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On the role of creativity in the formation of new complex words

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Abstract: This article presents the results of a large-scale interdisciplinary project aimed at a corroboration of the role of creativity in the way university undergraduates ($N = 309$) coin new complex words. Specifically, the tendency towards economy of expression, preferred by a speaker, and the tendency towards semantic transparency, preferred by a listener, were examined in the broader context of the creative potential of an individual, understood as divergent thinking abilities captured by the Torrance test of creative thinking (TTCT). The results indicate that divergent thinking abilities, as operationalized by the TTCT scores, negatively correlate with the general tendency to coin new complex words in a more economical fashion. More specifically, the general tendency towards economy of expression correlates negatively with Elaboration, Creative Strengths, and potentially with Creativity. A more detailed analysis indicates that this is especially the case for the word-formation task, where open-ended responses were analyzed and a drawing served as stimulus material for word formation. These results are not only novel but also encouraging for future research into the role of psychological factors in the psycholinguistic process of word formation conceived as a creative act of a language user.

Keywords: creativity; economy of expression; semantic transparency; Torrance test of creative thinking; word formation

The poet's eye, in a fine frenzy rolling, doth glance from heaven to Earth, from Earth to heaven—and as imagination bodies forth the forms of things unknown, the poet's pen turns them to shape, and gives to airy nothing a local habitation and a name. (Shakespeare, A Midsummer Night's Dream, (cited in Runco and Jaeger 2012)).

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1 Introduction

Psycholinguistic research has paid considerable attention to the *interpretation* of complex words in recent decades, primarily focusing on nominal compounds and the role of the modifier, the head and their semantic relation(s) in interpreting potential coinages (for an overview, see Gagné 2017; Gagné and Spalding 2014; Štekauer 2005a). Strangely enough, hardly any attention has been devoted to the role of the psychological factor of creativity in word formation despite the fact that this link is intuitively appealing and can be identified in folk wisdom, as outlined, for instance, by Shakespeare's poem illustrated above.

This paper presents the results of a large-scale interdisciplinary project focused on the evaluation of the role of *creativity*, as a psychological factor, in the way university undergraduates coin new complex words as a psycholinguistic process. Thus, the psychological term 'creativity' is studied through word-formation creativity. Word-formation creativity is conceived as the ability of any speaker of a language to approach the naming act in a creative way by selecting one out of a number of possible ways of semiotic representation of an object to be named (Štekauer 2005b). Word-formation creativity is, in the present research, evaluated in each of its manifestations in terms of the competition between two contradictory tendencies that are present in every language and manifested at every level of linguistic description: the tendency towards an *economy of expression* and the tendency towards *semantic transparency*.

We start with a summary of the basic theoretical principles underlying our research (Section 2). While Section 2.1 introduces the general concept of creativity, Section 2.2 discusses the relation between creative potential and creative performance in word formation. Special attention is paid to the comprehension of creativity in various approaches to word formation and an overview of onomasiological types as the basis of our research. This is followed by an account of the research method, with a special focus on the Torrance test of creative thinking (3.1) and the word-formation test (3.2). Section 3.3 introduces transparency and economy indices for the sake of statistical analysis (3.4), before the presentation and discussion of the results (Section 4). The last part (Section 5) summarizes the most important conclusions and considers perspectives for future research.

2 Theoretical framework

2.1 Creativity

When discussing creativity, many eminent historical figures – 'creative geniuses' (Simonton 2019a) – such as Shakespeare, Picasso, Beethoven, or Newton come to

mind with their remarkable contributions. These instantiations represent the so-called ‘Big C’ *Creativity* reserved for extraordinary products made by non-conventional people in their respective fields. Nevertheless, this is only the tip of the iceberg, and many more nuanced forms of creativity can be identified in the everyday activities of ordinary people (Cotter et al. 2019; Kaufman and Beghetto 2009).

Various approaches and methods can be traced in order to understand and assess these forms of creativity (cf. Kaufman and Beghetto 2009; Kozbelt et al. 2010; Plucker et al. 2019). Among them, the *Torrance test of creative thinking* (TTCT) occupies a prominent position, as, according to Kim (2006), it is considered as the most widely used and referenced test of creativity, and was created by Torrance with the aim to provide “a reliable and valid test of creative thinking abilities that could be administered to individuals from kindergarten through adulthood” (Runco et al. 2010b: 362).

According to a recent *integrative bio-psycho-behavioral model* (Jauk 2019), three hierarchical levels can be delineated when describing creativity. Real-life creative behavior is situated at the most visible level. This surface level is influenced by a deeper level, comprising psychological constructs related especially to abilities and personality. The middle level is further determined by deeper neurobiological systems such as the default mode network, the executive control, and the dopaminergic system. Although the neural level is beyond the scope of the present study, the two higher levels are crucial here as, according to Jauk (2019), the *cognitive creative potential*, in terms of the divergent thinking ability, occupies a prominent place at the center of the middle level. In fact, divergent thinking has been a synonym for creativity for many years, and its role in creative potential and creative problem solving is still considered as crucial (Glăveanu and Kaufman 2019; Jauk 2019; Runco and Acar 2019; Runco et al. 2010a).

Divergent *thinking* can be conceptualized as a “measure of ideation that fuels creative thinking” (Runco and Acar 2019: 244), and, in comparison to *convergent thinking*, it captures various directions of thoughts, which are necessary in situations where more than one correct answer exists. Torrance based his notion of creative potential on Guilford’s theory (Guilford 1956, 1986; see also; Cramond et al. 2005; Plucker et al. 2019; Runco et al. 2010b). Accordingly, four main scores, namely *Originality*, *Elaboration*, *Fluency*, and *Flexibility*, and one additional score, *Creative Strengths*, can be distinguished. Although various types of the TTCT can be traced depending on the specific version (cf. Torrance 1966, 1974, 1987, 1990, 1998) and the form (figural vs. verbal form), we used the most recent official Slovak version (Jurčová and Szobiová 2008) to find out whether the creative potential of an individual, as captured by various TTCT scores, relates to word formation as an act of creativity by a language user.

2.2 Creativity in word formation

The notion of word-formation ‘creativity’ has traditionally been connected with deviation from the established rules, with a non-rule-governed process. Marchand, as early as in his 1960 groundwork of English word formation, introduced the concept of ‘word-manufacture’, in which “[m]ore or less arbitrary parts of words may be welded into an artificial new word” (1960: 368) and therefore do not rely on any productive morphological process. Conversely, Bauer (1983: 63) emphasizes the factor of motivation, and defines creativity as “the native speaker’s ability to extend the language system in a motivated, but unpredictable (non-rule-governed) way.” Similarly, Renouf (2007: 70) maintains that “[c]reativity is typically thought of as the act or quality of an unpredictable departure from the rules of regular word formation.” Creativity, therefore, denotes cases in which “the (nonce) coined word obviously transgresses the morphological system” (Dal and Namer 2018: 224).

The term ‘creativity’ acquired a broader scope within various treatments of lexical creativity (see, for example, the contributions in Arndt-Lappe et al. [2018] and Munat [2007b]). In this context, it is first and foremost related to nonce-formations like blends, clippings, acronyms, initialisms, truncations and phrasal lexical items, but also to the metaphorical and metonymical shifts of existing words. These lexical items manifest various degrees of deviation from the expected patterns and “different degrees of ‘noteworthiness’” (Hohenhaus 2007: 16). They mostly serve as attention-seeking devices, means of humor, playfulness, ludicity, puns, wordplay, etc., and are therefore, as pointed out by Dal and Namer (2018), mostly shifted to the area of performance and pragmatics.

The extensive scope of the lexical creativity agenda is aptly expressed by López Rúa (2010), who maintains that

[l]anguage is thus used to break away from the norm, and also from what is foreseeable or even politically correct. In morphological terms, this is reflected in the manipulation of morphological rules, which results in the creative or deviant use of word-formation devices, such as affixation (*Preprophecy*), conversion (*Damnswells*), compounding (*The Lovemongers*), or blending (*The Beatscuits*). Moreover, the fragile correspondence between an orthographic word, a phonological word and a lexeme is constantly challenged by the creative use of graphemes and punctuation, word play, or semantically anomalous word combinations. (López Rúa 2010: 51)

This view is in accordance with Bauer’s (2001) delimitation of the scope of creative coinages: the formation of simple words (complex words are, in his view, the matter of productivity), the figurative extension of existing words, and formations produced by isolated individuals or by the extension of non-productive patterns.

In fact, this understanding of creativity in word formation is closely linked to the long-discussed problem of the relation between creativity and productivity. On the one hand, there are views that identify creativity with productivity (e.g., Chomsky 1964, 1965; Veale 2007). Opposed to this are views that strictly separate these two phenomena and consider linguistic creativity exclusively as a deviation from productive rules, or, in other words, while productivity is rule governed and therefore automatic and unintentional, creativity is non-rule-governed and therefore intentional (Bergs 2019; Botha 1968; Fernández-Domínguez 2010; Lieber 2010; Ronneberger-Sibold 2008; Schultink 1961). Finally, there are authors who treat the relation between linguistic creativity and productivity as a continuum (Chung 2008; Ladányi 2000; Mattiello 2018; Munat 2007a). In principle, this means that creative coinages “tend to be at least rule-related, up to the point where a distinction from ‘governed by productive rules’ becomes problematic” and therefore “it is preferable to consider the difference between creativity and productivity as a cline” (Hohenhaus 2007: 16).

