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Compositionality of Complex Concepts

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Abstract This paper looks into the nature of compositionality in language, specifically concerning the formation of complex concepts. This involves a look into the varying theories of how concepts themselves are characterised, and the ongoing debate concerning both the nature of compositionality and what information we include in compositionality. Semantic theories such as Default Semantics (Jaszczolt 2010), which include more than just our lexical and syntactic output as a source for default semantic meanings, are of particular interest in this investigation. A questionnaire was carried out asking for participants to describe compound nouns that fell into one of three categories: conventional and predictable, unconventional and unpredictable, and ambiguous between a part-based and a holistic interpretation. Responses support a weaker definition of compositionality, in which experience and familiarity play a significant role in the formation of complex concepts, especially visible in those compounds that are unconventional and unpredictable. This supports the less modular approach of Default Semantics.

1 Introduction

Compositionality as a property of language is the idea that our understanding of the meanings of whole sentences comes from our understanding of the sentences' constituent parts (concepts) and the way in which these constituents are put together. Szabó (2000) described the compositionality of human languages as a "significant…empirical assumption," and this treatment of compositionality as a necessary component has been present since at least the work of Frege in the late 19th and early 20th centuries. Frege (1892) notes that the productivity of language and our ability to understand novel sentences relies on this ability to construct whole meaning from individual constituent parts and the way they are put together. This argument is often given alongside that of systematicity, in which our comprehension of one sentence entails comprehension of a second sentence that contains the same lexical items in a different order, and which relies again on meaning being composed of smaller, rearrangeable units. If we have concepts for DOGS, CATS and CHASE individually then we can understand *dogs chase cats*, and if we understand *dogs chase cats* then we can also understand *cats chase dogs*.

1.1 Research question and background motivation

Despite agreement over compositionality as an essential property of language, the level at which this compositionality operates (whether it targets syntactic output

or operates at a more conceptual level) and the mechanisms through which units are composed are still topics of debate. Proposed theories allow differing degrees of involvement from context and experience, and vary in the extent to which we use productive compositionality. Conclusions drawn about compositionality have effects that reach beyond a theory of compositionality alone as they can inform theories about the simple concepts being composed, and can have wide-reaching consequences for semantics as a whole.

The combination of the debate surrounding the nature of compositionality in human language and a personal interest in pursuing theories of language which are not constrained to linguistic modules results in the following question: to what extent do we use this strict definition of compositionality in the production of complex concepts, and to what extent is the processing of compositionality consistent and conventionalised?

1.2 Objectives and methods

The aim herein will be to shed light on a theory of compositionality that is modelled around the formation of complex concepts, specifically the complex concepts of compound nouns such as SOUP KNIFE. This will be achieved firstly through an evaluation of existing theories of complex concept formation, and followed by an analysis of empirical evidence obtained via a questionnaire, the results of which will provide insight into the production of nominal complex concepts of differing degrees of familiarity. We should, as a result, be directed towards a theory of compositionality which operates at a higher conceptual level, in which personal experience, world knowledge and utterance context play an integral role in concept formation, and where lack of familiarity with a complex concept leads to a lack of uniformity in both the concept formed and mechanism used to reach this concept. This is consistent with the idea of interactive compositionality, as outlined in Recanati (2004) and Jaszczolt (2005, 2010).

Section 2 will expand upon the different theories of compositionality mentioned above, and provide a theoretical backdrop for the empirical evidence presented and discussed in section 3 and 4 respectively. Section 5 will conclude, discussing the wider theoretical implications of the empirical results.

2 Compositionality: Theoretical background

2.1 Compositionality at the level of simple concepts

The debate over the exact composition of our mental representations is ongoing, and while some theories have lost or gained prominence in the theoretical landscape, it is a debate that lacks a concrete outcome. The following is a brief outline of multiple dominant theories, discussed in Margolis & Laurence (1999).

The Classical Theory of concepts treats mental representations as a set of necessary and sufficient features. This theory brings about issues concerning concepts that don't seem to have definitions such as GAME (Wittgenstein 1958), concept fuzziness,

typicality effects, and our ability to recognise concept members that are missing a feature such as a cat with three legs.

