Topics in Linguistics (2017), 18(1), pp. 71-97

DE GRUYTER
OPEN

10.1515/topling-2017-0006

A database of semantic features for chosen concepts (Attested in 8- to 10-year-old Czech pupils)

Kristýna Konečná
Kristýna Vaňkátová
Palacky University Olomouc, Czech Republic

Abstract
In this paper, a database of semantic features is presented. 104 nominal concepts from 13 semantic categories were described by young Czech school children. They were asked to respond to the question "what is it, what does it mean?" by listing different kinds of properties for concepts in writing. Their responses were broken down into semantic features and the database was prepared using a set of pre-established rules. The method of database design, with an emphasis on the way features were recorded, is described in detail within this article. The data were statistically analysed and interpreted and the results along with database usage methodologies are discussed. The goal of this research is to produce a complex database to be used in future research relating to semantic features and therefore it has been published online for use by the wider academic community. At present, databases have been published based on data gathered from adult English and Czech speakers; however participation in this study was limited specifically to young Czech-speaking children. Thus, this database is characteristically unique as it provides important insight into this specific age and language group's conceptual knowledge. The research is inspired primarily by research papers concerning semantic feature production obtained from adult English speakers (McRae, de Sa, and Seidenberg, 1997; McRae, Cree, Seidenberg, and McNorgan, 2005; Vinson and Vigliocco, 2008).

Key words
children, concept, database, featural representation, semantic category, semantic features

Introduction
The research is centred around the idea of "concepts" and "conceptual categorization" as important to the understanding of the relation between the human mind and external world, as Murphy (2002, p. 1) says "our concepts embody much of our knowledge of the world, telling us what things there are and what properties they have." However such conceptual categorization should not be understood merely in terms of the real, tangible world. Medin (1989, p.1469) emphasizes:

> It is tempting to think of categories as existing in the world and of concepts as corresponding to mental representations of them, but this analysis is misleading. It is misleading because concepts need not have real-world counterparts (e.g. unicorns) and because people may impose rather than discover structure in the world.

In many theories regarding word meaning and concepts, such as those focused on conceptual representation or categorization of concepts within the mind, semantic features are considered a fundamental part of semantic representation.

The questions and theories which arise regarding categorization, concepts and their components can be founded in philosophy (for an overview of philosophical conception, see Lakoff, 1987), and are also important in terms psychology and linguistics (for an overview of linguistic conception, see Geeraerts, 2010; for an overview of psychological conception, see Murphy, 2002).

Current research is often conducted using an empirical approach, testing theories of natural language production in native speakers (including that of language disorder), and so the real usage of semantic features when calculating and defining meaning can also be verified empirically (for an overview, see Murphy, 2002).

The feature-listing method is typically used for obtaining an empirically based database of semantic features for chosen concepts belonging to different semantic categories. In numerous research studies, there is also often emphasis on distinguishing between "living thing" categories and "artefact" categories (see McRae and his colleagues for examples of work which inspired this research's data collection methodology: McRae et al., 1997; McRae et al., 2005; also work by Vinson and Vigliocco, 2008).

In this article, a new database of semantic features for 104 substantial concepts is presented. Data were collected from 381 Czech child participants. The purpose of such a collection was "to construct empirically derived conceptual representations that can be used to test theories of semantic representation and computation" (McRae et al., 2005, p. 547).

The term "featural representations" is used throughout the article as the conceptual representations derived are based solely on the participants' use of semantic features.

It can be assumed that the prototypicality of a concept could have influenced which features (type, amount, etc.) respondents gave. According to prototype theory, there are concepts which are more or less prototypical than others within categories. The more prototypical concepts are those which share a greater number of features in common with other members of their own category and share fewer features in common with concepts in other categories (see Rosch and Mervis, 1975; or Rosch and Lloyd, 1978, and Murphy, 2005, for further discussion). Although each participant was only given a single concept from each category, it is possible that they made comparisons with the other concepts. Many features of more prototypical concepts could be perceived by the participants to be self-evident due to their familiarity, and as such participants could be influenced as to whether or not to list them. The self-evident nature of the feature could be perceived as a clear signal to list it, but could also be interpreted as a reason to list something less "obvious" or more "distinct". At any rate, the probable influence of conceptual prototypicality can be taken into consideration.

Limits of feature-listing method

Although this article uses terms such as "concepts" and "collecting semantic features", and talks about the fact that the participants' conceptual representations (at least the featural ones) can be "constructed", it is important to keep in mind that the task is verbally restrictive and, in actual fact, "concept names" or "words" are presented, and the participants' knowledge of "word meanings" is received. However, these word meanings are not received as definitions akin to those found in a dictionary – here, they are based on the participants' descriptions and thoughts, and as such they are not always a clearly defined description (for more about the comparison of dictionary definitions and children's representations, see below). Participants are encouraged to list many kinds of features (not only visual aspects) and they have to decide for themselves as to what features they consider important enough to respond with.

The individual child participants' responses seem to be different when considering "the type of descriptiveness" of responses obtained from adults. McRae et al. (2005, p. 549) mention:

> One fact that becomes obvious when feature norms are analyzed is that participants' responses are somewhat biased toward information that distinguishes among concepts—that is, the pieces of information that enable people to distinguish a concept from other, similar concepts. Participants appear to either interpret this as a primary component of their task when listing features, or alternatively, this is

the type of information that is highly salient to people.

However, children's responses are not always clearly separable and/or comparable in relation to other concepts. On the contrary, participants are able to focus on listing typical features for a given concept, including even those which are common for the whole semantic category, without distinguishing the concept from others.

Moreover, although they have to express their thoughts through words, it is still possible to describe perceptions such as "sound", "pain", "taste", or "touch". However, one can presume that some attributes, or the relationships between attributes, are very complex and as such cannot be described easily through words. Thus, it should also be noted that a mere list of features may not be suitable for capturing these more complex attributes and relationships (see also McRae et al., 2005; p. 549).

In feature-listing tasks, participants are asked to list features for given concepts, meaning they have to respond (usually in writing) with all the attributes that they think are important for the given concept. Their responses are not restricted to visual description only; participants can list any and all characteristics which they consider important and worth mentioning (e.g. how it is beneficial to human beings, how it works, or where it can be found, etc.). These answers are processed and the database of concepts and their semantic features with tags (including the production frequency of any given feature) is created.

However, McRae and his colleagues (2005, p. 549) emphasize that they "(…) do not believe that semantic knowledge is represented in the brain literally as a list of verbalizable features. (…) a participant's list of features represents a temporary abstraction that is constructed online for the purpose of producing feature names" (p. 549).

Barsalou et al. (1993, p. 8) explain the issue in the following way:

> Rather than being a list of propositions stored in memory, a feature list reflects the sequential description of an experiential image. When people define a concept, they retrieve or construct a schematic image, focus attention on a subset of its perceptual symbols in a sequential manner, and describe the content of each focus with a linguistic description. On this view, feature lists do not exist in long-term memory as conceptual representations but are the result of a sequential on-line process that describes experiential images.

Child participants

The database presented in this article has been created specifically with data collected from child participants in a Czech environment and as such is set apart from the majority of pre-existing databases in this research area. There are pre-existing semantic feature databases based on data gained from adult English speakers (for example, in the case of the studies mentioned above), and adult Czech speakers (see Nagy, 2014).

This study corresponds with the ideas in Murphy's introduction to the chapter "Concepts in Infancy" in *The Big Book of Concepts* (2002, p. 271):

> It is not that common for reviews of the psychology of concepts to consider children's concepts at much length. (…) there are two compelling reasons for paying attention to development, however. The first is that the development of concepts speaks to central questions of cognitive science. In fact, if there is a single main theme to cognitive science, it would be the question of how people come to have knowledge. (…) The second reason for considering developmental evidence is that it may place constraints on our theories of adult competence and performance. Finding out how conceptual structure begins and how it develops may tell us about what structure is likely to be present in the adult, and how it is organized.

Similarly, the need for conceptual research concentrated on how children understand concepts and how they acquire them is also stressed by Carey (2009, p. 5): "Of course, any theory of the origin of concepts requires some idea of what concepts are and how their content is determined, just as any theory of conceptual content must comport with our best account of how concepts are acquired."