Our comprehension and use of the notion of creativity in word formation is different. Creativity is generally understood as a universal feature of human beings, as their creative potential (Kampylis and Valtanen 2010). Since creative potential is implemented through creative performance (Runco et al. 2010a: 343), we understand word-formation creativity as one of many areas of creative performance, as a manifestation of this creative potential in coining new complex words. We understand it as the ability of any and all language speakers to form a new complex word in response to the specific need of a speech community to give a name to a new object of extralinguistic reality or a new name to an already named object. It is assumed that every act of naming is a creative act that employs a language speaker’s cognitive abilities in order to select and employ one of a number of possible naming strategies. The creativity of word formation in this sense is manifested at each level of the naming process, i.e., at the conceptual level, the onomasiological level and the onomatological level. This fact also makes the onomasiological approach an advantageous tool for the examination of various word-formation strategies employed by different (groups of) language users in terms of the opposing tendencies to semantic transparency and economy of expression.

Our first attempt at treating each act of word formation as an act of *creativity* by a language user rather than an automatic process was more than a decade ago (see Štekauer et al. 2005). The notion of creativity lays emphasis on the active role of language users in coining new words by reflecting the fact that, in each act of naming, there is considerable space for a coiner’s individual preferences and for a selection from several options. Since language users have unequal experiences, knowledge, intellectual capacities, imaginations, education, ages, professional

interests, and so on, one can expect considerable variation in their approaches to the naming task.¹ These differences can be advantageously observed by examining the way(s) in which language users solve the conflict between the tendency towards economy of expression, which is preferred by a speaker (who is able to say more within a given time period), and the tendency towards semantic transparency, which is preferred by a listener (who is able to understand new complex words faster and more easily). These contradictory preferences were observed as early as the start of the 20th century by von der Gabelentz (1901: 181–185), who used the terms *Bequemlichkeit* (preferred by the speaker) and *Deutlichkeit* (preferred by the listener).²

The concept of semantic transparency plays a crucial role in research into the interpretation of compound words, especially Noun + Noun compounds. In psycholinguistic literature, it is usually understood as scalar relation between the meaning of a compound word and its constituents, in particular as a degree of correspondence of the meaning of a compound word with the meanings of its motivating constituents (e.g., Bell and Schäfer 2016; Gagné and Spalding 2009; Ji et al. 2011; Libben 1998; Schäfer 2018: 1). Libben (1998) distinguishes two types of semantic transparency. The first, ‘constituency’, pertains to the use of morphemes in their original/shifted meaning (in *shoehorn*, *shoe* is transparent because it is used in its original meaning, while *horn* is opaque). The second, ‘componentiality’, bears on the meaning of a compound as a whole: for example, *bighorn* is non-componential because the meaning of this word cannot be inferred from the meanings of its constituents, even if these are related to independent morphemes.

Psycholinguists differ, however, in their views of the importance of the head and modifier, respectively, in their contribution to the interpretation of compounds as a whole. This is reflected in asymmetric models that assign a higher value to one of the constituents in the process of interpretation. Thus, the role of the modifier is emphasized by Gagné and Shoben (1997), Gagné (2001), Spalding and Gagné (2008) and Spalding et al. (2010) in their CARIN model, even if later, in the RICE model, Gagné and Spalding (2014: 103) maintain that the information associated with both head and modifier is crucial to the evaluation phase of interpretation. In addition, as pointed out by El-Bialy et al. (2013), the processing of a compound also depends on whether the compound constituents have similar semantic transparency, i.e., whether the transparency of the first and the second constituents match.

¹ Certainly, at least within the limits determined by productive rules of word-formation.

² For similar views see also, among others, Vicentini (2003), Moravcik (2014) and Haspelmath (2014).

Another factor that plays a role in the semantic transparency of complex words is the semantic relations between the modifier and the head, the relations that various morphologists and psycholinguists have attempted to capture since Lees (1960). The most influential system appeared to be Levi's system of Recoverably Deletable Predicates (1970), even though it came to be the target of extensive criticism. What matters more with regard to the interpretation of the most common object of meaning-interpretation studies, i.e., *N+ N* compounds, is the competition between numerous potential semantic relations between the head and the noun of each such compound as a result of the absence of any verbal element. The idea of competition came to be the focal point of the above-mentioned CARIN and RICE models, and it also underlies Štekauer's theory of meaning predictability (2005a). Nevertheless, these are issues that go beyond the scope of the present research, which explores the influence of creative potential upon word-formation creativity rather than meaning interpretation.³

The conflict between the tendency towards semantic transparency and the tendency towards economy of expression can be analyzed and evaluated by means of an onomasiological theory of word formation (cf. Körtvélyessy 2010; Körtvélyessy et al. 2015; Štekauer 1998, 2005b, 2016). This theory accounts for the way in which new complex words are formed. It reflects a crucial *triad of relations* between extralinguistic reality (object to be named), a speech community (represented by a 'coiner'), and the word-formation system, thus emphasizing the fact that each act of naming responds to a specific naming demand on the part of a member (or members) of a speech community. It lays emphasis on the active role of language users in the process of giving names to objects. The naming act is not a purely linguistic act. New complex words do not come into existence in isolation from factors such as human knowledge and experiences, human cognitive abilities, human imagination and creativity, etc. This position is in accordance with Koch's idea that the onomasiological viewpoint is closer to that of the speaker as a linguistic innovator than the semasiological viewpoint (2001: 17). By implication, the naming act is a cognitively founded phenomenon that starts with a conceptual analysis of a class of objects to be named. This analysis captures the prototypical features of the class of objects by means of logical predicates (noemes). Some of these logical predicates, represented by corresponding semantic categories like Agent, Action, Instrument, Result, Location, Time, Diminutive, Causative, etc., are chosen to 'motivate' the future complex word at the onomasiological level, thus constituting an onomasiological structure. In accordance with Dokulil

3 Cf. Körtvélyessy et al. (2020) for research into the influence of creative potential upon the interpretation of novel complex words.

(1962, 1997), we understand the onomasiological structure as involving different forms of structuring the concept in view of its expression in the given language. The onomasiological structure is subsequently represented by morphemes of a language at the onomatological (morphemic) level. In other words, onomasiology establishes the cognitive basis for the naming act by identifying the semantic categories and the relations between them. Onomatology ‘cares’ for the representation of these semantic categories by morphemes of a language by means of the *Morpheme-to-Seme-Assignment Principle* (Štekauer 1998, 2005b). Then, the onomasiological type reflects the interrelation between the onomasiological and the onomatological (morphemic) levels.

In particular, the structure of the onomasiological level is prototypically constituted by three constituents: the base, the determining mark, and the determined mark. The phenomenon to be named is first classed with a certain conceptual class and functions as the onomasiological base. Within the limits of this class, its scope is narrowed down by the determining mark. In the prototypical ternary structure, these two constituents are related by the determined mark that always stands for the cognitive category of ACTION in one of its three modifications (Action proper, Process and State).⁴ Any of the semantic categories representing the onomasiological structure can but does not have to be represented at the onomatological level. The possibility (not) to represent individual semantic categories by corresponding morphemes determines the form of a new complex word and establishes various onomasiological types. As a result, they reflect different degrees of transparency/economy (see Figure 1).

In the following overview of onomasiological types, OT stands for ‘onomasiological type’, DingM for ‘determining mark’, DedM for ‘determined mark’, and R for ‘morphemically represented’.

(1)	OT1	DingM	–	DedM	–	Base	
		R		R		R	
Example:		Object	–	Action	–	Agent	
		talk		interrupt		er	I2
		miracle		believe		er	I3
		spider-web		love		er	II1
		alien		greet		er	II2
		Location	–	Action	–	Agent	
		car		ride		er	III1

Only two constituents are represented by morphemes in (2) and (3):

⁴ See Štekauer (1998) and (2005b) for a comprehensive account of the onomasiological theory of word formation.

(2) OT2 DingM – DedM – Base

Ø R R

Example: Object – Action – Agent

Ø smile man

(3) OT3 DingM – DedM – Base

Example: Object – Action – Agent

miracle Ø er I3

spider-web Ø ist II1

Location – Action – Agent

car-roof Ø er III1

Stative – State – Patient

clone Ø child II3

OT4 ranks among the most economical of all onomasiological types because a ternary structure is represented by a single morpheme. It is based on the ACTION-TO-SUBSTANCE recategorization:

(4) OT4 DingM – DedM – Base

Ø R

Example: Object – Action – Agent

Ø smile_N I1

Ø cut-in_N I2

OT5 employs the same feature as OT4, i.e., a joint representation of the base and the ACTION category. However, unlike OT4, the determining constituent of the onomasiological structure is represented by a morpheme. For illustration, this type is exemplified with a complex word for ‘a person who cheats tourists’ in (5).

(5) OT5 DingM – DedM – Base

R R

Example: Object – Action – Agent

tourist cheat⁵

Action – Agent – Object

catch bird III2

OT6 is another extremely economical onomasiological type. Neither the base nor the determined mark is expressed, as is the case with exocentric compounds like *redskin*, i.e., ‘a person with a red skin’ (referring offensively to American Indians). The absence of the base and the determined constituent of the mark at the morphemic level can only be explained by an effort of a coiner with the maximum possible economy of expression. By implication, the semantic transparency of this onomasiological type is poor. Anything can have red skin, as evidenced by another meaning of this word, i.e., ‘a potato that has red skin’.