Typicality effects as seen in Rosch (1975) where priming effects varied on goodness of example, or Posner & Keele (1970) where unseen typical examples of a category were more easily classified than previously seen, less typical examples, point towards a prototypical theory of concepts. The Prototype Theory, developed by Eleanor Rosch during the 1970s, attempts to provide a model that allows for more variation among concept members by encoding features that are typical but not necessary, an approach that seems more reflective of categorisation processes. More typical features are given a heavier weighting and membership rests on similarity to the prototype. However, this in turn creates issues concerning typicality that doesn't correspond to degree of membership (c.f Armstrong, Gleitman & Gleitman 1983: for an exploration of this regarding numbers) and concepts without prototypes (GRANDMOTHERS MOST OF WHOSE GRANDCHILDREN ARE MARRIED TO DENTISTS (Fodor 1981)). A dual theory that includes both typical and necessary features could resolve this but comes with the problems of Classical Theory. Additionally, prototype models do not encode frequency and yet this has been found to be something people are sensitive to (Kruschke 1996).

Fodor (1998) proposed an atomic, non-compositional view of concepts, rejecting a prototypical approach on the basis that prototypes themselves cannot compose due to the fact that prototypes are not always inherited from their constituents. This is outlined in the PET FISH problem, where a prototypical pet fish is neither a prototypical pet nor a prototypical fish, as well as in the aforementioned case of complex concepts lacking a prototype. Fodor sums this up as "can't think of a better way to say what 'keep' means than to say that it means keep. If…the concept KEEP is an atom, it's hardly surprising that there's no better way to say what 'keep' means than to say that it means keep." This is an appealing theory as it avoids the problems which arise from features; if BACHELOR contains the feature UNMARRIED, what features compose the concept UNMARRIED, or is it treated as atomic? However, the view suffers from explanatory impotence regarding issues of concept acquisition, and our intuitions of concept similarity.

Finally, Theory-Theory identifies concepts in terms of the role they play in a mental theory, and parallels cognitive development in children with the development of scientific theories. Following this approach, a cat painted like a skunk is not a skunk because it does not have a skunk's genetics. A speaker does not have to understand genetics but rather views skunks as having a concept-determining "essence," be it detailed (the genetic makeup itself) or schematic (an understanding that genetics make a categorical distinction). However, the vagueness of this "essence" poses a stumbling block, alongside the characterisation of concepts in terms of theories that later are proven erroneous.

Kamp & Partee (1995) depart from the idea of concept structure uniformity seen in the theories presented by Margolis & Laurence. They build upon the Prototype Theory, proposing variation in concept types between concepts which are vague and sharp [±V], concepts that have a prototype and those that do not [±P], and of the concepts with prototypes, those where the degree of membership of the extension

is a matter of prototype resemblance and those where it is not [±PE]. This allows for cases such as Fodor's GRANDMOTHERS MOST OF WHOSE GRANDCHILDREN ARE MARRIED TO DENTISTS which is not vague and has no prototype [-V, -P], or cases such as BIRD, which is a sharp concept with a prototype, but typical members such as pigeons are no less members than less typical members such as penguins [-V, +P, -PE]. For colours such as RED, the concept is vague, but closeness to the prototype is indicative of category membership [+V, +P, +PE].

Having discussed different approaches to how simple concepts are composed, I feel it is important to briefly touch upon varying factors that shape what concepts are composed of.

The first important factor is knowledge. A problem with Theory-Theory outlined in Margolis & Laurence (1999) is that while concepts are defined by their role in theories about the world, our increasing knowledge about the workings of the world may render these theories void. How can we root our concepts in theories that may potentially collapse? A similar issue concerning ignorance and error (Kripke 1980, Putnam 1970) arises in all the other theories (bar Fodor's atomism - its singularity seems to exclude it from as many issues as it causes). To use Margolis & Laurence's example, as our understanding of smallpox changes over time, so changes our concept and yet we are still able to understand texts about smallpox written in a time of a different, more ignorant concept of the disease. Does this indicate an understanding of concepts through their extension rather than shared background knowledge? This can be applied to synchronic variation, raising the question of whether differing beliefs result in differing concepts and if so, is only a similarity between concepts required to communicate?

The idea that our concepts are shaped by their place within a theory may not hold on its own, but some concepts do appear to be shaped by scientific theory. When encountering a platypus for the first time, we may be unsure whether it is a bird or a mammal. Upon being told it is a mammal, we do not need to understand the reasons for this categorisation to take on the concept with the "essence" of being a mammal. The opposite, however, is seen in cases like the common concepts of FRUIT and VEGETABLE diverging from the scientific ones.

Personal experience may affect our concepts. Someone's prototype may be guided by tokens of the concept they have been exposed to rather than reflecting statistical typicality. To take an example from personal experience, someone raised in an urban environment may express surprise to learn how big pigs typically are. Surprise suggests negation of a concept feature, perhaps a result of exposure to appealing images of cute piglets, rather than the grown farm animals. This does not impede communication unless, presumably, size is relevant to the conversation. It seems as long as there is sufficient similarity between individuals' concepts and the differences are not immediately relevant, that communication does not require participants to have identical concepts.