To understand the principles of how semantic memory works, it is necessary to move away from purely theoretical models towards more empirical research, collecting data as a source for future research which can be used to verify or debunk theoretical questions and assertions. In addition, there is an apparent necessity to compare data gathered from both adult and child participants as made evident in the previous quotes from Murphy and Carey above. As there is clearly a lack of data in this area from child participants, the decision was taken to sample only young Czech speakers.

A defining characteristic of this research is that data were collected from young school children aged 8 and 9 (occasionally 10) years old. This age group was chosen as some mental and verbal abilities are required for conceptual description (in the case of older children, the written feature-listing methodology seems appropriate; difficulty can arise when a child is unable to understand concepts or produce internal ideas, however this difficulty should not be prevalent at this age, especially when considering the concepts chosen for use in this database). A lot of research regarding child language and language development is focused on preschool children, leaving a lot of room for further research and analysis of the language of older children and how it changes as they age (for an overview of child language, language development and children's concepts, see Bloom, 2000, Keil, 1989, or Průcha, 2011).

Thus, the fundamental goal of this work is to make a database of conceptual descriptions which were created by child native speakers for use in further research, in which the traditional ideas of categorization, concepts, conceptual representations are investigated. It appears that this data is not only useful in terms of being a psycholinguistic tool but is intrinsically open to further investigation: children's conceptual descriptions contain different types of features, so the data can specifically outline the content of the concepts as the child participants understood them and the children's abilities and knowledge can be observed. The children's method of expression can be also observed.

It follows that it is also useful to compare the data gathered from child participants with that of adults. Such issues as average number of features given per concept, what types of features are listed, or comparing the number of taxonomical features in a child's and adult's response are able to be analysed. In addition, the data of differing child age groups can be compared to better understand how conceptual development occurs as children age. The participant age-range chosen for this study is described in developmental psychology as typical for a switch in cognition; when children pass the age of subjective descriptions of concepts to more objective definitions (Vágnerová, 2001). The extent to which children describe the concepts in a subjective or objective way can be observed in the database.

Due to the child-specific data gathered in this study, publishing the database has the potential to be useful in many practical areas: the data can be studied by teachers or by parents in order to gain a fuller understanding of how children understand and interpret the world around them.

The database is published online at www.childrenfeatures.webnode.cz [1] as an extensive source of data for other research, and further research is also intended by the authors of this article. Consecutive research to examine the usage of semantic features in untimed and in speeded tasks (see more in McRae et al., 1997) is an interesting potential area of further study.

1. Methodology of collecting data

1.1 Subjects

The data were obtained from 381 children. These children attend the third year of standard primary schools in the Moravian and Silesian regions of the Czech Republic, specifically in the towns and cities of Olomouc, Velká Bytřice, Opava, Ostrava, Nový Jičín and Krnov. Therefore, there are not any data collected from Bohemian regions and neither were data collected from smaller, rural villages of the Czech Republic. This should be taken into consideration when drawing conclusions from the analyses of this database.

The children in this school year are generally aged 8 and 9 years old. Since some children aged 10 also attend year 3,

[1] The web content is still in the process of being updated. Recently, the complete database and a matrix with data have been added, but more materials will be added in the future.

they were included. The number of participants at this age is negligible and it is assumable that their conceptual knowledge is the same or similar to that of the other children as they attend the same classes (it is expected that they are operating at the same cognitive level).

To motivate the children, they were rewarded with colouring pencils purchased from the student project finances obtained for this research.

1.2 Materials

All participants were assigned 10 concepts, each belonging to a different semantic category. Every unique concept was described approximately 20 times.

There were 8 nouns, 1 adjective and 1 verb issued to each participant.[2] Every participant was given a booklet of eight A5 pages (1 page to record the participant's details, 5 pages for the task, 1 page for notes, and the final page was blank). The task was set out across five A5 pages: each page assigning 2 concepts and providing blank lines for the participants' answers (the written method was used[3]). The concepts assigned to each participant's task were randomly chosen by a special tool installed on Microsoft Excel.

Data was collected for 13 semantic categories pertaining to both living and non-living things (i.e. objects which occur naturally and spontaneously versus man-made artefacts). The choice of categories was inspired by existing research papers concerning adult or child conceptual categorization, such as McRae et al. (2005, 1997) and Vinson and Vigliocco (2008) where the categories and concepts were chosen to cover a wide variety of semantic fields (often themselves guided by pre-existing studies, such as Rosch and Mervis, 1975). Additional inspiration for this research was drawn from papers concerned with child conceptual categorization, specifically Posnansky (1978) and Barbarotto, Laiacona, & Capitani (2008).

There were 8 concepts for each category. To decide which concepts should be chosen from each semantic category for the purpose of our database, a short questionnaire was prepared and adult respondents were asked to write down five representative concepts they consider typical for a given category. Subsequently, a statistical analysis of the responses was conducted, on the basis of which four very typical and less typical concepts were chosen for each category. Typicality for each category was derived from the frequency with which participants listed the concept as representative of the category. Next, pairs were found for these 4 concepts; the focus was on creating pairs bearing different levels of similarity. The pair members were ordered from "very similar" to "minimally similar" (this similarity was preliminarily estimated by us in accordance with the work of McRae et al., 1997). For example, in the category of mammals there were the following pairs: ***a hare*** & ***a rabbit*** (most similar), ***a cat*** & ***a tiger*** (similar), ***a red deer*** & ***a horse*** (some similarities but many differences) and ***a dolphin*** & ***a monkey*** (minimal similarity). These pairs were prepared in advance for the purpose of the consecutive research as outlined below.

The chosen categories and some concept examples are presented in the following table (1).

Some concepts were considerably difficult for children to describe (e.g. many children may have been unaware of certain specific concepts, such as ***a revolver***), thus these concepts were provided for description more frequently, and were repeatedly administered until the required number of descriptions were obtained.

The following table (2) shows examples of concepts and shows a ratio indicating what proportion of participants who were assigned the concept were actually able to offer a description for it. Even if participants did not describe a concept correctly, their response was accepted as a part of their featural representation of the concept under scrutiny.

Occasionally, participants misread their concept word and produced featural representation for an unsolicited concept

[2] As the database has been designed as a team project, the other word classes were collected by colleagues. In this paper, only nouns are discussed; however, the other classes are part of the complete featural database. This paper only focuses on the one part of the task that its authors were responsible for.

[3] The written method (answering in columns) is not unusual for adult participants undertaking this type of task; however, in the case of children, three methods (writing in columns, writing on lines, or the spoken method) were compared in a pilot experiment (Konečná and Večeřová, 2016). Optimal responses were obtained from child participants using the written method, answering on lines. Read more below in this article.

(e.g., the Czech word ***prak*** ‘a catapult’ was mistaken for ***park*** ‘a park’). In cases such as this, the response was eliminated from the dataset. On other occasions it was not clear what the participant had attempted to describe; in such cases the response was also eliminated on the assumption that two concepts had been confused. Finally, some participants made no attempt to describe an assigned concept at all. This could be attributed to a number of factors; they may not have had enough motivation or time to complete the task in full, or they simply had not understood the meaning of the assigned concept.

Living Things Categories	Concepts – Examples	Artifact Categories	Concepts – Examples
Mammals	a cat, a donkey, a dolphin	**Furniture**	a door, a chair, a lamp
Birds	a pigeon, a swan, a parrot	**Vehicles**	a car, a plane, a bus
Plants	a rose, a linden, a daisy	**Kitchen items**	a pot, a spoon, a mug
Body parts	a tooth, a nose, a heart	**Tools**	a spade an axe, a rake
Vegetables	a carrot, an onion, a pea	**Weapons**	a sword, a bow, a pistol
Fruits	an apple, a cherry, an orange	**Clothing**	a hat, a T-shirt, a skirt
		Musical instruments	a piano, a flute, a harp

Table 1: Categories and concept example

1.3 Collecting data

The participant’s task was to write down meanings for their assigned concepts. The participants were each given one task (a booklet as described above) and given oral instructions (Appendix A) as a group. The key question was “what is it, what does the concept mean?” and the participants were asked to describe each concept by listing its characteristic attributes (features). They were informed they could note down any kind of information; not only visual but also other sensory attributes (e.g. smell, taste or touch). Additionally, they were informed that functional features or other kinds of non-sensory attributes could be listed. The children were told examples of concepts (both living thing and artefacts) and their possible features. This information was written on the introductory page as well. The children were also invited to convey their own ideas to practise the task.