- (6) OT6 DingM – DedM – Base
 R Ø Ø
 Example: Object – Action – Agent
 spider-web Ø Ø II1

In OT7, the mark cannot be structured into determining and determined parts, which yields a binary onomasiological structure, comprising a mark and a base. Both base and mark are morphemically represented.⁶

- (7) OT7 Mark – Base
 R R
 Example: Negation – Quality
 un *happy*

In OT8, the mark of a binary onomasiological structure is not expressed. This can be illustrated with an example of a SUBSTANCE-TO-ACTION conversion, such as ‘to bridge (something)’.

- (8) OT8 Mark – Base
 O R
 Examples: Object – Action
 O *bridge*
 Manner – Action
 O *laze*

In OT9, both mark constituents are expressed with the meaning ‘a person smiling on a billboard’. This type develops OT6, which is restricted to the expression of the determining mark:

⁵ Variants of OT5, characterized by the reversed order of the semantic categories, are represented by *pickpocket* and other similar exocentric compounds.

⁶ With regard to compounding, this onomasiological type encompasses noun incorporation of the ‘to *brainwash*’ type.

- (9) OT9 DingM – DedM – Base
 R *R* \emptyset
Example: State – Location – Patient
 smile *face* \emptyset I1

It follows from these examples that the differences between the extent of the morphemic representation of the ternary or binary onomasiological structure reflect the competition between the above-mentioned contradictory tendencies and make it possible to determine which way of forming new complex words is preferred by various groups of speakers distinguished by age, profession, education, psychological concept of creativity, etc. Figure 1 illustrates the relations between semantic transparency and economy of expression:

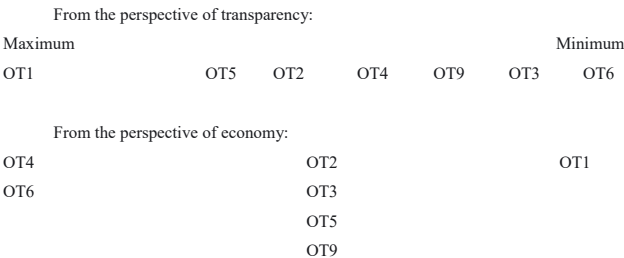


Figure 1: Scales of transparency and economy (OTs that occur in our research).
On the omission of OT7 and OT8, see below.

The reasoning that underlies Figure 1 builds on the crucial role of the morphemic representation of the cognitive category ACTION in the concept of onomasiological type. Similar to the verb which, with its valency, is at the core of sentence semantics, the significance of the category ACTION stems from its capacity to semantically relate the other two constituents of the onomasiological structure. Without a morphemic representation of this category, the relation between the polar constituents remains vague owing to the usual diversity of possible interpretations. Its crucial position is also reflected in various morphological and psycholinguistic models of word-interpretation of (primarily) Noun + Noun compounds which are aimed at the identification of the semantic relation between two nominal constituents. The best-known attempt is Levi’s (1978) system of Recoverably Deletable Predicates.⁷

⁷ For overviews of various approaches that try to represent this kind of semantic relations see, for example, Štekauer (2005), Gagné and Spalding (2014), Libben (2015), and Gagné (2017).

The system of onomasiological types that ranges over all word-formation processes (prefixation, suffixation, compounding, conversion, etc.) is advantageous for the evaluation of the discussed contradictory tendencies in word formation because it makes it possible to capture various naming strategies that manifest different degrees of preferences for semantic transparency vs. economy. Taking the above-outlined onomasiological theory of word formation as a theoretical framework, four basic criteria can be identified for the classification of individual onomasiological types in terms of semantic transparency and economy of expression:

- (i) A ternary vs. binary onomasiological structure
- (ii) The number of constituents of the onomasiological structure represented by morphemes at the onomasiological structure
- (iii) Constituents of the onomasiological structure that are/are not represented by a morpheme:
 - Base
 - Determining mark
 - Determined mark
- (iv) A shared representation of a single constituent of an onomasiological structure by one common morpheme

Based on these principles, it is assumed that:

- The transparency of OT1 is the maximum possible because each semantic constituent of the ternary structure is morphemically represented.
- OT2 is more transparent than OT3 thanks to the morphemic representation of the semantic category of ACTION. The same is true of OT4.
- OT5 is more transparent than OT4 because, apart from the base and the ACTION being merged, it is also represented by a morpheme standing for the determining mark.
- OT2 is more transparent than OT4 because both the base and the ACTION are represented by morphemes.
- OT5 is more transparent than OT2. Although its ACTION and base are represented by a common morpheme, in contrast to OT2, the determining mark is also represented by a morpheme.
- OT9 is more transparent than OT3 because while it lacks a morpheme for the base, the ACTION and the determined mark are expressed.
- OT9 is less transparent than OT4, which contains morphemes for the ACTION as well as for the base.
- OT6 is the least transparent because it only contains the determining element of the mark.

It should be noted that the scales in Figure 1 only represent those onomasiological types that occurred in the respondents' answers to the specific tasks of the word-formation test. The absence of OT7 and OT8 is understandable because the scope of the naming tasks in the test was restricted to Agent and Patient names. As will be seen in the evaluation of the data obtained, the uses of individual onomasiological types for these kinds of named objects vary considerably.

3 Research method

The sample for the present research originally consisted of 357 university undergraduates. The respondents came from two universities in Košice, Slovakia. One group of them studied in the Faculty of Arts at P. J. Šafárik University in Košice. These students were selected from two study programs: British and American Studies and Translation and Interpretation. The other group came from three faculties at the Technical University in Košice: the Faculty of Civil Engineering, the Faculty of Economics, and the Faculty of Fine Arts and Design. Their participation was voluntary and implemented in class settings. The participants were allowed to end their participation at any time. No financial benefits were provided as compensation; instead, information about the Torrance test of creative thinking (TTCT) testing as well as its results were offered to the students. Testing was conducted in accordance with the APA ethical standards for research.

The group of university undergraduates were homogeneous with respect to their age (22 years old) and level of English (B2/C1 according to the Common European Framework of Reference for Languages).

The testing was implemented in two rounds within regular classes with the help of the respective teachers and members of the research team. In the first round, the respondents were tested for creative potential by means of the TTCT. Ten minutes were provided to accomplish every task (see 4.1 below). In the second round, which took place about two months after the first, the respondents were tested for word formation. Since the test was focused on English word formation, the participants provided English coinages. The time reserved for the word formation test was 15 min.

Obviously, only those respondents who undertook both tests were taken into consideration in our research. This means that our evaluation is based on 309 university undergraduates (61% female and 39% male, mean age = 20 years; SD = 1.67).

The TTCT coding was conducted to be as objective and reliable as possible. The coders were a small group of psychology graduates specifically chosen, trained, and supervised for this purpose. The coding was conducted in accordance with an

official test manual in which examples, standards, and further information for the purpose of reliable coding are provided. Moreover, during the process, the coders were supervised by a clinical psychologist, and potential discrepancies and questionable cases were discussed and consequently resolved in small group sessions with supervision. The word-formation test was coded separately first by the two team members who specialize in an onomasiological theory of word formation. Any discrepancies were discussed and resolved in this case as well.

3.1 Torrance test of creative thinking (figural form)

The TTCT, as an indicator of creative potential, consists of various scores (subscales). These are assessed across three tasks. In every task, participants are encouraged to create something special. Ten minutes are provided to accomplish every task.

In the first task, named *Picture construction*, a colored sticker in the shape of a jellybean and a blank sheet of paper are provided. The goal is to stick the sticker on the paper to create a picture incorporating the sticker and to name it. The stimulus material and instructions are illustrated below (see Figure 2).

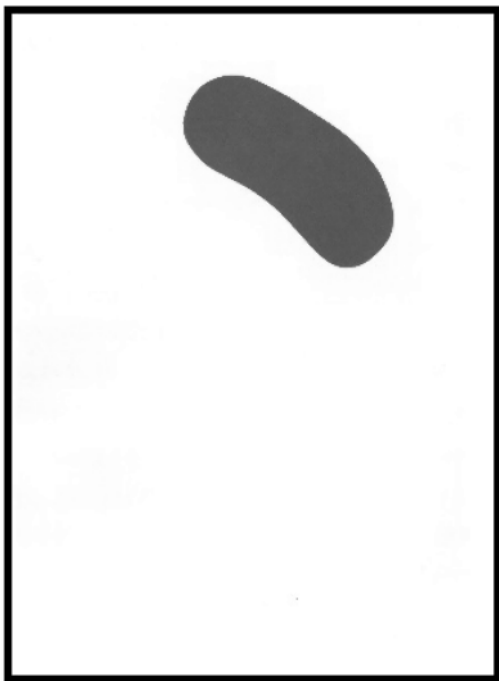


Figure 2: Sheet of a paper with a sticker as an illustration of the stimulus material for the first task.

Task 1. In front of you, there is a rounded piece of colored paper. Think of a picture of an object that you can draw when you use this piece as a part of the overall drawing. Then, draw lines to create the intended image. Try to think of a picture that you assume no one else would invent. Add elements to your sketch so that the image you create expresses a most interesting phenomenon. When you finish drawing, think of a name for your image and write it at the bottom of the page. Think of a very accurate and unusual name to help explain your drawing.