Similarly, personal beliefs and attitudes seem to affect prototypes. Someone's prototypical concept of DOG may include LOYAL, FRIENDLY etc, whereas someone else's may include features such as CLAWS and DANGEROUS. This would result in two very different interpretations of the reply in the dialogue 'should I go in the house?'

'there's a dog in there' that can't be put down to implicature as the same Gricean process would be used by both people in the same context.

One important clarification is that until this point, the theories have essentially viewed concepts as unchanging, or have at least used the idea of concepts without context. However, I wish to argue that there is no such thing as zero context. Rather, what is thought of as being zero context is itself a context, a null context which is an absence of the context typically available when accessing concepts during speech. It is a context that lacks a surrounding discourse and a surrounding world. Changing the context in which a concept has to be formed seems to affect the concept.

A key element of concept theory, following Kripke's and Putnam's arguments, is that concepts are imputed from the world based on how we have observed their associated words being used. How we process or abstract away from this input varies between theories, but exceptions and unusual cases can be viewed as being due to word use and the state of the world rather than a fundamental problem with the concept theory. Margolis & Laurence (1999) propose here concept pluralism, where different conceptual structures can be called on for different functional purposes. While concepts have an atomic core, they may also have prototypes and be understood via their roles in theories about the world, and these different structures in turn play different explanatory roles.

2.2 Compositionality at the level of complex concepts

Needless to say, the unresolved nature of concept structure is a complicating variable when determining the manner in which these units compose. While section 2.2 follows the direction of the literature and focuses on composing concepts as being prototypes, the open discussion concerning concept structure will be kept in mind during the empirical discussion in section 4.

As mentioned in section 2.1, Fodor proposes the lack of prototype inheritance in compositionality as a problem with Prototype Theory. The fuzzy nature of prototype concept contents and non-necessity of prototype features seem antithetical to the view of compositionality being all and only its constituent parts and how they are put together. Fuzzy set theory was proposed as a potential reconciliation wherein the complex concept should be a member of the fuzzy intersection of two fuzzy concepts to the degree of the lower membership of the individual composing sets. However, as Osherson & Smith (1981) explain, there are still cases such as STRIPED APPLE, a good example of a striped apple and so a member of the fuzzy intersection to a high degree, but neither a good example of an apple nor a good example of stripes, with a low degree of membership of those categories.

This, however, relies on an assumption of strong compositionality. As the strength and necessity of compositionality is to be investigated, it seems an irrelevant assumption on which to dismiss a theory of concepts at this juncture. The following sections examine a range of approaches to compositionality within compound nouns.

2.2.1 Modulation: Del Pinal (2016) and Recanati (2010)

Prinz (2012) takes a strong, context sensitive view of compositionality, with an internalist pluralist approach to prototypes. The lack of prototype inheritance is explained as prototype "modulation*", the activation of feature subsets of concepts at the lexical level on terminal syntactic nodes prior to composition. The resulting complex concept is constructed from no more than the constituent concepts and the way they are put together. Del Pinal's prototypes encode normative tendencies as well as statistical, salient and diagnostic information along multiple dimensions, and are not simply average exemplars. These sets of dimensions make context-sensitive prototype modulation* possible by allowing it to affect only what is in the rich lexical representation rather than being the product of feature addition. Prototypes are not the only conceptual components, but Del Pinal fails to expand on what these further components are and how they contribute to compositionality. Emergent features, those which do not come from either constituent, are reasoning- and working-memory-based, and are put down as post-linguistic.

Taking the example of PET FISH, the prototypical features of PET change in the context of FISH and vice versa. Emergent features that other approaches would take as part of the PET FISH prototype, such as LIVES IN A BOWL, are here considered pragmatic and not part of the linguistic prototype of a small ornamental fish. This, however, feels like formality for the sake of formality in that it seems to ignore default uses and interpretations of language, putting aside prototypical features of a complex concept simply because it doesn't align with a theoretical view. It also means that features in the output of compositionality can be overridden by reasoning, such as ARCTIC BICYCLE not having wheels despite the BICYCLE prototype. Finally, it seems that this insistence that modulation* is confined to within the lexicon isn't supported by any argument other than wanting to fit within a strict idea of compositionality.

