthetics N (11.92)
- ai-model N (11.92)
- allude V (11.92)
- and-selective-retention N (11.92)
- artistic N (11.92)
- associative N (11.92)
- big N (11.92)
- boredom N (11.92)
- canalise V (11.92)
- chorale N (11.92)
- chord N (11.92)
- coevolutionary N (11.92)
- conformist J (11.92)
- consensual J (11.92)
- consequent N (11.92)
- copycat N (11.92)
- curious J (11.92)
- curvilinear J (11.92)
- defocused J (11.92)
- divergent N (11.92)
- drosophila N (11.92)
- falsify V (11.92)
- fixedness N (11.92)
- freshman N (11.92)
- hemispheric N (11.92)
- hood N (11.92)
- hypothesised J (11.92)
- ideational N (11.92)
- intrapsychic J (11.92)
- inventor N (11.92)
- judgemental J (11.92)
- kindergarten V (11.92)
- knowledge-based J (11.92)
- macroscopic J (11.92)
- neuroscientific J (11.92)
- one-armed J (11.92)
- painter N (11.92)
- patent V (11.92)
- planetary J (11.92)
- poet N (11.92)
- problem-finding N (11.92)
- punctuation N (11.92)
- re-invent V (11.92)
- selectional J (11.92)
- serendipitous J (11.92)
- shortcut N (11.92)
- sonnet N (11.92)
- substitutive J (11.92)
- tire N (11.92)
- unregulated J (11.92)
- valuation N (11.92)
- viability N (11.92)
- wild N (11.92)
- map N (11.75)
- advance V (11.75)
- assemble V (11.73)
- loosely R (11.73)
- invent V (11.72)

- revise V (11.72)
- elementary J (11.49)
- happen V (11.42)
- aberrant J (11.39)
- aspiration N (11.39)
- broad-based J (11.39)
- cellular J (11.39)
- chase N (11.39)
- clue N (11.39)
- dynamical J (11.39)
- gas N (11.39)
- intellectually R (11.39)
- nobel N (11.39)
- obvious N (11.39)
- propensity N (11.39)
- richness N (11.39)
- sociological J (11.39)
- synonymous J (11.39)
- elaboration N (11.23)
- flexible J (11.07)
- empirically R (10.9)

Appendix B: List of words used in the free association study in English, Dutch and German

* The words have been gathered from the word list by Jordanous (2012).

^ The words have been gathered from study 1.

The words have been named during study 1, but they also are in the word list by Jordanous although they have not been selected by the three researchers.

English	Dutch	German
Aesthetic*	Esthetisch	ästhetisch
Different^	Anders	anders
Artist*	Artiest	Artist
Artistic*^	Artistiek	artistisch
To knit^	Breien	stricken
Exceptional#	Buitengewoon	außergewöhnlich
Composer*	Componist	Komponist
Creation^	Creatie	Kreation
Creative^	Creatief	kreativ
To create^	Creëren	kreieren
Thinking*^	Denken	Denken
Divergent*	Divergent	divergent
Interpretation^	Interpretatie	Interpretation
Imagination*^	Fantasie	Phantasie
Flexibility#	Flexibiliteit	Flexibilität
Thought*	Gedachte	Gedanke
Poem*	Gedicht	Gedicht
Mind^	Geest	Geist
Genius*	Genie	Genie
Feeling^	Gevoel	Gefühl
Graphic design^	Grafisch design	Grafisches Design
Crafts^	Handvaardigheid	Fingerfertigkeit
Hippies^	Hippies	Hippies
Idea*^	Idee	Idee
Hunch#	Ingeving	Eingebung
Innovation*	Innovatie	Innovation

Innovative*	Innovatief	innovativ
Inspiration*^	Inspiratie	Inspiration
Inspire*	Inspireren	inspirieren
Intelligence*	Intelligentie	Intelligenz
Insight*	Inzicht	Einsicht
Knowledge*	Kennis	Wissen
Color^	Kleuren	Farben
Colorful^	Kleurrijk	farbenfroh
To craft^	Knutselen	basteln
Art^	Kunst	Kunst
Artist*^	Kunstenaar	Künstler
Loose#	Los	lose
To make^	Maken	machen
Hard^	Moeilijk	schwer
Music^	Muziek	Musik
Musical*	Muzikaal	musikalisch
New*^	Nieuw	neu
Novelty*^	Nieuwigheid	Neuartigkeit/ Neuheit
Unconventionel#	Onconventioneel	unkonventionell
To design^	Ontwerpen	entwerfen
Nonsense^	Onzin	Unsinn
Education^	Opleiding	Bildung
Solution^	Oplossingen	Lösung
Originality*	Originaliteit	Originalität
Original^	Origineel	originell
Out of the box^	Out of the box	Out of the box
Passion^	Passie	Leidenschaft
Pictures^	Plaatjes	Bilder
Planning^	Planning	Planung
Poetic*^	Poëtisch	poetisch
Potential*	Potentieel	Potenzial
Process*	Proces	Prozess
To programm#	Programmeren	programmieren
Painter*^	Schilder	Maler