In the second task, named *Picture completion*, the goal is to complete 10 incomplete figures and to name them. The stimulus material and instructions for the task are illustrated below (see Figure 3).

Task 2. By adding lines to the incomplete figure on the next page, you can turn the sketched shapes into interesting objects or pictures. Again, try to think of an object or picture that no one else would invent. Complete and expand your first idea and try to add lines to create the most complete and interesting image. Think of an interesting title for your drawing and write it at the bottom of the frame next to the image number.

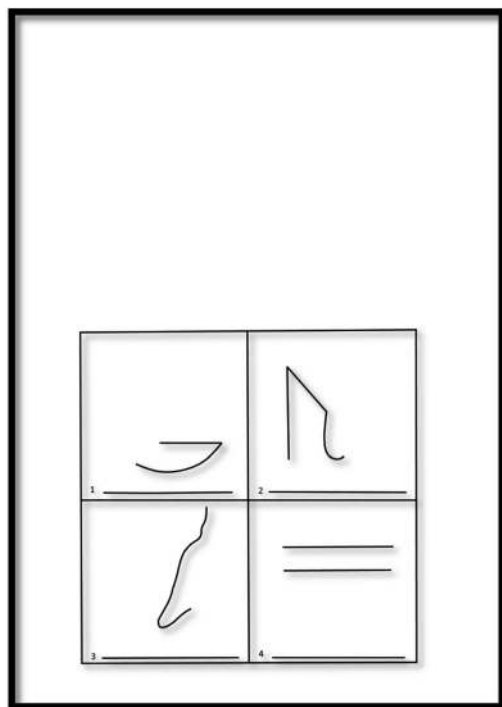


Figure 3: Sheet of a paper with incomplete figures as an illustration of the stimulus material for the second task.

In the third task, called *Circles*, the goal is to complete the circles and to create a picture (or pictures). The circles are illustrated below (see Figure 4).

Task 3. In the next 10 min, see how many objects and pictures you can create from the circles on this and the next pages. Circles should be the main part of everything you create. Draw a line to the circles to create an image. Try to figure out things that no one else could come up with. You can draw between, inside and outside the circles. Create as many different pictures as you can and put as many ideas into each as possible. Try to make them show the most interesting scene. Write names under the pictures.

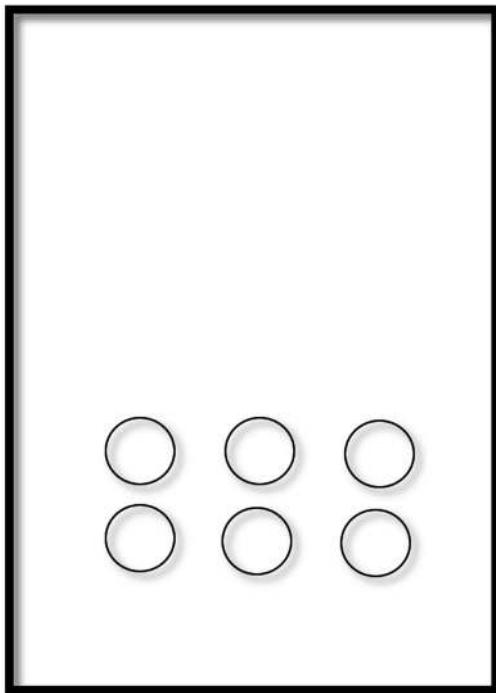


Figure 4: Sheet of a paper with circles as an illustration of the stimulus material for the third task.

The above-mentioned tasks were used to assess various aspects of divergent thinking. In particular, scores for Creativity, Fluency, Flexibility, and Elaboration can be derived from the tasks. Moreover, one additional score, called Creative Strengths, is assessed.

Originality captures how unique the creative product is in comparison to the existing standards. Statistically speaking, the less frequent the answer is in the normative sample, the higher the originality score is. For illustration purposes, we will use the fourth drawing of the second task (Picture completion). The task consists of completing two horizontal lines. Although there are numerous possibilities for completing the drawing, we will mention two hypothetical scenarios. As illustrated in Figure 5, in the A variant (the second from the left), the completed picture depicts ‘a rail’. In contrast, in the B variant (the third picture from the left),

the completed picture depicts ‘a belt’. Since B is much less common according to the standards specified in the manual (less than 1% in a normative sample in comparison to 3–5% for the second answer), the originality score for B is higher (3 points) in comparison to A (1 point). Note, however, that even the second answer is relatively original. For an answer occurring in more than 5% of all answers, drawings such as ‘a road’ will be considered as non-original, and 0 points will be given to the participants.

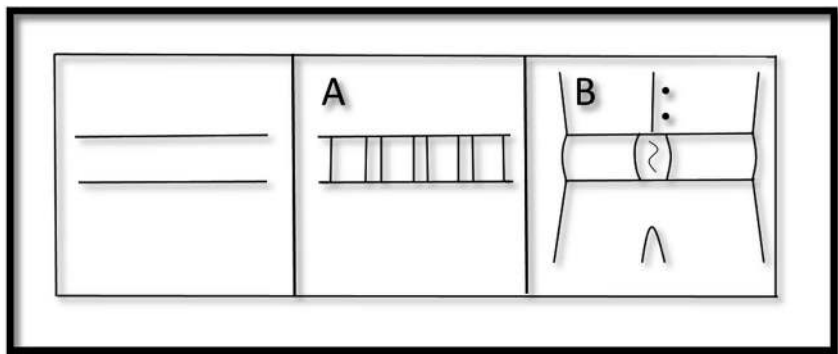


Figure 5: Illustration of (A) less vs. (B) more creative drawings.

Fluency captures the number of relevant answers provided by a participant. The higher the number of completed pictures, the higher the fluency score. For example, Figure 6 illustrates two situations that can hypothetically occur in the second task (Picture completion). In the upper line (A), (only) four legitimate answers are provided. Therefore, the score is 4. In comparison, the lower line (B) provides 10 different answers, and therefore a score of 10 is given to the participant.

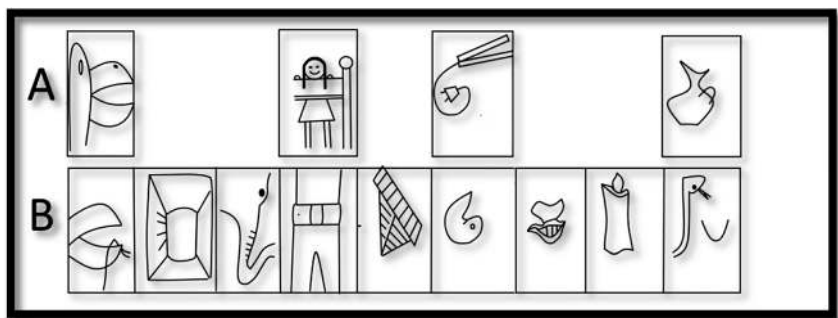


Figure 6: Illustration of (A) less vs. (B) more fluent answers.

Flexibility captures the number of different categories provided in the pictures. The more diverse the answers are, the higher the flexibility. One point is gained for every new category that is presented in the drawings. We can illustrate this with two hypothetical scenarios in solving Task 3 (Circles). As illustrated in the upper line (A) of Figure 7, the circles can be completed in such a way that every circle belongs to the same category. As all pictures capture emoticons, no points for flexibility will be given to the participant. In comparison, in line B, all three drawings differ regarding their content because the football, the seven-spotted ladybird and the yin-yang symbol represent different categories. As the category shifted twice in example B, 2 points are provided to the participant for their flexibility score.

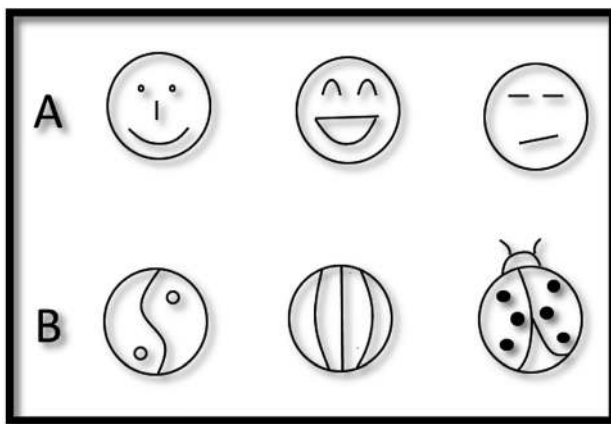


Figure 7: Illustration of (A) lower vs. (B) higher flexibility.

Elaboration captures how many details are provided in a drawing beyond what is necessary to understand the drawing. The more details are provided beyond what is necessary to capture the idea, the higher the elaboration score. This can be illustrated by the third picture of the second task (Picture completion). While there is a plethora of possible ways as to how to complete the picture, two hypothetical scenarios are illustrated in Figure 8. In B (the third picture from the left), a lot of additional details can be found, such as a skiing site, trees, a star, and a cabin. In contrast to this more elaborate drawing, the picture of a needle in situation A (the second drawing from the left) does not provide any additional details. Therefore, no points for elaboration are given to the participant for this picture.