The foundations for modulation* were laid in Recanati's compositionally weaker modulation. Unlike Del Pinal's lexically-rich modulation*, the original modulation in Recanati (2010) Truth-Conditional Pragmatics was a contextual process by which underspecified lexical processes were saturated through addition. This principle of semantic flexibility, essentially, is the understanding that the occasion meaning of lexical items in an utterance is context-dependent, using both the surrounding linguistic context (lateral influence) and the non-linguistic situational context (top down influence) to modulate the lexical content. Recanati extends the Kaplanian notion of character and content (in this case corresponding to standing meaning and occasion meaning) beyond indexicals and words such as *big* that have a "gappy" meaning, to all lexical items and expressions. To apply this to the PET FISH example seen in Del Pinal, the features such as SMALL and ORNAMENTAL would be added to the lexical output rather than retrieved from it. Complex concepts can then, as functions of modulated concepts, be modulated themselves as modulation is not limited to terminal syntactic nodes.

One aspect of these two approaches that I take issue with is that they both insist on constantly productive compositionality, rather than allowing familiarity to play

a larger role in complex concept formation. In the case of PET FISH, it seems more intuitive that world experience and exposure to the complex concept as a whole would mean that we do not construct SMALL ORNAMENTAL FISH before pragmatically adding features such as LIVES IN A BOWL. This leads to questions pertaining to the threshold between simple and complex concepts. If PET FISH is taken to be a concept that is understood as a whole, does the fact that it can be decomposed ensure its complexity?

2.2.2 Prinz (2012)

Prinz's (2012) approach to compositionality takes into consideration the familiarity of certain concepts. Rather than being purely intensional, it allows complex concepts to rely on extensional feedback. In Hampton (1987), it was found that features considered necessary and impossible for constituents were deemed equally necessary and impossible for their complex concept. One exception to this was birds' ability to talk (impossible in BIRD but possible in PET BIRD). Extensional feedback allows real-life tokens of pet birds that talk to be drawn upon, and it is possible that had the participants been asked about PET BIRD prior to BIRD, the small atypical subset of talking birds would not have been forgotten and the judgement of impossibility would not have been made. This highlights the contribution of experience to concept formation, at least partly corroborating my discussion of how decomposition does not entail compositionality, and extending the idea of concepts being imputed from the world from simple to complex concepts. Building upon this, Prinz proposes the RCA (retrieval, composition, analysis) model to account for different types of emergent features derived from outside knowledge. The retrieval stage retrieves whole concepts that have been stored, either as lexicalised compounds or as exemplar representations cross-listed under their constituent concepts as is suggested to be the case for WOODEN SPOON, complete with the non-compositional emergent features. The compositional stage then uses compositional combination rules to create a compound prototype through either feature replacement, feature pooling, or the introduction of a relation if the concepts are not similar enough to combine in cases where there is no extensional knowledge of the concept. Finally, the analysis stage uses non-compositional reasoning and background information to fill in any missing information or relationships and resolve conflicts.

According to Prinz, compounds are compositional only when we lack background or extensional knowledge. Emergent features come from cognitive resources that rely on information we have, and so increased complexity increases potential background knowledge, therefore promoting emergent features. As such, Prinz argues that PET FISH WHO LIVE IN ARMENIA AND HAVE RECENTLY SWALLOWED THEIR OWNERS would have emergent features such as VICIOUS and VORACIOUS. While it makes sense that general knowledge informs concepts, there seems to be a dismissal of the difference in significance of emergent features that are real-world-driven, and those that arise from reasoning.

2.2.3 Schurz (2012)

Schurz takes an evolutionary approach to how prototypes can compose, following the argument that evolution leads to an abundance of normic laws in our environment wherein As are normally but not exclusively Bs. As a result, our coping with prototypes and normic laws is not language-specific. One of the major cognitive functions that has evolved to process these normic laws is efficient predictive and diagnostic reasoning since predictively and diagnostically efficient categorisation is considered an evolutionary advantage. This means that rather than being a general theory of concepts, Schurz views the domain of Prototype Theory as being an evolutionary system. Due to the evolutionary nature of natural prototypes, Schurz says that the natural distribution of properties has resulted in peaks that allow people to acquire the same prototype even with differing acquisition processes, which opposes the previously-discussed ideas of communication with non-identical concepts. When modifying a prototype with an adjective, properties of the prototype are defaultly inherited by the complex concept provided that the adjective forms a subclass that is statistically non-exceptional, meaning that it does not contradict the wider class-defining prototypes. This follows from the process put forward in the Selective Modification Model of Smith, Osherson, Rips & Keane (1988), where a single-attribute adjective (such as RED in RED APPLE) shifts the relevant prototype attribute to its own value while leaving the structure of all other attributes unchanged. An exceptional adjective (GREEN APPLE) would also change other attributes such as SWEETNESS, a prototypical feature of APPLE. While I have problems with treating the common, if not typical, GREEN APPLE as exceptional, this reasoning follows for the example of KILLER DOG also given. Therefore, according to Schurz, non-exceptional adjectives satisfy the default-to-prototype rule (DP) and are compositional, while exceptional adjectives, and modifiers that combine exceptional and non-exceptional adjectives, violate DP and are non-compositional.