To paint^	Schilderen	malen
To play#	Spelen	spielen
Games#	Spelen	Spiele
Spontaneous*	Spontaan	spontan
Spontaneity^	Spontaniteit	Spontanität
Talent*	Talent	Talent
To draw^	Tekenen	zeichnen
Theater^	Toneel	Theater
Expression^	Uiting	Äußerung
To invent*	Uitvinden	erfinden
Inventor*	Uitvinder	Erfinder
Unique^	Uniek	einzigartig
Skill*	Vaardigheid	Fähigkeit
Imaginativeness^	Verbeelding	Einbildung
Regenerative^	Vernieuwend	erneuernd
To implement^	Verwerkelijken	verwirklichen
Resourceful^	Vindingrijk	einfallsreich
To shape^	Vormen	gestalten
Free thought^	Vrij denken	frei denken
Happy^	Vrolijk	fröhlich

Appendix C: Questionnaire

Association Test

proefpersoon nummer:

leeftijd:

geslacht:

land van herkomst:

studie:

Waarover denk je dat het onderzoek ging?

_____

_____

_____

Heb je nog opmerkingen met betrekking tot het onderzoek?

_____

_____

_____

Bedankt voor je deelname!

Appendix D: The Results of the Association Study of the Dutch and the German Participants (Roppelt, 2014)

Dutch

Word	Creatief	Creativiteit	Creëren	Total Strength
artistiek	0,238			0,238
vindingrijk	0,238			0,238
maken			0,190	0,190
originaliteit	0,190			0,190
creatie	0,190			0,190
kunstenaar	0,190			0,190
knutselen	0,143			0,143
handvaardigheid	0,095		0,048	0,143
innovatief	0,143			0,143
inspiratie	0,048	0,048	0,048	0,143
uitvinden	0,048	0,048	0,048	0,143
schilderen	0,095		0,048	0,143
artiest	0,095			0,095
ontwerpen			0,095	0,095
origineel	0,095			0,095
Grafisch design	0,048			0,048
inspireren		0,048		0,048
breien	0,048			0,048
creëren	0,048			0,048
kunst	0,048			0,048
idee	0,048			0,048
innovatie	0,048			0,048
Out of the box	0,048			0,048
Spontaan	0,048			0,048
verbeelding		0,048		0,048
Total Strength	2,190	0,190	0,476	2,857

German

Word	Kreativ	Kreativität	Kreieren	Total Strength
Einfallsreich	0,476			0,476
entwerfen	0,190			0,190
Kreation	0,143	0,048		0,190
Künstler	0,143	0,048		0,190
Inspiration	0,048	0,095		0,143
erfinden	0,048		0,095	0,143
Idee	0,095			0,095
Grafisches Design	0,095			0,095
inspirieren	0,095			0,095
innovativ	0,095			0,095
Originalität	0,095			0,095
Phantasie		0,095		0,095
Frei denken	0,048			0,048
Artist	0,048			0,048
artistisch	0,048			0,048
kreativ	0,048			0,048
kreieren	0,048			0,048
musikalisch	0,048			0,048
originell	0,048			0,048
Out of the box	0,048			0,048
Theater	0,048			0,048
Total Strength	1,952	0,286	0,095	2,333

Appendix E: The Found Synonyms and the Demographic Variables of the Respondents

			Field of study		Gender		nationality	
Association	**Synonym**	**StoA**	**Engineering**	**Social studies/ music**	**Male**	**Female**	**Dutch**	**German**
artiest	kunstenaar	0,62	14	17	13	18	13	18
artistiek	Kunstzinnig	0,54	12	15	11	16	11	16
creëren	Maken	0,6	21	9	15	15	26	4
Grafisch design	Ontwerp	0,24	9	3	8	4	11	1
handvaardigheid	Knutselen	0,3	12	3	10	5	15	0
idee	Ingeving	0,26	7	6	3	10	7	6
idee	Gedachte	0,28	5	9	10	4	8	6
innovatie	Vernieuwing	0,4	18	2	13	7	20	0
innovatief	Vernieuwend	0,46	16	7	12	11	20	3
inspiratie	Idee	0,24	5	7	2	10	6	6
kunstenaar	Artiest	0,54	14	13	13	14	19	8
maken	Creëren	0,38	16	3	15	4	19	0
schilderen	Verven	0,36	15	3	11	7	18	0
uitvinden	Bedenken	0,28	7	7	8	6	12	2
verbeelding	Fantasie	0,3	9	6	11	4	15	0
vindingrijk	Creatief	0,48	11	13	14	10	12	12

Appendix F: The Found Antonyms and the Demographic Variables of the Respondents

			Field of study		Gender		nationality	
Association	**Antonym**	**StoA**	**Engineering**	**Social studies/ music**	**Male**	**Female**	**Dutch**	**German**
Creatief	Oncreatief	0,22	3	8	2	9	0	11
Creëren	Vernietigen	0,28	6	8	7	7	6	8
Innovatief	Oud	0,22	1	10	3	8	1	10
Muzikaal	Onmuzikaal	0,28	3	11	3	11	0	14
Out of the box	In the box	0,28	5	9	5	9	7	7