Creative Strengths consist of 13 categories (e.g., fantasy, colorfulness of imagery, humor, emotional expressiveness, and so on). The score increases as the number of these categories grows.

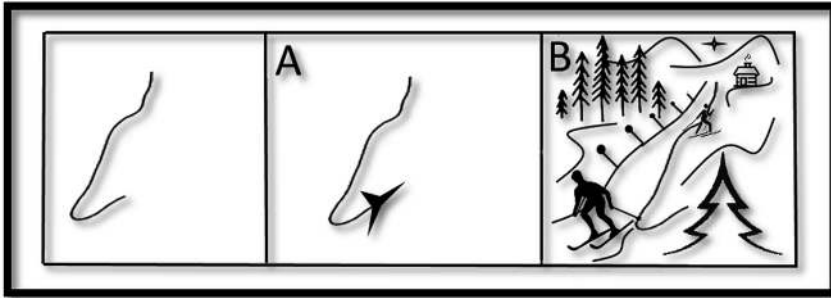


Figure 8: Illustration of (A) lower vs. (B) higher elaboration.

3.2 Word-formation test

The word-formation test was aimed at coining names for Agents and Patients. The reason for this focus consists in the availability of numerous options in this field of word formation, comprising suffixation with a number of suffixes (*-er*, *-ist*, *-ian*, *-ee*, *-eer*, *-ant/-ent*), different types of compounding with various possibilities of how to express the onomasiological base (*man*, *woman*, *person*, etc.) and conversion (as in *cheat_N*). If we add numerous possibilities for the expression of the determining and the determined marks in every specific act of naming to these, this area of naming offers a number of options that can be captured by the system of established onomasiological rules and evaluated in terms of the examined contradictory tendencies towards transparency or economy.

The test itself consisted of three tasks, each of them consisting of three subtasks. The three tasks were different in their nature: the first one was based on multiple-choice questions, the second on verbal descriptions, and the third on drawings. This structure of the word-formation test complies with the domain-specificity/task-specificity theory of creativity, according to which “the skills, traits, and understandings that underlie creative performance ... vary from domain to domain” (Baer 2017: 379). In Task 1, the participants were offered a range of options for naming a person described by some text. The last option indirectly prompted them to come up with a non-rule-governed solution by offering a ‘free choice’. The second set of tasks differed from the first by offering no options. The respondents were asked to propose their own new complex word based on a brief specification of the object to be named. Finally, the third set of three tasks replaced the wording with a drawing of a situation in which an object performs an unusual activity.

Since the test was aimed at the formation of new words, the respondents were expressly asked not to use either existing words in a shifted meaning or descriptive phrases (see Figures 9–11).



Figure 9: Drawing for Task 3/1.

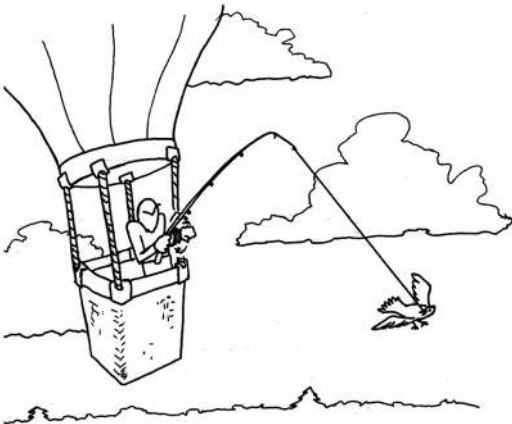


Figure 10: Drawing for Task 3/2.

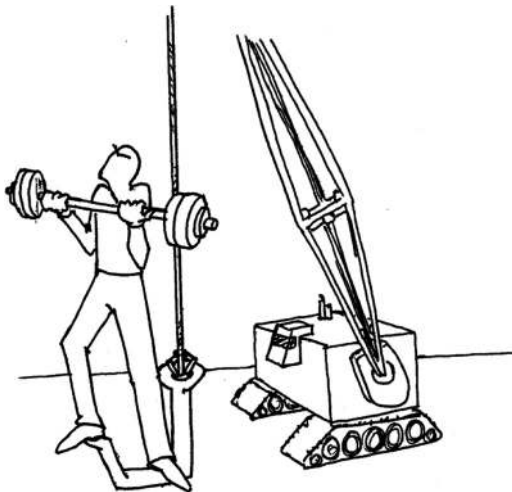


Figure 11: Drawing for Task 3/3.

Task 1. *Choose the word that you think is the most suitable for the person described in the task.*

Task 1/1. *A person whose smiling face is used for billboard advertisements:*

- a. smiler
- b. smilist
- c. smileman
- d. smile
- e. smile-person
- f. smile-face
- g. billboard smile-face
- h. [free choice]

Task 1/2. *A person who frequently interrupts other people when they are talking:*

- a. interrupter
- b. cutter-in
- c. cutter-inner
- d. interrupt
- e. talk-interrupter
- f. talk-interrupt
- g. interrupt-man
- h. [free choice]

Task 1/3. *A person who believes in miracles*

- a. miraclist
- b. miracler
- c. miracle-man
- d. miracle-believer
- e. miracle-hoper
- f. miracle-hope
- g. [free choice]

Task 2. *Each question describes a person in an unusual situation. If you had to come up with a name or title for the person, what would it be? You may make up a word or choose a word that already exists in English.*

Task 2/1. *What would you call someone who does research about spiders' webs?*

Task 2/2. *Suppose that aliens were about to land on Earth for the first time. What would you call a person who was supposed to meet them as a representative of the human race?*

Task 2/3. Suppose that a woman has a clone made of herself. Then suppose that a man has a clone made of himself. Now suppose that the two clones marry each other and have a child. What would you call the child?

Task 3. Each drawing below shows a person performing an unusual action. If you had to come up with a name or title for the person in each drawing, what would it be? You may invent a word or choose a word that already exists in English.

3.3 Transparency and economy indices

An index that captures the general inclination of a language speaker to form words in a more or less transparent or economical fashion was computed across all word-formation tasks (general index). This index facilitates the statistical evaluation of economy and transparency at a more general level. Moreover, since the individual tasks differed in the stimulus material and their answer format, we computed indices for each of the three word-formation tasks (specific task-related indices). These indices enable us to capture the general inclination of a language speaker to form words in a more or less transparent or economical fashion.

To accomplish this task, firstly, all individual answers in the word-formation test were analyzed and ranked according to their level of semantic transparency and economy of expression based on their OT, as described above in Section 2.2 (maximum to minimum transparency – 1(OT1), 2(OT5), 3(OT2), 4(OT4), 5(OT9), 6(OT3), 7(OT6/OT10); and maximum to minimum economy – 1(OT4/6/10), 2(OT2/3/5/9), 3(OT1)).⁸ For instance, hypothetically, if the answers of a participant in the second word-formation task (where participants had to come up with a name for a person in three unusual situations on the basis of a verbal description) were classified as OT4, OT6 and OT5, from the economy point of view, the values of 1, 1, and 2 were assigned to the participant.

Note, however, that this classification, based on scales ranging from 1 to 7 for semantic transparency and 1 to 3 for economy, is categorical in its nature. Although the rankings emerged naturally, the differences in the hypothetical space between two categories could differ across the scale. In comparison to measures such as size, weight, or temperature, it is not possible to say that the difference between 1 and 2 is the same as that between 2 and 3. Moreover, in our scales, there are no absolute zero points in a strict sense unlike, for instance, measures of size or weight, for which plausible zero values exist. Thus, instead of treating these values at an interval or ratio level, they are considered as ordinal level data. An important

⁸ Since neither OT7 nor OT8 appeared in the respondents' answers, these onomasiological types are not taken into consideration here.

implication is that the application of algebraic operators for ordinal level data is more problematic than for an interval/ratio level. Therefore, to provide a summary measure of the center in the numerical data (a measure of central tendency), we preferred to use the median over the mean/average values for these scales. For instance, to provide the measure of the central tendency for the above-mentioned hypothetical situation (1, 1, 2), the median value will be 1 (instead of the mean 1.33).

Consequently, based on the summary median value for three tasks and across the whole word-formation test, we identified general tendencies to form words in a more or less transparent or economical fashion (i) for each of the three word-formation tasks (specific task-related indices), and (ii) for all three word-formation tasks as a whole (general index). These values of the median central tendencies were used for a non-parametric correlation analysis with data from the TTCT (ratio-level data). Note, however, that to bolster the intuitiveness of the interpretation, the scales for transparency and economy were inverted so that a higher score represents a stronger tendency. For instance, after inversion, a value of 7 represents more transparent answers than a value of 1.⁹

3.4 Statistical analysis

The non-parametric Spearman's Rank-Order Correlation was used to ascertain the pattern of the relationship between the TTCT scores and the general indices of an individual's tendency towards transparency or economy in word formation. Spearman's Rho can be understood as a proportion of the variability accounted for with rank data. Since there are both the ordinal level of indices regarding the word-formation test and a violation of the assumption of normality regarding the TTCT, the non-parametric alternative is preferable to the parametric one (Field 2017).

Null hypothesis significance testing was used as the main interpretational framework. More precisely, due to the exploratory nature of the study, a Fisherian approach to null significance testing was used for interpretation purposes. According to this approach, significant results indicate that either H_0 does not explain the research data or a rare event emerged (Perezgonzalez 2015).