2.2.4 Hampton & Jönsson (2012)

Hampton & Jönsson do not consider all concepts to be prototypes, only those in our conceptual repertoire and those which are valuable for thinking and communication. They view prototypes as composing to form complex prototypes, and propose a modified principle of compositionality where a complex concept is composed of its parts, their mode of combination, and general knowledge. Unlike Prinz (2012), background knowledge is treated as part of compositionality rather than indicative of its absence. This recruitment of general knowledge resolves the PET FISH problem by allowing compositionality to draw from beyond the features of the composing prototypes. While still viewing PET FISH as productively compositional, it is a weaker sense of compositionality than in Del Pinal (2016) and is more appealing as a less theoretically-bound view of concept formation.

The composition process is viewed as systematic non-logical reasoning. Both typicality and category membership of complex concepts were found to overextend the logical concept boundaries. For example, RED & RIPE APPLE, logically, would

only include apples that are both red and ripe. Hampton & Jönsson argue that there are cases where a high value for one of the conjoined modifiers compensates for a lack of the other. While distant from the prototypical red ripe apple, an apple that is almost ripe and strongly red could be considered a red ripe apple. This extends to single modifiers that contain multiple prototypical features. When two prototypes combine, the resulting prototype may fall within these areas of overextension, should general knowledge place it there, without enough prototypical features of one constituent to independently be classified as an extension of it.

Since redness is indicative of ripeness in red apples, it would be interesting to see if similar overextension effects are present with RIPE GREEN APPLE, or with completely unrelated adjectives. If not, then perhaps overextension would be more closely linked to general knowledge than concept features. Again, with PET FISH, this approach seems informative concerning how we identify real world members of a complex concept, but it feels insufficient when it comes to the production of those complex concepts themselves, putting it down to productive compositionality fed by general knowledge. The fact that the general knowledge determines the prototype for PET FISH implies an understanding of PET FISH that precedes compositionality. Additionally, as discussed in section 2.1, Kamp & Partee (1995) identified concepts where membership is not aligned with typicality, which may lead to a lack of overextension.

2.2.5 Wisniewski & Wu (2012)

In the case of noun-noun combinations, Wisniewski & Wu consider the rise of emergent features that are constructed from existing features to be the result of mapping from one constituent to the other based on similarity. Examples given include ROLLERCOASTER DINNER being interpreted as 'a series of courses that alternate from tasting good to tasting bad' and PORCUPINE MUSHROOM meaning 'a mushroom with prickly protrusions on the cap of the mushroom or on both cap and stem'. Similarly, ZEBRA FOOTBALL would be a black-and-white-striped football, but the stripes would not necessarily have to match those found on an actual zebra. Using the idea of mapping, people interpret PORCUPINE MUSHROOM as having spines on the mushroom head as that aligns itself with the porcupine's back, and Wisniewski (1998) found that 'a porcupine pig is a prickly pig' was preferred over 'a cactus pig is a prickly pig' based on the level of similarity between the combined concepts. Their interpretation of ROLLERCOASTER DINNER raises some problems for me though. My default interpretation in null context was a relational one of a meal eaten on a rollercoaster. Once the context was specified, specifically a dinner in a house, I interpreted it as a meal where there were ups and downs that were emotional rather than culinary as put forward by Wisniewski & Wu. My assumption is that this is through analogy with the phrase 'emotional rollercoaster', where familiarity with the phrase allows transfer of the emotional aspect. While they go on to discuss the important role analogy plays in concept formation, this operates more in terms of simply identifying the type of relationship between constituents, such as KIWI PIE being understood through analogy with APPLE PIE. There also seems to be a lack

of discussion of the role of context. If the phrase 'rollercoaster meal' was uttered in a discussion about the varying quality of a meal then I doubt that my default interpretation would be the same as that in a null or locational context.