There is a fundamental difference between our method of semantic features collection and the method used in the research papers mentioned previously in this article. In the methodologies typical of prior research, participants have been asked to record the features in a column and to write each piece of information on a new line. It was decided (in compliance with the results of a pilot study) that the child participants in this study should not be restricted in this way. They were free to list the features according to their personal preference; they were free to write whole sentences, separate each piece of information by a comma, or even (as is typical of prior studies’ methodologies) write the information in a column. This freedom was afforded to the participants as it was thought to be more practical in collecting data specifically from children. It was felt that restrictions and limitations might have prevented them from filling in their responses as fully as possible due to being disincentivized or confused by a complex set of requirements. The results of the pilot test also implied that this method was the most appropriate one for our purposes (in comparison with spoken collection methodologies or the traditional, written “column” collection method).

The participants could only participate with their parents’ consent. All participants worked simultaneously but individually.

concepts (examples)	**a catapult**	**a revolver**	**a horse**	**an onion**	**a nose**	**a spoon**
number of times the concept was administered for description	24	40	20	21	23	25
accepted descriptions	20	16	20	20	20	24
rejected descriptions	3	0	0	0	0	1
spaces left blank	1	24	0	1	3	0

Table 2: Concepts and children – collecting data

Each had their own sheet with 10 concepts chosen at random from the conceptual set. Importantly, it was ensured that all the concepts on any given sheet belonged to a different category from each other. The children were not able to copy their neighbours' answers as there were many versions of the booklets; this was made possible by there being a wide variety of concepts, as well as each version of a sheet having a "reversed" edition, whereby the order of the concepts in the list was reversed (the reversal of each sheet was a useful method for preparing differing versions of the same concept list and was also a measure taken to minimize any potential influence the order might have had on the participants' responses as it offers differing iterations of the same lists).

The children were allowed to work for a whole 45-minute school lesson.[4] Often they finished earlier and only some participants were unable to complete the task within the given timeframe. Despite this, their responses were collected and the features they did manage to list were included in the data. Those pupils in the class without their parents' consent to participate were either instructed to do the task simultaneously without submitting it afterwards, or were given a different task as determined by their teacher.

2. Processing of the database

2.1 Encoding features

As many conceptual features were obtained in the participants' responses, criteria were consulted and established in logging and processing the semantics (meanings) of the concepts (words) in order to better enable systematic processing of the data. Some rules and codes were created later, ad hoc – when certain responses were found to be more complicated and the efficacy of previously given rules was called into question.

The basic rules were adopted from McRae's paper (McRae et al., 2005), with others being established with respect to the Czech language and to the language (of conceptual description) of the child participants.

The data collected were analysed into a set defined by single items of semantic information (semantic features). The same information could be expressed by various words and it was necessary to encode it identically[5]: for example, children could say "*it is clever*" or "*it is intelligent*", but as the information is synonymous, it was encoded as "**it is intelligent**" in both cases.

Similarly, "*we have it in the kitchen*", "*it is in a kitchen*", "*you can find it in the kitchen*" or just "*kitchen*" and similar responses were encoded as "**it is in a kitchen**". At the same time, different meanings must be encoded by a different code: for example, when some kind of vegetable "*is good*", it means "**it is tasty**", so it is encoded in that way. "**It is good**" is a code for things such as ***a T-shirt*** or for ***a shovel*** (it is not entirely clear what exactly participants might have meant in this case, but it is fair to assume a kind of practical meaning, like "useful"). Also when some information was more complex, for example "*has four wheels*", it is divided as "**has four wheels**" and "**has wheels**".

In cases when children used modal or adverbial language ("*it can be*", "*often*",

[4] The 45 minutes included the instruction section. If participants wanted to finish their idea they could continue into their school break. This was not a speeded or timed task, therefore the allotted time is only approximate and given for practical reasons – as it meant only disturbing a single school lesson (typically sufficient for the task).

[5] The concepts are cited in bold and in italics at the same time. The examples of (possible) children's answers are written in italics. The code for the semantic feature assigned for the database is written in bold.

"*sometimes*"), these quantifying parts of the answers were not covered in the database. As in the manner of McRae's research, this is expected to be explained by production frequency: if the children listed that ***an apple*** was red 15 times, was green 5 times, and only occasionally wrote that it was yellow, we could infer that this production frequency is correlated with importance and the typicality of the features of a child's understanding of the concept. In practice, this means it is not necessary to consider the quantifying information in a response such as "*it can be also yellow*", the feature "**it is yellow**" and the production frequency of the feature is sufficient for the database.

It is really difficult to differentiate the features in some cases – the features are able to be separated in several different ways. For example when considering the feature of "legs" in the cases of furniture, animals, insects or birds etc., the question arises as to whether "legs" are always the same part of the object or if they should be separated as two or more features, which further gives rise to the question of how this should be decided. The most important thing for this research was to choose one possible method of distinction and consistently apply the subsequent rules stated/created throughout the whole database systematically.

The intent was to collect the answers and make a complex, systematic database of semantic features, where the same information was always recorded in the same way within and also between given concepts. This simplifies the richness of the children's responses of course, but it is necessary to emphasize that the real goal of this database is not to observe the language form of the answer. (However, some effort was put into looking into the children's language specificity and some interpretation is given in the Results and Discussion section of this article.)

The features were tagged in many ways. Each feature was tagged by a code which refers to the participant's gender, age, mother tongue, and the task version (each of the versions was composed of an original mix of concepts in differing orders). Also the tag refers to the researcher who collected the data and the phase of the collection process during which it was collected.

The knowledge types of the features were also determined and tagged using the taxonomy developed by McRae and Cree (Cree and McRae, 2003). McRae and Cree also used this taxonomy for their semantic feature production norms (McRae et al., 2005). They explain that "(…) we developed a knowledge type taxonomy that we believe both can be linked to neural processing regions and incorporates minimal assumptions. We classified features into nine knowledge types (…)" (Cree and McRae, 2003, p. 175)

Some knowledge types refer to visual information: parts and surface, motion and colour. For the purpose of this research, "parts and surface" was divided into two visual types. The next four sensory types correspond to touch, taste, smell, and sound. The last two are the function type and the encyclopaedic type. The encyclopaedic feature includes any additional information. It is used in our featural typology inspired by McRae's papers. These features are about all other types of learned facts – from history, geography etc. Also, McRae explains that there are presumably important feature types other than the ones used in the database (see the quote below). Thus, encyclopaedic features are practically "the rest" of the features which were not able to be classified under existing categories (usually meaning "learned facts", as mentioned above).

The next level of classification is taxonomical. In this study, the "taxonomical" and the "taxonomical-parts" classes have been differentiated – the first class being used for features which refer to an important (basic) superordinate category and the remaining features of categorization being tagged as "taxonomical-parts" (e. g., ***an apple*** "*is a thing*"). McRae et al. emphasize that

> (…) other types of information may also be important (such as emotional reactions to objects that might be processed in the limbic system), but due to insufficient numbers of these, Cree and McRae excluded this knowledge type from their analyses, classifying them as encyclopaedic features instead. (McRae et al., 2005, p. 553)

Finally, the features were tagged by their production frequency, denoting the number of participants who listed them. From these data, a matrix was prepared for statistical analysis: the concepts were listed across 104 columns and the features were listed down 2,146 rows (as many as 2,146 various features were listed by the children). The cells contain the production frequency and thus the occurrence of each feature for all concepts can be observed. A matrix without taxonomic features is provided as well, as McRae et al. (2005, p. 552) emphasize:

> (…) the following variables were also calculated with taxonomic features excluded because we consider statements regarding the superordinate category (or categories) to which a concept belongs as being somewhat different from information regarding other types of features (parts, function, etc.). The taxonomics also include some subordinates and coordinates but are dominated by superordinates.

2.2 The database and statistics

The data were obtained from 381 child participants. 104 nominal concepts were described and each concept was described approximately 20 times. In total, 2,146 distinct and separate features were listed by the children.

In order to describe the data in more detail, a number of statistical characteristics were calculated. The following section describes the meaning of such characteristics (McRae et al., 2005), and the next section presents some interesting results. Both datasets with and without taxonomic features were considered in the computations (see the reasons above).