Although null hypothesis significance testing is widely used and has significant merits, this approach also has its limits. For instance, multiple comparisons could increase type one errors (false positives) and a null hypothesis could be

⁹ Additionally, to preserve the intuitive interpretation of the ordinal level of the data in the subsequent computations, the resulting number was multiplied by a factor of two to eliminate potential decimal numbers when the median for an even number of variables is computed due to missing values.

rejected incorrectly merely by chance. Consequently, to reflect this inherent limit, we use the Benjamini-Hochberg p -value adjustment aimed at controlling false discovery rates.¹⁰ Additionally, one of the other disadvantages of the null hypothesis significance testing is that it “does not allow one to distinguish three evidential states of affairs, namely evidence for H_0 rather than H_1 , evidence for H_1 rather than H_0 , or not much evidence either way. By contrast, Bayes factors do allow this three-way distinction” (Dienes and Mclatchie 2018: 215). Therefore, as recommended by many authors (e.g., Dienes and Mclatchie 2018; Halsey 2019), the null hypothesis significant testing was accompanied by additional statistical indicators to further bolster the verisimilitude of the results. For this purpose, the method of triangulation was used, where both the effect size (with 95% credibility intervals) and the Bayes factor are reported and interpreted beyond the null hypothesis significance testing (Halsey 2019).

The Bayes factor can be understood as the extent to which the observed data give support to one hypothesis over another. For instance, let us imagine a situation in which H_1 assumes that the effect is present, and H_0 assumes that there is no effect. An alternative hypothesis (H_1) states that there is a relationship between the two variables in question. The null hypothesis (H_0) postulates that there is no relationship between the two variables. A Bayes factor of magnitude 6 represents the information that, according to the available data, the strength of evidence for an alternative hypothesis is six times greater than for the null hypothesis (the data are six times more probable under H_1 than under H_0). As this study is novel and no prior information was available, the default prior and two-sided tests were used. To facilitate the communication and interpretation of the strength of evidence, Jeffrey's adjusted benchmarks were used (Wagenmakers et al. 2018).¹¹

The effect size represents the magnitude of the effect and, in the case of correlations, it is manifested by the correlational coefficient itself. This is crucial, as this estimate is, in comparison to the p -value, not determined by the sample size and can confirm the practical significance of the results. Moreover, 95% credibility intervals could be understood as (given the observed data) the effect having a 95% probability of falling within the range of the lower and upper thresholds. This

10 Note that a more stringent correction could be used than the B-H procedure (e.g., the family-wise error rate-controlling procedures, as in the Bonferroni correction). However, as this study is novel and exploratory in its nature, type two errors were crucial. Thus, the B-H approach was preferred due to its greater power (lower probability of type two errors). Nevertheless, more strict corrections could be used for future confirmatory work.

11 Note that as a non-parametric alternative of is preferable in the present case and as Bayesian Inference for Spearman's Rank-Order correlational coefficient was (at the moment of writing) not yet implemented, Bayesian inference for Kendall's Rank coefficient was used for the computation of BF and CI instead.

information can help us better understand the uncertainty related to the estimated parameters.¹² The analysis was conducted by means of the R-based software Jamovi 1.2 with JSQ module.

4 Results

4.1 Descriptive results

The first part of the analysis provides summarized descriptive information for the variables in question. The mean, median, mode, standard deviation, skewness, kurtosis, and Shapiro-Wilk normality test figures for the TTCT subscores are depicted in Table 1.

Table 1: Descriptives for TTCT scores.

	Elaboration	Fluency	Flexibility	Originality	Creative strengths
Mean	16.24	14.61	11.41	23.92	5.53
Median	14.00	14	11.00	22.00	5
Mode	12.00	11.00	9.00	19.00 ^a	3.00
Standard deviation	10.95	5.14	4.31	11.78	3.51
Skewness	1.23	0.57	0.60	1.14	0.93
Std. error skewness	0.14	0.14	0.14	0.14	0.14
Kurtosis	2.04	0.62	0.67	1.88	0.57
Std. error kurtosis	0.28	0.28	0.28	0.28	0.28
Shapiro-Wilk <i>W</i>	0.92	0.98	0.97	0.93	0.93
Shapiro-Wilk <i>p</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

^aMore than one mode exists, only the first is reported.

The median, mode, skewness, and kurtosis figures for the word-formation test are provided in Tables 2 and 3.

4.2 Inferential results

Before proceeding to a more advanced analysis, Table 4 depicts (for the sake of clarity) the correlation matrix based on the null hypothesis significant testing for relationships among the TTCT scores and the general tendencies to economy and

12 Supplementary Material, data and an analysis syntax can be found at https://osf.io/8uqgn/?view_only=60e8d30a96f446029d1d62911979b9de.

Table 2: Descriptives for indices dedicated to the tendency to economy in word formation.

	General economy index	Economy task 1	Economy task 2	Economy task 3
Median	2	2	2	2
Mode	2	2	2	1
Skewness	−0.40	−0.60	−0.64	0.58
Std. error skewness	0.14	0.14	0.14	0.14
Kurtosis	−1.76	−1.35	−0.77	−1.49
Std. error kurtosis	0.28	0.28	0.28	0.29

The scale is Minimum (1) to Maximum (3) economy; 2 (OT2/3/5/9); 1 (OT1).

Table 3: Descriptives for indices dedicated to the tendency to transparency in word formation.

	General transparency index	Transparency task 1	Transparency task 2	Transparency task 3
Median	5	5	3–4	7
Mode	7	5	4	7
Skewness	−0.62	−0.25	0.36	−0.99
Std. error skewness	0.14	0.14	0.14	0.14
Kurtosis	−0.66	−0.45	−1.60	−0.59
Std. error kurtosis	0.28	0.28	0.28	0.29

The scale is Minimum (1) to Maximum (7) transparency; 5 (OT2); 7 (OT1); 3–4 (between 3 (OT9) and 4 (OT4)).

transparency. Moreover, since the word-formation test employed three tasks with different types of instruction and stimulus material (word-related material in Tasks 1 and 2 vs. drawing in Task 3) and different types of answers (multiple-choice in Task 1 vs. open-ended answers in Tasks 2 and 3), the relationship between the TTCT and the specific word-formation task is provided as well.

The following sections provide a more detailed analysis and description of the results.

4.2.1 General tendency to economy in word formation

In the first part of the results dedicated to inferential statistics, we focus on the general economy index as a measure of the tendency to form words more economically in all three tasks.

Table 4: Correlation between variables.

	Elaboration	Fluency	Flexibility	Originality	Creative Strengths
General economy	-0.14*	0.03	0.02	-0.12*	-0.17**
Economy task 1	-0.08	0.07	0.02	-0.12*	c
Economy task 2	-0.09	0.11	0.09	0.08	0.01
Economy task 3	-0.19**	-0.10	-0.08	-0.12*	-0.18**
General transparency	0.10	-0.02	0.01	0.08	0.10
Transparency task 1	0.11	-0.04	0.02	0.08	0.10
Transparency task 2	0.00	-0.13*	-0.12*	-0.05	-0.01
Transparency task 3	0.17**	0.09	0.07	0.10	0.16**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

First, there is a small and negative correlation between the general economy index and Elaboration ($r_s = -0.14$, $p = 0.013$; $BF_{10} = 6.97$; 95% CI $[-0.04, -0.19]$), which means that the more the individuals elaborated the product in the TTCT, the weaker the general tendency to economy in word formation is in all three tasks. This means that the more details were provided in the TTCT, the more the language speakers tend to prefer OT1 over OT2/3/5/9 and OT2/3/5/9 over OT4/6 (e.g., preference for *novel write er* over *write_N*). As indicated by the Bayes factor, the observed data are nearly seven times more probable under H_1 than under the null hypothesis, which gives moderate support to H_1 over the null.

Second, there is a small negative correlation between the general economy index and Creative Strengths ($r_s = -0.17$; $p = 0.004$; $BF_{10} = 49.79$; 95% CI $[-0.06, -0.22]$), meaning that the more Creative Strengths were used in the TTCT, the less economical the new words were. This means that the more aspects of humor, fantasy and so on were presented in the TTCT, the more the language speakers tended to prefer OT1 over OT2/3/5/9 and OT2/3/5/9 over OT4/6/10 (e.g., preference for *novel write er* over *write_N*). The observed data are nearly 50 times more probable under H_1 than under the null, which gives very strong support to H_1 over the null.

Third, there is a small and negative correlation between the economy index and Originality ($r_s = -0.12$; $p = 0.039$; $BF_{10} = 1.68$; 95% CI $[-0.02, -0.17]$), meaning that the more original the products in the TTCT were, the lower the general tendency was towards economy in word formation. This means that the more the TTCT products were unique according to the existing standards, the more the language speakers tended to prefer OT1 over OT2/3/5/9 and OT2/3/5/9 over OT4/6/10 (e.g., preference for *novel write er* over *write_N*). However, when applying the Benjamini and Hochberg correction for multiple comparisons, the adjusted p -value is not significant. Thus, this result could only be a false positive. In line with this, the

observed data are only 1.7 times more probable under H_1 than under the null hypothesis. This is anecdotal evidence (moderate to anecdotal evidence when using the robustness check).