What I think is especially important when it comes to noun-noun combinations, where only certain aspects of a modifying noun are relevant to the head, is that they often originate in the physical world. Words are sought to describe attributes before we have to retrieve those attributes from the word, extrapolating backwards to view a particular noun as providing a specific property. Take for example SKUNK FOOTBALL. A skunk is a striped animal but since it is more commonly used to refer to bad smells, the idea that it could mean striped may not cross a listener's mind. There seems to be a two-way relationship between the salience of STRIPED among zebra characteristics and the salience of zebras among things that are striped, coupled with the metaphorical use becoming normalised. When interpreting novel complex noun-noun concepts, often identifying which feature should be selected from the modifying noun or the type of relationship between modifier and head comes from memory or analogy of how that word or similar words have been previously used. This is seen in the KIWI PIE example, and ZEBRA CLAM may remind someone of a striped clam they have encountered.

2.3 Pragmatic compositionality

Contextualist theories operate on the basis that contextual information contributes to the truth-conditional representation of an utterance. In this vein, Recanati (2004) proposed an "interactionist" approach to semantic compositionality. By this what is meant is:

> [T]he meaning of the whole is not constructed in a purely bottom-up manner from the meanings of the parts. The meaning of the whole is influenced by top-down, pragmatic factors, and through the meaning of the whole the meanings of the parts are also affected.
>
> (Recanati 2004: 132)

This top-down influence that builds up the meaning as a whole comes not only from interaction with the linguistic context (lateral influence), but also from the discourse topic and the situational context of the word's use. Words and utterances do not have a fixed meaning. Rather, words provide a semantic potential, the collection of past uses, which then interacts with linguistic and situational context to give meaning. As such, a non-null context may be required, whether truly present or imagined, to understand some utterances.

Jaszczolt's (2010) radically contextualist Default Semantics (DS) builds upon Recanati's proposition, furthering it to propose that the output of this pragmatic compositionality can go beyond simply developing the logical form of the sentence. This approach to semantic composition views information sources that would in

less radical theories be considered pragmatic as contributing to a default truth-conditional proposition. While one of these sources is the syntactic output, this is not treated as a starting point to work up from as in Recanati's approach, but rather one of five equally available information sources. The five sources from which a truth-conditional proposition is composed through merging are: the already-mentioned word meaning and sentence structure (WS), world knowledge (WK), the situation of discourse (SD), properties of the human inferential system (IS) and stereotypes and presumptions about society (SC). DS follows on from Schiffer (1991, 1994, 2003) in that the compositionality of meaning reflects the compositionality of reality, and the burden of compositionality is placed at an utterance level, rather than at the level of syntactic output. This approach should help account for issues that concern compositionality in other theories, specifically regarding intensional contexts (propositional attitude reports, modal expressions, temporal adverbials), by bringing truth-conditional representations closer to a cognitive, conceptual level of analysis. In a case of synonym substitution bringing about different truth-conditional values, the coreferential nature of the synonyms is not problematic as they are distinct in the belief of the speaker.

What is of particular interest is that some points argued against contextualist semantics actually seem to sit better, or at least equally as well, with DS. In particular, Borg (2004) notes that speakers and listeners seem able to access the literal meaning of an utterance, even when it is not the typically understood meaning. She uses the example a pedantic speaker who says they will bring the washing in and then, having failed to do so before it starts to rain, points out that they never specified when they would bring the washing in. Borg views this as a speaker purposefully ignoring the pragmatic role of context creating the implicature 'soon (before the impending rain)' but I believe a rather more appealing approach is that this literal meaning is imposed through the cancellation of the default interpretation, wilfully shifting from the default meaning by unnaturally weighting the WS source. The sources contributing to the compositionality of the proposition are changed by the speaker, allowing for these deliberate misunderstandings.

One issue that can be levelled against DS is a lack of computability and predictability, with no clear set of rules determining how to form a merger representation. Part of this is due to the fact that default locality is vaguely defined as being over "adequate" units, deliberately flexible to give the correct result for a particular case in question. This is weakly compositional, as opposed to the strong definition given in section 1, with no clear-cut building block units to be put together, but at the same time the nature of the concepts provided by lexical items may themselves not be clear-cut. However, rather than viewing the inclusion of context as a slippery slope, Jaszczolt's inclusion of sources external to syntactic output as compositional seems to have more explanatory power. The rejection of such a narrow approach to compositionality may be difficult to formalise but this itself feels a more natural improvement on complicated formal theories that try to fit the nebulousness of meaning into a predetermined formal language of deductive logic.

3 Compounds and Compositionality: An emperical enquiry

The aim of this enquiry was to obtain data via a questionnaire concerning people's concepts of compound nouns and the process through which they are arrived at. This data sought to help answer the question of the strength and nature of our compositional processes.