The statistical analysis incorporates category description, concept description, and featural representation data. It shows the significance and importance of every single feature, and, moreover, concept similarities and featural relationships can be measured and observed. Analyses can be performed not only in terms of a single concept but also across multiple concepts or categories, as some relationships presumably exist in this manner. McRae notes that "Distributional statistics, such as statistical regularities among features, have proven particularly insightful with regard to understanding semantic computation" (McRae et. al, 2005, p. 548).

Prior to performing statistical calculations, each dataset was reduced in order to eliminate possibly insignificant features. The reduction consisted of all features in concepts that were not listed more than once being omitted. The occasions when a feature appeared in a concept only once in the database were considered not presentable. Due to this reduction of concept features, some features were excluded from the dataset entirely.

The basis for all calculations is *(n×p)* matrix *M* of production frequencies. Each element of this matrix in position *i,j* contains some information about the number of participants who listed the *i*th feature for the *j*th concept. The rows contain information about features, the columns describe concepts.

However, in some cases it is more desirable to work with relative instead of absolute information since the number of participants is not always the same for different concepts. This relative information is saved in matrix *R* and is given by the conditional probability that a feature will appear in a concept:

$$P(F_i|C_j), \tag{1}$$

where F_i denotes the event that feature *i* was listed and C_j denotes the event that concept *j* is being described. Formula (1) can be also rewritten as

$$r_{ij} = \frac{m_{ij}}{\sum_{h=1}^{n} m_{hj}}, \tag{2}$$

using elements *m* of matrix *M*.

When addressing how informative the analysis is in regard to specific concepts, emphasis is placed on the examination of heterogeneity of concepts and their similarity. Initially the characteristics are assessed allowing for discrimination among similar concepts. Using matrix *R*, it is a matter of an elementary computation to obtain **cue validity.** This characteristic is simply the conditional probability of a concept *j*, given a feature *i*. Following the first Bayes' theorem, the probability $P(F_i \vee C_k)$ can be simplified and defined as

$$P(C_j|F_i) = \frac{P(F_i|C_j)\,P(C_j)}{\sum_{k=1}^{p} P(F_i|C_k)\,P(C_k)} = \frac{P(F_i|C_j)}{\sum_{k=1}^{p} P(F_i|C_k)}, \tag{3}$$

since it is assumed that the probability for an arbitrary concept to be described is always the same. Let *V* be the matrix of cue validity values, having the same dimension as both previous matrices. Then

$$v_{ij} = \frac{r_{ij}}{\sum_{k=1}^{p} r_{ik}}. \quad (4)$$

Meaning, cue validity is a quotient of the production frequency of the *i*th feature for the *j*th concept and the sum of the production frequencies of the *i*th feature over all *p* concepts.

Cue validity, defined by Rosch and Mervis (1975, p. 575), "(…) is a processing model of classification in which the validity of a cue is defined in terms of its total frequency within a category and its proportional frequency in that category relative to contrasting categories". Murphy (2002, p. 213) summarizes Rosch's hypothesis as follows:

> (…) basic categories exist as inherently separable clusters of objects in the world. The basic level is the level at which objects are most differentiated in the environment. (…) basic-level categories maximize *cue validity*, the probability that a particular object belongs to some category, given that the object has a particular feature, or cue.

Distinguishing features are basically features that discriminate a given concept from all other concepts. The number of distinguishing features per concept was computed as the number of a concept's features that occur in only one or two concepts in the database. More effectively, the ratio (as a percentage) of a concept's features that were identified as distinguishing, i.e. the number of distinguishing features divided by the total number of features in the concept, was calculated. Distinctiveness is a related measure that reflects how much a given feature distinguishes its concept separately from others – on a scale from extremely distinguishing to highly shared. The characteristics for each feature specify the inverse value of the number of concepts in which the feature appears in the database. The derived criterion is mean distinctiveness, stating the mean of each concept's values of distinctiveness (over those features that appear in a given concept). In extreme cases, if a feature is truly distinguishing, it will have the maximum score for distinctiveness and cue validity, which is 1.0, and vice versa, if a feature appears in many concepts, its distinctiveness and cue validity are extremely low.

Besides distinguishing features, features that are somehow typical of a given semantic category were also considered. The aim was to find the most frequently mentioned features that were also listed for most concepts in a category. Using suitable decision-making methods, three highly typical features were computed for each category.

The similarity of concepts can be very easily quantified using some kind of measure of association between two variables. Considering the previously mentioned matrix *R*, we accepted every column as a vector of *n* observations of random variable $C_j, j = 1, \dots, p$. A commonly used measure of similarity is the well-known Pearson's correlation coefficient. Nevertheless, Ahlgren, Jarneving, & Rousseau (2003) question the usage of Pearson's coefficient as this measure is sensitive to zeros. Analytically, the addition of zeros to two variables should contribute to their similarity, but the above-mentioned authors demonstrate that this addition can in fact weaken the correlation coefficient between variables. Salton and McGill (1983) suggest a cosine as a possible alternative since this similarity measure is not sensitive to the addition of zeros. The cosine for two vectors *x* and *y*, both of length *n*, can be formulated in terms of this study as follows

$$\cos(C_j, C_l) = \frac{\sum_{h=1}^{n} r_{hj}\, r_{hl}}{\sqrt{\sum_{h=1}^{n} r_{hj}^2}\,\sqrt{\sum_{h=1}^{n} r_{hl}^2}}. \quad (5)$$

The formula indicates that cosine is calculated as the dot product between two concept vectors from the matrix of production frequencies *R*, divided by the product of their lengths. And since Pearson's correlation coefficient is defined as

$$\mathrm{r}(\boldsymbol{x}, \boldsymbol{y}) = \frac{\sum_{h=1}^{n} (x_i - \overline{x})\,(y_i - \overline{y})}{\sqrt{\sum_{h=1}^{n} (x_i - \overline{x})^2}\,\sqrt{\sum_{h=1}^{n} (y_i - \overline{y})^2}}, \quad (6)$$

where $\overline{x}(\overline{y})$ is a sample mean of vector $x(y)$, it is obvious that the formula of the cosine is identical to the one of the Pearson correlation, only without a centring of the vectors to the mean. In geometrical terms, this means that the origin of the vector space is located in the middle of the set, while the cosine constructs the vector space from an origin where all vectors have a value of zero (Egghe and Leydesdorff, 2009). This study is certain to deal with vectors containing a large number of zeros, and therefore a cosine criterion has been used in computations thus far. Cosine varies from −1 (opposite vectors) to 1 (identical vectors), where 0 indicates independent vectors. Conceptual similarity was calculated for each pairwise combination of the concept vectors and then stored in a (*p*×*p*) matrix.

The calculated conceptual similarities found in this research could be used in potential consecutive research, in verifying that feature-based representations are used in some human judgments bound to word meaning. It could be used to verify findings when speeded versus untimed similarity judgment tasks are performed. In speeded tasks, the calculation should also be based on featural information – meaning that the conceptual similarity observed from this task type should correspond with the similarity calculated from this database. Conversely, in untimed tasks, the meaning calculation is based on additional information sources (alongside featural information) and as such, it should not correspond with the similarity calculated from the database (see more in McRae et al., 1997).

In contrast, for features, Pearson's correlation coefficient was applied to measure their similarity. This approach suggested by McRae et al. (2005) is advantageous in terms of interpretation and further calculations which could be desirable in the future. Considering the nature of this study's data, it is important to avoid spurious correlations – correlation indicating dependence when there is none. Many ways of interpreting spurious correlations are known (see for example Aldrich, 1995). In order to avoid these false similarities, only features that appeared in three or more concepts were included in the correlational analysis. A pair of features was acknowledged as significantly correlated if the features shared at least 65% of their variance. Considering that the shared variance of two variables is defined by a squared correlation coefficient, only pairs of features with *r* greater than 0.8 are interesting. The threshold of 0.8 was chosen based on practical results in our study and with regard to the basic correlation analysis theory suggesting the thresholds for significantly high correlation coefficient in various fields.

In an effort to visualize similarities of features, the qgraph package for *R* was used, introduced by Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom (2012). The package allows us to represent a correlation matrix as a network in which each node represents a variable, and each edge represents a correlation. The colour and width of edges indicate the sign and strength of correlation (all of the correlations are positive, thus the darker and wider the edge, the stronger the correlation is between two given features).

It is probable that the correlations outline the relationships between features which seem to exist. Thus, these correlations can play an important role in semantic computations (see for example McRae et al., 1997).