Fluency ($r_s = 0.02$; $p = 0.674$; $BF_{10} = 0.09$; 95% CI [0.09, -0.06]) and Flexibility ($r_s = 0.02$, $p = 0.767$; $BF_{10} = 0.08$; 95% CI [-0.09, -0.06]) were not related to the economy index, as both p -values are > 0.05 . In fact, the Bayes factor indicates that the observed data are 10 and 12 times (strong evidence) more probable under the null hypothesis for Fluency and Flexibility, respectively.

4.2.2 General tendency to economy in the three word-formation tasks analyzed separately

A more differentiated analysis indicates that the general pattern of results, as delineated above, is determined mainly by the third word-formation task. In this task, participants would come up with a name (open-ended alternative) for a person depicted in a drawing (visual stimulus). In particular, as was shown in the general economy index, in the third word-formation task, economy is negatively related to Elaboration ($r_s = -0.19$; $p = 0.001$; $BF_{10} = 102$; $BF_{01} = 0.01$; 95% CI [-0.07, -0.26]) and Creative Strengths ($r_s = -0.18$; $p = 0.002$; $BF_{10} = 91$; $BF_{01} = 0.011$; 95% CI [-0.07, -0.23]), both of which provide very strong evidence for the alternative hypothesis over the null according to the Bayes factor. Originality ($r_s = -0.12$; $p = 0.039$; $BF_{10} = 1.59$; $BF_{01} = 0.63$; 95% CI [-0.02, -0.18]) is related to the economy index in the third task; nevertheless, if we apply a procedure to correct p -values due to multiple comparisons, this is no longer significant. Thus, there is a possibility that this result is a false positive. This is also the case for Originality in the first task ($r_s = -0.13$; $p = 0.032$; $BF_{10} = 2.27$; $BF_{01} = 0.44$). The evidence for the alternative hypothesis over the null is anecdotal.

None of the other correlations are significant for the first or the second tasks. More specifically, for the second task, Elaboration ($r_s = -0.09$; $p = 0.130$; $BF_{10} = 0.39$; $BF_{01} = 2.57$; 95% CI [0.01, -0.15]), Fluency ($r_s = 0.11$; $p = 0.068$; $BF_{10} = 0.16$; $BF_{01} = 1.08$; 95% CI [0.16, 0.01]), Flexibility ($r_s = 0.09$; $p = 0.132$; $BF_{10} = 0.41$; $BF_{01} = 2.45$), Creative Strengths ($r_s = 0.01$; $p = 0.835$; $BF_{10} = 0.08$; $BF_{01} = 12.54$; 95% CI [0.09, -0.07]) and Originality ($r_s = 0.08$; $p = 0.188$; $BF_{10} = 0.27$; $BF_{01} = 3.73$; 95% CI [0.14, -0.02]) are all > 0.05 . The Bayes factor indicates anecdotal to strong evidence for the null.

Similarly, for the first task, Elaboration ($r_s = -0.08$; $p = 0.187$; $BF_{10} = 0.28$; $BF_{01} = 3.58$; 95% CI [0.01, -0.14]), Fluency ($r_s = 0.07$; $p = 0.204$; $BF_{10} = 0.25$; $BF_{01} = 3.96$; 95% CI [0.13, -0.02]), Flexibility ($r_s = 0.02$; $p = 0.703$; $BF_{10} = 0.08$; $BF_{01} = 11.77$; 95% CI [0.09, -0.06]) and Creative Strengths ($r_s = -0.10$; $p = 0.085$; $BF_{10} = 0.79$; $BF_{01} = 1.26$; 95% CI [-0.01, -0.16]) and Originality are also all > 0.05 .

The Bayes factor indicates anecdotal to strong (for Flexibility and Fluency) evidence for the null hypothesis.

4.2.3 General tendency to transparency in word formation

In this section, we focus on the general transparency index as a measure of transparency in word formation in all three tasks. When no direction is expected, none of the measures are related to transparency (all p -values > 0.05). Note that when the opposite direction to economy is expected, Elaboration ($r_s = 0.104$; $p = 0.036$) and Creative Strengths ($r_s = 0.103$; $p = 0.039$) are significant due to higher power. We mention this to inform future studies regarding the potential pattern of results; nevertheless, as a specific directional hypothesis was absent due to the exploratory nature of the study and due to the higher possibility of type one errors (false positives) owing to multiple comparisons, these values should be considered as insignificant. In fact, even if a specific direction is assumed, when p -values are adjusted with the Benjamini and Hochberg procedure, no correlation remains statistically significant. This indicates that these results could be false positives. More specifically, the correlations between the general transparency index and Elaboration ($r_s = 0.10$; $p = 0.073$; $BF_{10} = 0.66$; $BF_{01} = 1.51$; 95% CI [0.08, 0.00]), Fluency ($r_s = -0.02$; $p = 0.795$; $BF_{10} = 0.08$; $BF_{01} = 12.46$; 95% CI [0.06, -0.09]), Flexibility ($r_s = 0.01$; $p = 0.848$; $BF_{10} = 0.08$; $BF_{01} = 12.85$; 95% CI [0.08, -0.07]); Creative Strengths ($r_s = 0.10$; $p = 0.078$; $BF_{10} = 0.76$; $BF_{01} = 1.32$; 95% CI [0.16, 0.01]) and Originality ($r_s = 0.08$; $p = 0.147$; $BF_{10} = 0.29$; $BF_{01} = 3.44$; 95% CI [-0.01, 0.33]) are all > 0.05 . The evidence for the null hypothesis is very strong for Fluency, strong for Flexibility, moderate for Originality, and only anecdotal for Creative Strengths and Elaboration.

4.2.4 General tendency to transparency in the three word-formation tasks analyzed separately

Regarding the pattern of relations between the creativity and transparency scores in the three word-formation tasks separately, Elaboration ($r_s = 0.17$; $p = 0.004$; $BF_{10} = 21.33$; $BF_{01} = 0.01$; 95% CI [0.21, 0.05]) and Creative Strengths ($r_s = 0.16$; $p = 0.007$; $BF_{10} = 10.62$; $BF_{01} = 0.01$; 95% CI [0.20, -0.05]) are significantly and positively correlated to transparency in the third word-formation task (strong evidence according to the Bayes factor). This is logically plausible and in line with previous results. The more a language speaker elaborated the creative product in the TTCT (more details were provided) and the more the individual demonstrated

Creative Strengths in the TTCT (more humor, emotional expressiveness, colorfulness of the imagery, fantasy and so on can be found), the stronger the general tendency towards transparency can be observed in the third word-formation task – language speakers tend to prefer OT1 over OT5; OT5 over OT2; OT2 over OT4; OT4 over OT9; OT9 over OT3; and OT3 over OT6 (e.g., preference for *novel write er* over *novel ist*). However, none of the other correlations were significant in the third word-formation task. More specifically, the correlations between the transparency index and Fluency ($r_s = 0.10$; $p = 0.113$; $BF_{10} = 0.41$; $BF_{01} = 2.41$; 95% CI [0.15, -0.01]), Flexibility ($r_s = 0.07$; $p = 0.246$; $BF_{10} = 0.20$; $BF_{01} = 5.06$; 95% CI [0.13, -0.03]) and Originality ($r_s = 0.10$; $p = 0.105$; $BF_{10} = 0.46$; $BF_{01} = 2.19$; 95% CI [0.15, -0.01]) are all > 0.05 . The Bayes factor indicates anecdotal to moderate (for Flexibility) evidence for the null hypothesis.

In the second word-formation task, Fluency ($r_s = -0.12$; $p = 0.036$; $BF_{10} = 1.80$; $BF_{01} = 0.55$; 95% CI [-0.02, -0.18]) and Flexibility ($r_s = -0.12$; $p = 0.046$; $BF_{10} = 1.23$; $BF_{01} = 0.81$; 95% CI [-0.02, -0.17]) are statistically significant. The correlation is negative. This means that the more answers were provided in the TTCT (Fluency) and the more the answers differed from each other regarding the content (Flexibility), the less transparency in the word-formation task was preferred by the participants. In this case, language speakers preferred OT6 over OT3; OT3 over OT9; OT9 over OT4; OT4 over OT2; OT2 over OT5; and OT5 over OT1 (e.g., preference for *novel ist* over *novel write er*). Nevertheless, this could be a false positive result because if the correction for multiple comparisons is applied, these correlations would no longer be significant.

In line with this, the evidence for an alternative hypothesis is only anecdotal according to the Bayes factor. Additionally, Elaboration ($r_s = 0.01$; $p = 0.978$; $BF_{10} = 0.08$; $BF_{01} = 12.89$; 95% CI [0.08, -0.08]), Originality ($r_s = -0.05$; $p = 0.374$; $BF_{10} = 0.13$; $BF_{01} = 7.73$; 95% CI [0.04, -0.12]) and Creative Strengths ($r_s = -0.01$; $p = 0.815$; $BF_{10} = 0.08$; $BF_{01} = 12.51$; 95% CI [0.07, -0.09]) are not statistically significant. There is moderate to strong (for Elaboration and Creative Strengths) evidence for the null hypothesis.