3.1 Questionnaire design

The questionnaire's structure was loosely based around the experiment in Johnson & Keil (2000: as described in Del Pinal (2016)), in which participants took part in a feature production task for complex concepts, followed by a reasoning task in which they explained how the emergent features produced in the previous task were obtained from the compound's compositional parts. Similarly, in this questionnaire participants were presented with a compound noun and were asked to both describe their concept of it and then explain how they knew this concept. The pilot version of this questionnaire asked participants to explain how they arrived at, rather than knew, the concept they described but this was deemed too leading towards a compositional explanation. Unlike Johnson and Keil, the explanatory section was open-ended rather than being restricted to the constituent words, allowing for explanations that were both compositional and non-compositional. There was a final optional section for each compound, left for additional comments. Two examples were provided to the participants, one which is shown in 1.

(1) Example 1. christmas tree

a. **Describe what your concept of this is**
A fir tree that can be real or fake. People have them in their homes around Christmans time and decorate them, often with lights and tinsel. Christmas presents are put under the tree.

b. **Explain how you know this**
I have had one at home every year and have seen many so I am familiar with what they are

c. **Any additional comments?**
–

One of the flaws Del Pinal identified with Johnson & Keil's experiment was the lack of a time limit to constrain answers to default concepts. My questionnaire gave participants up to two minutes to respond to each compound noun, ensuring immediate responses while allowing time for typing. My questionnaire consisted of 21 compounds, divided evenly into three categories. The first category was familiar compounds (+F). These had emergent features that were standardised but non-essential and were predicted not to be productively compositional. The second was unfamiliar compounds (-F) that participants may not have encountered before, predicted to elicit varying responses achieved through weak productive compositionality. The third was ambiguous compounds (A). These potentially had a

compositional interpretation as well as a holistic standardised interpretation with essential emergent features, and were predicted to favour the holistic interpretation. The full compound list is in Appendix A.

3.2 Participants and process

The questionnaire was created on Qualtrics and distributed online. A pilot questionnaire was distributed to 5 participants to test the time limit, clarity and possible bias of the instructions. The final questionnaire was distributed to 20 participants. Age and sex were not control factors. All participants had English as their first language, had received an English education, were not linguistics students, and were paid £5 for their participation.

3.3 Results

Tables 1-3 provide an overview of the results for the three compound categories. As can be seen, the majority of the responses aligned with the predictions for their respective category. Judgements of compositional retrieval were not limited to strict compositionality, and include cases where no concept was produced if compositional retrieval was attempted. Unclassifiable responses were those where the explanation was insufficient to determine whether compositional retrieval was used. These are descriptive, qualitative results based on my own judgement. All responses can be found at https://tinyurl.com/compoundcompositionality. The following outlines key patterns and points of interest.

Compound	Evidence of compositional retrieval	Evidence of non-compositional retrieval	Evidence of both types of retrieval	Unclassifiable
PET FISH	4	12	3	1
WOODEN SPOON	2	17	0	1
RUBBER DUCK	0	20	0	0
BABY BOTTLE	0	20	0	0
COFFEE TABLE	0	20	0	0
ICE CUBE	0	18	2	0
BIRTHDAY CAKE	0	20	0	0

Table 1 Questionnaire results for the category of compounds classified as +F.

Familiar compounds showed a strong preference for non-compositional retrieval. In terms of emergent features, those predicted were not as consistent as would have perhaps been expected. 70% of participants included a variation upon LIVES IN A TANK for the compound PET FISH. 15% of responses described WOODEN SPOON as being a large spoon or having a long handle and 80% included a variation upon

Compound	No. of different answers	No. of converging answers	Evidence of compositional retrieval	Unclassified
SOUP KNIFE	9	2, 3, 2, 4, 4, 2	15	3
BLUE GRAPEFRUIT	8	2, 11, 2, 2, 2	19	0
HOSPITAL BICYCLE	10	5, 3, 3, 6, 2	15	2
RAT LIZARD	6	8, 5, 6	16	4
HAMMER SANDWICH	12	2,3,7,3	14	2
TREE STATION	13	2, 3, 2, 3, 2	15	2
ROLLERCOASTER DINNER	11	2, 6, 4, 2, 2, 2	12	1

Table 2 Questionnaire results for the category of compounds classified as -F.