3. Results and discussion

Statistical measurements were described in the previous section. Extensive data tables relating to concepts and features were obtained from the calculations. The database (and these statistics) is published online (see the link below) to make it available for other researchers. Some results and interpretations are presented in the discussion below.

In total, 2,146 various features for 104 concepts were collected. Every concept was described by approximately 20 participants (see examples in table 2 above). On average, the participants each listed 4 features per concept. The average production of features per given concept by participant (separated by semantic category) is depicted in the following table (3).

The listed features belong to different knowledge types. The number of features based on the production frequency was not used in calculations, only the number of different features listed for each knowledge type were tallied. For ***an eagle***, there were 2 features listed for "white", 4 features for "black", and 2 for "brown" (2 children listed the colour white, 4 children mentioned "black", and 2 children listed "brown" for ***an***

eagle) in terms of visual-colour features, but only 3 features were tallied as mentioned for "colour" (that these three colours were listed 8 times in total was not considered significant).

The next figure (1) describes the proportion of these feature types[6] in the "living thing" and "artefact" categories and these two categories are compared to each other. It can be observed that the child participants were inclined to list visual properties, especially concerning parts of things, and they also often described the surface. They mentioned a lot of encyclopaedic features, especially for living things (for example, they listed their own experiences or the biological facts with which they were familiar). They typically listed a high incidence of taste features in connection with living things and the only taste feature for artefacts which was listed was for ***a pistol***, where the child noted that "*It doesn't have any taste*". It was fairly typical that the children listed features which the concept "does not have". These negative answers were possibly mentioned in the context of examples prior to the task or influenced by previous concepts which they had described, i.e. they might have felt a desire to mention certain lingering features from previous concepts when considering the next. The listing of taxonomic features was quite typical for the child participants and this corresponds with the idea that children start to think more objectively at this age. The basic taxonomy (read more about our division of taxonomic features above) was given more often in the case of living things, since these category memberships often seem to have been given clearly, as the parameters of the category are quite firmly defined and the categorization is frequently used in everyday life: for example we often speak about ***apples*** and ***oranges*** in connection with the idea of "fruit", but it is probable that there are many contextual scenarios in which ***a bed*** can be thought of other than simply as "an item of furniture". However, the taxonomic-parts were more typical of artefacts and it seems this is connected with the fact that children show a high tendency to list "*it is a thing*" especially in consideration of inanimate objects (but sometimes even for categories such as animals).

The distinguishing features per concept and the typical features of each category were calculated. The average distinctiveness crossed 0.5 in approximately 40 % of concepts which means there were a lot of strong distinguishing features. The concept showing the highest number of features shared with other concepts was *an eagle* (0.168) which can be explained by the fact that the children did not know this bird sufficiently to differentiate it from

category	mammals	fruits	birds		vegetables	plants	body parts	
child's average feature production per single concept	5,8	5,2	4,8		4	4	3,5	---
category	**vehicles**	**tools**	**weapons**		**furniture**	**kitchen items**	**clothing**	**musical instruments**
child's average feature production per single concept	4,2	4	3,9		3,9	3,8	3,7	3,5

Table 3: Child's average feature production per one concept (for categories)

[6] As this calculation was made with the aim to understand the proportion of feature types listed by children – the goal is to describe what kinds of conceptual features child participants were inclined towards mentioning – the features mentioned only once per concept are also included in this case.

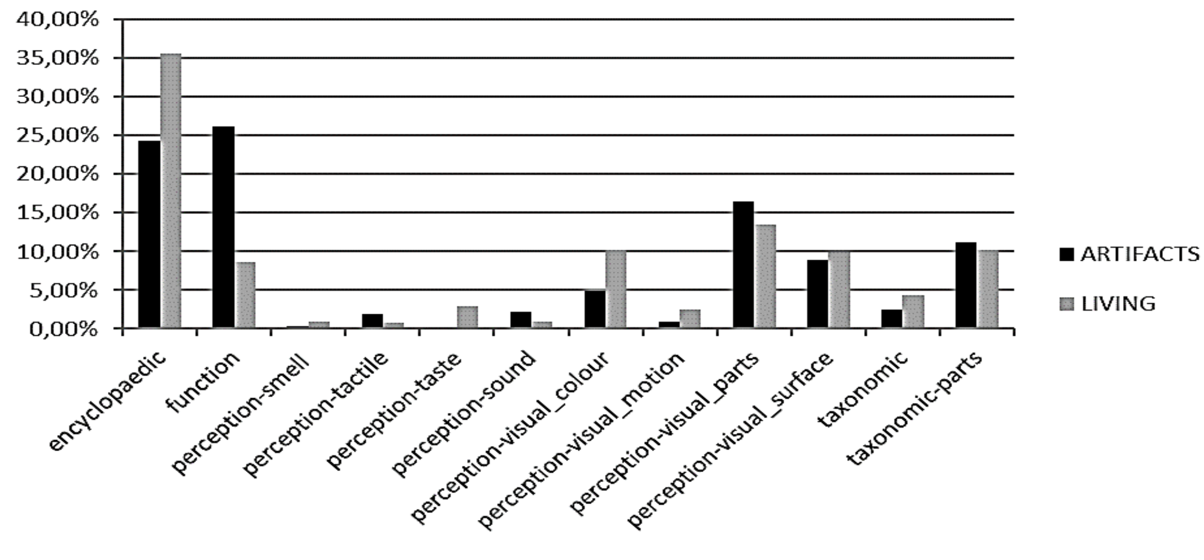

Figure 1: Living thing and artefact categories – proportion of feature types

others and, as such, they did not list any specific characteristics. On the other hand, a high number of shared features were typical for concepts from biological categories (vegetable, fruit and plants); this could indicate homogeneity in these categories, i.e. these concepts probably share many features with other concepts from the same category, or their features are shared in living thing categories in general. The highest distinctiveness of features was seen for *a leg* (0.810). Many other concepts from the "body parts" category have a high level of distinctiveness as well and it seems the whole category is somewhat atypical – the body parts of beings category is not a typical "living thing" category. Although children are presumably very familiar with body parts, the average feature production per concept from this category shared the lowest rank alongside that of musical instruments (it can be presumed this low ranking was due to a low familiarity with some musical instruments).

Table (4) shows examples of semantic categories and their typical features (after excluding those which were taxonomical).

16 pairs of correlated features were established, when the conditions were given (read more above). For example pairs like "**it is sour**" and "**it has vitamins**", "**it is juicy**" and "**it is sweet**", "**it has wings**" and "**it flies**", "**it has a stone/pit**" and "**it is on the tree**", "**it floats**" and "**it is on the water**", "**it smells good**" and "**it is pretty**" among others. The data shows that the relations and dependences are often between two knowledge types of features.

The following figure (2) shows how all relations between features can be depicted. The width and the darkness of lines indicate the strength of correlation.

The wider and darker the line is, the stronger the correlation between any two given features is. The examples given above, "**it is sour**" and "**it has vitamins**" are numbers 18 and 77; "**it is juicy**" and "**it is sweet**" are 36 and 33; "**it has wings**" and "**it flies**" are 60 and 52; "**it has a stone/pit**" and "**it is on the tree**" are 66 and 23; "**it floats**" and "**it is on the water**" are 86 and 24; and "**it smells good**" and "**it is pretty**" are numbers 93 and 11.

The conceptual similarity when taxonomical features are not included is the highest for *an orange* and *a tangerine*. The next pairs are *a cherry* and *a sour cherry*, and then *a hat* and *a cap*. This similarity information could be used for future research into the usage of semantic features in semantic tasks (read more above).

The language of children is somewhat specific and a database created using child participants is therefore probably different in many ways from one based on adult data. The children gave remarkable responses and they used many atypical and original descriptions, probably due to being unfamiliar with common phrases that are acquired later in life. They also used some very specific examples for the concepts.