Similarly, in the first word-formation task, none of the TTCT scores are statistically significant. The results are as follows: Elaboration ($r_s = 0.11$; $p = 0.066$; $BF_{10} = 0.81$; $BF_{01} = 1.23$; 95% CI [0.16, 0.01]), Fluency ($r_s = -0.04$; $p = 0.453$; $BF_{10} = 0.11$; $BF_{01} = 8.79$; 95% CI [0.04, -0.11]), Flexibility ($r_s = 0.02$; $p = 0.711$; $BF_{10} = 0.09$; $BF_{01} = 11.90$; 95% CI [0.09, -0.06]), Creative Strengths ($r_s = 0.10$; $p = 0.086$; $BF_{10} = 0.71$; $BF_{01} = 1.41$; 95% CI [0.16, 0.01]) and Originality ($r_s = 0.08$; $p = 0.151$; $BF_{10} = 0.33$; $BF_{01} = 3.05$; 95% CI [0.14, -0.01]) are all > 0.05 . The Bayes factor indicates strong evidence for the null for Fluency and Flexibility, moderate for Originality, and only anecdotal for Elaboration and Creative Strengths.

4.3 Discussion

Even though, from the psycholinguistic and the broader psychological perspectives, both word formation and creativity are important and prolific fields of study on their own, the scarcity of evidence connecting these two fields is evident and motivated the present large-scale interdisciplinary research. In a nutshell, the present work indicates that creative potential, understood as the ability to produce novel and useful ideas, as captured by divergent thinking abilities, seems to be related to the way individual language users coin new words, especially in the broader context of the tendency towards economy of expression or semantic transparency. More specifically, from a general perspective, it has been shown that the Economy and Creative Strengths scores are negatively correlated with the general tendency towards economy of expression. Originality has been shown to be significant as well; nevertheless, there is a possibility that this result is only a false positive and should be considered with a grain of salt.

When analyzing the three tasks separately, it was shown that the present pattern of results for transparency is, logically, complementary to economy of expression. In particular, in the third word-formation task, both Elaboration and Creative Strengths were related to the tendency to coin new words more transparently and less economically. Although in the present study, it is not possible to infer causality, our working hypothesis is that various facets of divergent thinking, such as the tendency to elaborate or not, could be considered as the cognitive underpinning of the way how language speakers coin new complex words and, more specifically, how the creative potential is manifested in the word-formation process. For instance, Elaboration captures the number of details provided and “it is suggested when the individual follows an associative pathway for some distance” (Runco and Acar 2012: 67). The ability to follow these associative pathways is reflected in coining more transparent and less economical complex words. This is important for the theory because some other candidate processes could be identified at a deeper neurobiological level (e.g., Executive Control Network, Default Mode Network, and Dopaminergic System (Jauk 2019; Runco and Acar 2019)).

Moreover, it seems that the third task was especially suitable in the present research context. In the third word-formation task, participants were asked to propose a name for the person depicted in a drawing. This is crucial with regard to ecological validity, as this task entailed both visual stimuli, as presented in many real-life scenarios where natural naming occurs, and open-ended responses where divergent thinking could be freely manifested.

Moreover, according to the present results, Elaboration is not the only potentially important correlate of word formation. It was observed that the criterion-referenced measures (Creative Strengths), comprising factors like humor and colorfulness of imagery, and, potentially, also the tendency to create rare but still meaningful responses (Originality) are related to the way language speakers coin new complex words (although, the latter could be a false-positive finding).

Fluency and Flexibility seem to be related to the tendency to coin new words less transparently. Fluency captures the number of generated meaningful ideas. Flexibility captures the number of different categories provided. Thus, language speakers that tend to provide more answers and are able to switch categories more easily prefer to coin new words less transparently. Note, however, that these results could also be false positives and that this pattern of results occurred only in the second-word formation task. In this task, participants were given a verbal description of a person in an unusual situation. This indicates that word-formation creativity is task-specific (see above, Section 3.2) and that divergent thinking abilities seem to play more important role in some contexts than in others.

In general, the present pattern of results is in accordance with the approach accenting that “the creative potential of human minds is directly reflected in language structure and use” (Langlotz 2015: 40). In fact, from the psycholinguistic perspective, the present pattern of results is important as it suggests that the word-formation process is not just any ‘blind process’ but rather an act of creativity by a language user, as stressed by Štekauer (1998) and Štekauer et al. (2005). This fact is captured by the principle of *Creativity within Productivity Constraints*, which lays emphasis on the creativity of any member of a speech community who implements the act of naming by an individual choice of a word-formation process/rule and, within it, its name-motivating constituents. Since each individual has unequal experiences, general knowledge, intellectual capacity, imagination, education, age, professional interests, and linguistic knowledge and experiences, one would expect speakers to bring considerable variation to the naming task. In other words, word-formation creativity in our understanding is based on the availability of a number of options at (i) the onomasiological level that reflects the cognitive processing of an object to be named and identifying those semantic categories that will constitute the basis for the linguistic representation of the object, and (ii) the onomatological (morphemic) level that consists of selecting the linguistic constituents that represent the semantic categories of the onomasiological level. From the psychological perspective, the present pattern of results is in line with the biopsychobehavioral model stating that behavioral outcomes (as an act of creativity

in coining new words) are determined by a deeper psychological level where abilities, in the form of divergent thinking potential, play an important role (Jauk 2019).

5 Limitations and perspectives for future research

While the present study provides novel and encouraging findings, some of its limitations, as well as perspectives for future research, should be mentioned. First, due to the specificity and novelty of the research topic, no pre-registered hypotheses regarding relations between the creativity scores and word formation captured by transparency and economy could be specified beforehand. The present study is thus exploratory in nature, and the Fisherian approach (1954, 1955) to null hypothesis testing was used. According to this approach, significant results indicate that either H_0 does not explain the research data or rare events emerged (Perezgonzalez 2015). However, due to multiple comparisons inherent in correlational data, the risk of type I error and the occurrence of false positive findings naturally increase. To account for this possibility, p -adjustments controlling false discoveries, rated on the basis of the Benjamini-Hochberg procedure, were made. Furthermore, the effect size and the Bayes factor were reported and interpreted. However, pre-registered confirmatory replication with more stringent criteria and further conceptual extensions of the present study are encouraged in future because only the systematic accumulation of empirical evidence can provide information regarding the existence and robustness of the effect across various conditions (Hüffmeier et al. 2016; Schmidt 2009).

Second, statistically significant correlations (from the Frequentist perspective) were found in the present research and, in line with this, the data are in line with H_a (from a Bayesian perspective). Nevertheless, the correlations that were found are modest in magnitude. Specifically, the effect size is between 0.12 and 0.17. According to the classic works of Cohen (1977, 1988), correlations of 0.1–0.3 could be considered as “small” in terms of the magnitude of the effect size, although this label can be misleading (see e.g., Funder and Ozer 2019). First, this benchmark is somehow arbitrary and not sufficiently based on empirical evidence. In fact, according to more recent evidence, the average effect size in social and personality psychology, for instance, is not much bigger – approximately 0.19 (Gignac and Szodorai 2016). Additionally, although the small effect is not consequential in a single event, in the long run and at the societal level, effects of this magnitude could matter, especially for research regarding individual differences (Funder and Ozer 2019) and when considering the role of creativity in society (Simonton 2019b). Moreover, as noted by Funder and Ozer (2019) regarding a slightly bigger effect size

than in the present study, an effect size of 0.2 could have explanatory and practical merit even in the short run and, therefore, could be considered as medium in size. The present correlation could, thus, be considered as small (to medium) in magnitude and potentially important at a large-scale level. To illustrate a similar magnitude in a real life-related outcome, the effect of anti-inflammatory drugs, such as ibuprofen, on pain reduction is considered to be approximately 14 (Meyer et al. 2001).

Third, in addition to the discussion of type I error (false positives), it is important to discuss type II errors concerning false negatives as well, although the Fisherian approach to null significance testing (1954, 1955) does not deal with statistical power explicitly (Perezgonzalez 2015). A type II error means that the study was not able to find the effect even though the effect exists, mainly due to low statistical power. However, a decent sample size was used in the present research (more than three hundred respondents). Despite this fact and the reasonable power available to detect small to medium effects, some extremely small relationships that are not statistically significant in the present study could be, at least hypothetically, significant with a much bigger sample size. Nevertheless, even if statistically significant results emerge in bigger samples, their clinical and practical significance will be of low(er) importance even if, hypothetically, still of some interest (Funder and Ozer 2019) for future multi-cultural large-scale research. Thus, similarly to our discussion of the type I error, large-scale replication could be encouraged for future research, informed by the effect size from the present study.

Fourth, correlation does not mean causation. Although creativity and word formation were assessed at two time-points, and a pattern assuming that word formation is predicted by creative potential is logically plausible, causal interpretations are not warranted. Therefore, further experimental examinations (cf. Spencer et al. 2005), longitudinal designs and Cross-Lagged Panel Models, or alternative methods, such as the usage of graphical causal models for observational data (Rohrer 2018), could be recommended for future research.

Finally, we believe that the present results provide novel and encouraging insights into the topic of the role of creative potential in the process of forming new complex words. Additionally, we not only hope that the present study will encourage future research into potential mechanisms (mediators) and boundary conditions (moderators) of the relationship between creativity and word formation as an act of creativity by an individual, but we also believe that it can instigate examinations of the role of other middle-level psychological variables, e.g., personality, in coining new complex words and beyond.

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Supplementary Material: Supplementary material, data and an analysis syntax can be found at https://osf.io/8uqgn/?view_only=60e8d30a96f446029d1d62911979b9de.