This could be related to an element of developmental psychology which states that the age of participants in this research is often characterized by a shift in cognition

- where children start to think more objectively, but the tendency to communicate through subjective experience can still somewhat be observed (Vágnerová, 2001).

living thing categories examples	*typical features*	artefact categories examples	*typical features*
birds	*it flies, it has feathers, it is living*	**tools**	*it is made of metal, it is made of wood, it has a handle*
mammals	*it is living, it has a tail, it jumps*	**weapons**	*it is for shooting, it is dangerous, it is sharp*
fruits	*it is sweet, it grows, it is red*	**musical instruments**	*it is for playing, it makes sounds, it is made of wood*
vegetables	*it is eaten, it is green, it grows*	**clothing**	*it is worn, it has various colour options, it is made of textile*

Table 4: Examples of semantic categories and their typical features

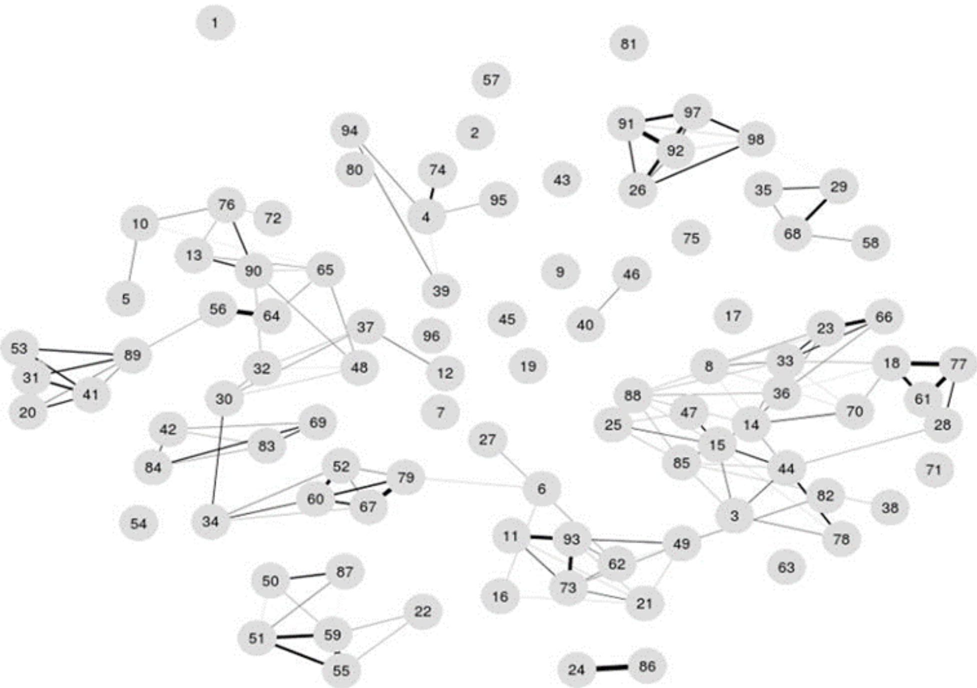

Figure 2: Feature correlations

Thus the participants listed known examples of things, or they spoke about themselves ("*I had this for a snack today*") or about their relatives and friends ("*My brother plays this instrument*") etc.

It is also possible to see the tendency (which is described above) for the children to sometimes be influenced by a previous concept or given examples; they tried to compare these concepts and examples with subsequent concepts, giving responses such as "***a pistol** does not have any taste*" or "***a coat-stand** does not speak*".

In appendix D, the encyclopaedic definition of the words (concepts) can be compared with children's answers. Only two examples have been presented as this comparison is not the main goal of this work. The concepts ***a parrot*** for living things and ***a triangle*** (musical instrument) for artefacts were used. It is evident that all the attributes (of the chosen examples) mentioned in the dictionary were also mentioned by the children. It seems there is a correspondence in frequency as well: as the most important attributes of a word (concept) are assumed to be mentioned in the dictionary and the most important conceptual features were mentioned by the highest number of children, a correlation can be found between the children's answers and the dictionary definition. With respect to the children's inaccurate answers, we can assume that the dictionary attributes could often be matched with more than one feature, for example, in the case of ***a triangle***, the attribute "**is metallic**" could be related to "**is made of metal**",[7] but probably also to "**is made of iron**", as iron is a type of metal. It is also not clear that the children really understood the difference between metal and iron, nor whether they were clearly differentiating between them at all (they may have understood them as completely synonymous).

Conclusion

In this article a new database of semantic features has been described, which was built with data collected for 104 substantive concepts from 381 children. The method of data processing and a description of the statistical analyses performed have been presented. This research was inspired by prior research papers which described their own semantic feature production norms, particularly that of McRae et al. (2005).

However, as this type of research is more concerned with producing a database to be used as a psycholinguistic tool in future research and not to produce an actual interpretation of gathered statistics and draw conclusions, a true comparison between this research and that of McRae et al. cannot be made (some statistical analysis of data relations has been conducted, but these results are often really extensive since the database is huge). Essentially, it would appear however that there are no fundamental differences between data gathered from adults and that gathered from children. For example, types of features (visual, functional etc.) listed by children correspond to Vinson and Vigliocco's (2008) table of feature types for categories obtained from adults. Children did not think only about visual features, but when it was reasonable, they also mentioned function or features of motion etc. The similarities are also noticeable when comparing the representations gathered from child participants in this study to the appendix of featural representation, which McRae et al. (2005) evidence in their paper.[8]

Interestingly, when compared to that of adults, individual children's responses are seemingly more disorderly or inaccurate and often don't clearly distinguish concepts from each other; on the other hand, the fundamental basis for children's representations is very similar to that of adults. Both age groups consider the same or similar features (or feature types) of similar importance for many given concepts.

This could be attributed to the various ways children acquire knowledge – both through formal education and through experience. In terms of formal education there are a great many things that this age group have yet to be exposed to, and therefore they are completely or partially unaware of some specific concepts, which may have resulted in more muddled or "childish" responses. However, through their informal exploration of the world, children's interaction with adults (such as teachers or relatives) could result in their being influenced by adult perspectives and contexts as they gain knowledge and understanding of concepts, i.e., the children's knowledge and understanding is skewed through an "adult lens", which may explain the fundamental similarity in the basis of both age groups' representations. This may explain why their representations are so similar to that of adults. The authors of this study would like to investigate this question more carefully, with conformity to theories such as Vygotsky's theories about conceptual development.

[7] We have used the code "**is made of metal**", however answers such as "*is metallic*" are included in this feature.

[8] Appendix E compares two of this study's featural representations with McRae et al.'s (2005). Since the same concepts were not used for both databases, the two concepts assumed to be most similar to each other were compared.

Some of the statistical findings and interpretations with respect to child participants have also been presented in this article. The database was primarily intended for future research into semantic feature usage in semantic computation. As the raw data for the database was gathered specifically from Czech children, it could be useful in psycholinguistic research, particularly with regards to child language acquisition in a Czech environment. As such, the authors of this study are contributing this database to the wider academic community by publishing it online. Alongside the database, a complete set of statistical analyses for use in other research areas will be also released at a later stage. It is believed that a great deal more statistical, interpretive and comparative data can be derived from this database making it not only useful to parents and teachers but particularly to other research teams, who will ultimately find their own means of utilizing these data and potentially conduct further research in a multitude of areas.

Appendix A

Instructions for Feature Production Database

(Czech language; examples included)

Mám pro vás teď úkol. Jde spíše **o hru**, není to na známky, nemusíte se bát.

Poprosím vás, abyste ke každému slovu, které najdete v sešitku, který jste dostali a máte ho před sebou, **napsali krátce a stručně popis**, jako byste vysvětlovali mladšímu sourozenci nebo mladšímu kamarádovi, **co to slovo znamená.**

Například, když se řekne **citrón**, co vás napadne? Podívejte se se mnou na příklady na přední straně sešitu.

Mohli byste napsat, že:

Citrón: je ovoce, je šťavnatý, má žlutou kůru a uvnitř je také žlutý, je kyselý, hezky voní, má pecky, je k jídlu, může se přidat do čaje, někdo ho jí jen tak, roste na stromě, neroste u nás a tak podobně, že?

A třeba **nůž: je to věc, nástroj, pomocí kterého můžeme řezat věci a krájet jídlo, je hodně ostrý, je dlouhý, má dřevěnou rukojeť a má kovové ostří, je nebezpečný, používáme ho v kuchyni nebo třeba v dílně, může to být i zbraň,** že?

Klepat: znamená vydávat zvuk nebo ťukat, zvuk může vydávat člověk prsty, a může ho také vydávat nástroj nebo zvíře, člověk klepe na dveře a datel klepe do stromu, nejčastěji klepeme, když chceme vstoupit k někomu domů.

Průhledný: když je něco průhledné, znamená to, že **je skrz to vidět** a **je to průsvitné**, také **tím prochází světlo**, **může takové být sklo**, **ale i voda**, **často je průhledná výplň oken**.

Zkuste to teď vy: co je to **slunce**? … (*společně)*… Výborně.

Rozumíte tomu, co po vás teď chci? Není to těžké, že?

Důležité je vědět, že můžete psát, **k jakému druhu nebo skupině ta věc patří**, **jak vypadá, třeba to, jak voní, jak chutná, jaké vydává zvuky, také jak funguje, k čemu ji používáme, kde ji můžete najít**… **a cokoliv**, co jiného vás ještě napadne.

Teď máte celou vyučovací hodinu na to, abyste mi psali ke každému slovu, **co znamená.** Nezapomeň, že mě zajímá, co o tom víš a co si myslíš **zrovna a jen ty**. Prosím, jste velké děti, jistě **zvládnete neopisovat**. Otočte se ke kamarádovi zády a pište každý sám. Není to písemka, zapojte fantazii a **pište to, co máte v hlavě**. Neraďte se mezi sebou, prostě napiš, co víš zrovna ty.

Pokud nevíte k některému slovu **nic**, **nevíte co napsat**, vůbec to **nevadí**. Zkus si vzpomenout, ale pokud to nepůjde, můžeš ho **vynechat úplně**, nechat místo u slova **prázdné**. Jakmile ale **půjdeš k dalšímu slovu, už se prosím nevracej**, **nelistuj sešitem zpět**, jdi dál a nech vše tak, jak jsi to napsal.

Nemusíte spěchat, ale snažte se psát **čitelně**.

Prosím, teď začněte.

Appendix B

Featural representations for *Tiger* and *Guitar*

(note that these contain only the features which were mentioned more than once)

Concept Name	Feature	Production Frequency	Brain Region Classification ('Featural Type')
TIGER			
described by 27 participants	is an animal	19	taxonomic
	is a mammal	2	taxonomic
	is a beast of prey	9	taxonomic-parts
	is a carnivore	8	taxonomic-parts
	is a felid	6	taxonomic-parts
	is not a thing	2	taxonomic-parts
	has fur	4	reception-visual_parts
	has legs	3	reception-visual_parts
	has teeth	3	reception-visual_parts
	has four legs	3	reception-visual_parts
	has claws	2	reception-visual_parts
	has skin	2	reception-visual_parts
	is striped	9	reception-visual_surface
	is orange	5	reception-visual_colour
	is black striped	4	reception-visual_colour
	has orange fur	2	reception-visual_colour
	has orange skin	2	reception-visual_colour
	has sharp teeth	2	reception-tactile
	is dangerous	7	encyclopaedic
	is living	6	encyclopaedic
	eats meat	4	encyclopaedic
	is in the zoo	4	encyclopaedic
	chases	2	encyclopaedic
	is bad	2	encyclopaedic

	is in Africa	2	encyclopaedic
	is in the savanna	2	encyclopaedic
GUITAR			
described by 21 participants	is a musical instrument	16	taxonomic
	has strings	7	reception-visual_parts
	is made of wood	7	reception-visual_parts
	is brown	3	reception-visual_colour
	is white	2	reception-visual_colour
	makes a nice sound	2	reception-sound
	makes sound	2	reception-sound
	is played	11	function
	is used for strumming	2	function
	is made (by people)	2	encyclopaedic
	is played at concerts	2	encyclopaedic
	is played with hands	2	encyclopaedic

Appendix C

Child participants' answers – examples to comparison

(including child spelling mistakes, respecting their usage of capitals etc. – the answers are given in original form given by participants; note that the mistakes are not noticeable in the translation)

Girl (Y8)	**POMERANČ (AN ORANGE)**	Je to ovoce. Má oranžovou barvu. (It is a fruit. Its colour is orange.)
	MEČ (A SWORD)	Je to železné i kovové. Má to rukojeť a používalo se to do bitvy. (It is iron and metallic. It has a handle and it was used in fights.)
Girl (Y8)	**ORANGE**	JE K JÍDLU, JE DOBRÝ, JE ORANGOVÍ (IT IS SOMETHING TO EAT, IT IS TASTY, IT IS ORANGE)
	SWORD	OSTRÝ, BOJUJE SE S NÍM, není na jídlo, není na HRANÍ. MAJÍ HO RYTÍRI. (SHARP, WE FIGHT WITH IT, it is not something to eat, it is not something TO PLAY WITH. THE KNIGHTS HAVE IT.)
Boy (Y8)	**ORANGE**	ovoce, oranžová (a fruit, orange)
	SWORD	rytíř (a knight)
Boy (Y8)	**ORANGE**	je ovoce které se může jíst je orangové vnitřek je orangový (is a fruit that you can eat it is orange the inside is orange)
	SWORD	Je ostrá zbraň rukojet je drevěná čepel je ostrá kovová stříbrná (Is a sharp weapon the handle is wooden the blade is sharp metal silver)

Appendix D

Dictionary definitions and the children's answers

PAPOUŠEK (A PARROT)	dictionary definitions by **Slovník spisovné češtiny pro školu a veřejnost (Academia)**	children's answers (frequency)
barevný je	*pestře zbarvený*	6
buráky živí se		1
býložravec je		1
část přírody je		1
červený je		1
doma je		2
domácí je		2
dvě nohy má		1
hmyzem živí se		1
hračky má (vlastní)		1
chová se		1
jablky živí se		1
k jídlu je		1
krásný je		1
křídlo/a má		1
létá		4
lidé mluvit to učí		1
malý je		2
malým hmyzem živí se		1
mazlíček je		1
mluví		7
moudrý je		1
nejedlý je		1
nohu/y má		1
oranžové nohy má		1
oranžový je		1
peří má		2
potravou živí se		1
pták je	*pták*	12
různé druhy má		2
různobarevný je		4
řeč opakuje	*schopný napodobit zvuky lidské řeči*	4
tvor je		1
v české republice není		1
v džungli je		1
v pralese je		2
v tropickém deštném pralese je	*tropický*	1

velký je		2
velký prostor musí mít		1
vzácný je		1
zelený je		1
zobák má		2
zpívá		1
zvíře je		10
zvuk/y vydává	*s pronikavým hlasem*	2
živý je		3

TRIANGL (A TRIANGLE)	dictionary definitions by **Slovník spisovné češtiny pro školu a veřejnost (Academia)**	children's answers (frequency)
cinká		3
do toho udírá se	*bicí*	3
hlasitý je		1
hudbu vydává		1
hudební nástroj je	*hudební nástroj*	18
kovovou tyč má		2
lidský produkt je		1
melodii vydává		1
na to cinká se		1
na to hraje se		4
stříbrný je		1
šňůru má		1
tvar trojúhelníku má	*v podobě trojúhelníku*	7
tyč má		6
tyčí do toho udírá se		1
tyčí na to cinká se		1
tyčí na to hraje se		1
v písních používá se		1
věc je		2
z kovu je	*kovový*	3
za šňůru drží se		1
ze železa je		5
zvuk/y vydává		2
železnou tyč má		2

Appendix E
Comparison of the answers of both our and McRae et al.'s (2005) participants

our concept: **JELEN (A DEER)**	production frequency	their concept (McRae et al., 2005): **A MOOSE**	production frequency[9]
býložravec je	2	an herbivore	8
člověk není	1		
čtyři nohy má	1	has four legs	12
dva parohy má	1		
hezký je	1		
hezký ocas má	1		
hlasitý je	1		
hnědou srst má	1		
hnědý je	7	is brown	10
huňatou srst má	1		
kopyta má	3	has hooves	5
král je	1		
král zvířat je	1		
loví se	1	hunted by people	17
malý ocas má	1		
maso chutné je *(its meat is tasty)*	1		
maso tmavé barvy je	1		
maso zvěřina je *(its meat is called game)*	1		
mládě kolouch je	1		
myslivec to střílí	1		
na hlavě parohy má	1		
nohu/y má	1	has legs	14
o samici samci bojují	1		
ocas má	3		
parohy má	16	has antlers	23
parohy shazuje	1		
plachý je	2		
podobný losovi je	1		
rychlý je	2		
samec je	1		
samice laň je	1		
savec je	1	a mammal	9
silný je	1		
srst má	3	has fur	7
trochu podobný losovi je	1		

[9] It is important to take into consideration that production frequency is the number of participants who mentioned the feature. A comparison between our and McRae's production frequency cannot be made because of the different numbers of people who described the concept, but it is possible to compare the production frequency of features within the concept and assess the importance of a given feature in our and in McRae's concept.

v lese je	13	lives[10] in woods	14
v zimě parohy shazuje	1		
velké parohy má	1		
velký je	1	is large	27
z masa je	1		
zvíře je	17	an animal	17
zvuk/y vydává	1		
živý je	10		
-	-	has hair	5
-	-	eaten for meat	5
-	-	lives in wilderness	8

our concept: **DÝKA (A DAGGER)**	production frequency	their concept (McRae et al., 2005): **A KNIFE**	production frequency
brousí se	1		
dlouhý je	1		
dřevěnou rukojeť má	1		
chrání	1		
koženou rukojeť má	1		
krátký je	1		
krutý je	1		
krvavý je	1		
loupežník Karaba to používá	1		
loupežník to používá	1		
malý je	1		
nářadí je	1		
nástroj je	2	is utensil	9
nebezpečný je	2	is dangerous	14
nůž je	5		
ostrý je	15	is sharp	29
ostřejší než klasický nůž je	1		
ostří má	1	has a blade	11
podobný noži je	5		
pytlák to používá	1		
rukojeť má	4	has a handle	14
řezný je	1		
špičatý je	2		
tím bojuje se	1		
tím krájí se	1	used for cutting	25
tím zabíjí se	4	used for killing	7
tupý je	1		
v dílně je	1		
v plátěné pochvě je	1		
v pohádce je	1		
v pohádce Tajemství staré bambitky je	1		
v pochvě je	1		
ve filmu je	1		

[10] In our case, "**it lives**" is an individual feature ("**živý je**")

ve středověku používalo se	1		
věc je	6		
velký je	2		
větší než klasický nůž je	1		
vojenský je	1		
vraždí	2		
z kovu je	1	made of metal	7
z kůže je	1		
zabíjí	1		
zbraň je	8	is weapon	11
ze železa je	1		
-	-	made of steel	8
-	-	made of stainless steel	5
-	-	is shiny	5
-	-	used by butchers	5
-	-	is serrated	8
-	-	found in kitchens	8
-	-	used with forks	6
	-	a cutlery	5

Acknowledgement
The research is supported by the IGA_FF_2014_100 and IGA_PrF_2016_025 student projects at Palacky University (Olomouc, Czech Republic) and it is part of a collective project.
We are immensely grateful to our colleagues Mgr. Martina Navrátilová, Mgr. Michaela Kopečková and Mgr. Kristýna Bajerová, who helped us with gaining and processing the data, and to Mgr. Lucie Večeřová, who is the co-author of the complete database.
We thank Mgr. Marek Nagy, PhD., who provided insight and expertise that greatly assisted the research, although he may not agree with all of the interpretations and conclusions of this paper.
We are profoundly thankful to Iain Mungall for assistance with the English language arrangement of this paper.
Finally, we would also like to show our gratitude to those anonymous reviewers without whose insights we may never have published this paper.

References
AHLGREN, P., JARNEVING, B. and ROUSSEAU, R., 2003. Requirements for a cocitation similarity measure, with special reference to Pearson's correlation coefficient. *Journal of the American Society for Information Science and Technology*, vol. 54, no. 6, pp. 550-560.
ALDRICH, J., 1995. Correlations genuine and spurious in Pearson and Yule. *Statistical Science*, vol. 10, no. 4, pp. 364-376. *doi:10.1214/ss/1177009870*.
BARBAROTTO, R., LAIACONA, M. and CAPITANI, E., 2008. Does sex influence the age of acquisition of common names? A contrast of different semantic categories. *Cortex*, vol. 44, no. 9, pp. 1161-1170.
BARSALOU, L. W., YEH, W., LUKA, B. J., OLSETH, K. L., MIX K. S. and WU, L., 1993. Concepts and meaning. *barsaloulab.org* [Accessed 20 March 2017]. Available at: http://barsaloulab.org/Online_Articles/1993-Barsalou_et_al-chap-concepts_meaning.pdf
BLOOM, P., 2000. *How children learn the meanings of words.* Massachusetts: The MIT Press.
CAREY, S., 2009. *The origin of concepts*. New York: Oxford University Press.
CREE, G. S. and McRAE, K., 2003. Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese and cello (and many other such concrete nouns). *Journal of Experimental Psychology: General*, vol. 132, no. 2, pp. 163-201.
ČERVENÁ, V. et. al, 2005. *Slovník spisovné češtiny pro školu a veřejnost*. Praha: Academia.
EGGHE, L. and LEYDESDORFF, L., 2009. The relation between Pearson's correlation coefficient r and Salton's cosine measure. *Journal of the American Society for Information Science and Technology*, vol. 60, no. 5, pp. 1027-1036.
EPSKAMP, S., CRAMER, A. O. J., WALDORP, L. J., SCHMITTMANN, V. D. and BORSBOOM, D., 2012. qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software*, vol. 48, no. 4, pp. 1-18.
GEERAERTS, D., 2010. *Theories of lexical semantics.* Oxford: Oxford University Press.
KEIL, F. C., 1989. *Concepts, kinds, and cognitive development.* Massachusetts: The MIT Press.
KONEČNÁ, K. and VEČEŘOVÁ, L., 2016. Baterie sémantických rysů: data získaná od dětí z třetích tříd základních škol – zpráva z pilotního sběru dat. *Studie z aplikované lingvistiky*, vol. 7, no. 2, pp. 48-71.
LAKOFF, G., 1987. *Women, fire and dangerous things. What categories reveal about the mind*. Chicago: The University Chicago Press.
McRAE, K., CREE, G. S., SEIDENBERG, M. S. and McNORGAN, C., 2005. Semantic feature production norms for a large set of living and non-living things. *Behavior Research Methods, Instruments & Computers*, vol. 37, no. 4, pp. 547-559.
McRAE, K., de SA, V. R. and SEIDENBERG, M. S., 1997. On the nature and scope of featural representations of word meaning. *Journal of Experimental Psychology: General*, vol. 126, no. 2, pp. 99-130.
MEDIN, D. L., 1989. Concepts and conceptual structure. *American Psychologist*, vol. 44, no. 12, pp. 1469-1481.
MURPHY, G. L., 2002. *The big book of concepts.* Massachusetts: The MIT Press.

NAGY, M., 2014. Produkce sémantických rysů u dospělých mluvčích. In: J. Keseelová, M. Imrichová, M. Ološtiak, eds. *Registre jazyka a jazykovedy (I).* Prešov: Filozofická fakulta Prešovskej university v Prešove, pp. 237-249.
POSNANSKY, C. J., 1978. Category norms for verbal items in 25 categories for children in grades 2-6. *Behavior Research Methods & Instrumentation*, vol. 10, no. 6, pp. 819-832.
PRŮCHA, J., 2011. *Dětská řeč a komunikace : poznatky vývojové psycholingvistiky.* Praha: Grada Publishing.
ROSCH, E. and MERVIS, C. B., 1975. Family resemblances: Studies in the internal structure of categories. *Cognitive psychology*, vol. 7, no. 4, pp. 573-605.
ROSCH, E. and LLOYD, B. B., 1978. *Cognition and categorization.* Hillsdale: Lawrence Erlbaum Associates.
SALTON, G. and McGILL, M. J., 1983. *Introduction to modern information retrieval.* Auckland, etc.: McGraw-Hill.
VÁGNEROVÁ, M., 2001*. Kognitivní a sociální psychologie žáka základní školy.* Praha: Karolinum.
VINSON, D. P. and VIGLIOCCO, G., 2008. Semantic feature production norms for a large set of objects and events. *Behavior Research Methods*, vol. 40, no. 1 (psychology module), pp. 183-190.
The database is available at: http://www.childrenfeatures.webnode.cz

Author's adress and contact details

Mgr. Kristýna Konečná
Department of General Linguistics
Faculty of Arts
Palacký University Olomouc
Czech Republic
E-mail: kristyn.konecna@gmail.com

Mgr. Kristýna Vaňkátová
Department of Mathematical Analysis and Applications of Mathematics
Faculty of Science
Palacký University Olomouc
Czech Republic
E-mail: kristyna.vankatova@centrum.cz