Compound	Evidence of compositional retrieval	Evidence of non-compositional retrieval	Evidence of both types retrieval	Unclassified
BIG CAT	2	8	10	0
BLUE CHEESE	0	20	0	0
BOX OFFICE	0	20	0	0
AIRPORT GATE	0	20	0	0
RED PANDA	7	9	3	1
HIGH CHAIR	0	20	0	0
FAST FOOD	0	20	0	0

Table 3 Questionnaire results for the category of compounds classified as A.

used to mix ingredients. 65% of responses for RUBBER DUCK included the emergent feature YELLOW while 95% included a variation upon being a toy or played with in the bath. 70% of responses for BABY BOTTLE included the bottle having a special lid, and one added that it could also describe a small bottle. 75% of responses for COFFEE TABLE included the emergent feature LOW HEIGHT. 75% of the responses for ICE CUBE described it as being used to chill drinks. 60% of responses for BIRTHDAY CAKE included candles.

The responses for the unfamiliar compounds were diverse both regarding the concepts and their compositional methods. The explanations usually expressed some level of confusion, or that the participant did not know and 'made up' the answer they gave. Table 4 contains some examples of responses where the participants explicitly mentioned never having encountered the term before or being unfamiliar with the concept as a factor in their unsureness.

	Explain how you know this concept
SOUP KNIFE	I have no idea, and I'm not sure my explanation of why is correct…I may have made that up
	Guess
RAT LIZARD	I've never heard the phrase before, so this seems like the most logical option based on what I know of animals
HAMMER SANDWICH	I have no idea, again, I have not heard of this noun
TREE STATION	I went on a high ropes course and there were 3 tree stations along the way to reach - sort of like checkpoints. I think there might be other meanings but this is the one I've heard of. **If I hadn't done a high ropes course I wouldn't have much of a concept of a tree station.**

Table 4 Responses in category -F demonstrating uncertainty in their concepts.

Even when appearing able to produce purely compositional responses such as TREE STATION being a station for trees, some participants clarified that they were unsure what that description entailed, as exemplified in Table 5.

	Describe your concept of this	Explain how you know this concept
TREE STATION	A station for trees? I want to say where trees stop (like trains) but that makes little sense!	I think from the above it is clear I don't know. Merely a rather eccentric guess!

Table 5 A response in category -F demonstrating uncertainty in the meaning of a given concept.

Similarly, several responses showed participants able to describe the compositional parts but unsure of the whole, as in Table 6.

	Describe your concept of this	Explain how you know this concept
SOUP KNIFE	i can't really imagine what this might be - it is a contradiction in terms!	soup is liquid and knives are for cutting things. You can't cut liquids so this makes no sense.
	A soup is a type of food. Its [sic] served hot and is a liquid. You can made [sic] it or buy ready made packs which you only have to heat up. A knife is a sharp kitchen utensil but probably has a different meaning here as knifes [sic] would be useless to use when eating soup	Soups are eaten regularly and I know what a knife is from parents telling me and cooking lessons at school

Continued on next page

	Describe your concept of this	Explain how you know this concept
HAMMER SANDWICH	A sandwich is a type of food usually made with two slices of bread and various fillings in between the slices of bread. Some sandwiches are toasted but most aren't. A hammer is a tool used to nail screws into wall.	My dad is a builder so he showed me what a hammer is. A sandwich is a popular food item which you can buy at most restaurants
TREE STATION	Trees are plants which vary in size. Some shed leaves and some don't. They can live for hundreds of years. Stations are places which often serve a role in connecting people to something so a train station helps connect people to other places whereas a drinks station helps people stay hydrated	Going for walks and learning about trees from parents as a child. Reading about trees in encylcopedi [sic]
	don't know might have a meaning but don't recall encountering it before. Styation [sic] is a stopping place of a from [sic] of transport trees don'tr [sic] move unkless [sic] cut down or dug up	I know trees and I have seen stations bus train and of the cross.

Table 6 Responses in category -F demonstrating cases where participants were able to form concepts for the compositional parts, but not for the whole complex concept.

Eleven respondents, spread between SOUP KNIFE (4), HOSPITAL BICYCLE (1), HAMMER SANDWICH (3) and TREE STATION (3), were unable to provide any description. Six respondents produced idiomatic descriptions, those of which were productive as opposed to established idioms I was unaware of when producing the questionnaire are shown in Table 7.

Several explanations operated through analogy with similar compounds, as in Table 8.

The non-compositional concepts in this category were cases where the participant was able to identify a familiar real-world entity to which the compound could be applied.

As a whole, the responses for the ambiguous compounds demonstrated the predicted preference for holistic interpretations, notable exceptions being BIG CAT and RED PANDA. While only 40% of the responses for BIG CAT were purely non-compositional, the predicted holistic preference was confirmed by only 10% of the responses being purely compositional. In the case of RED PANDA, 50% of the respondents lacked knowledge of red pandas and so treated it as an unfamiliar compound, these responses presented in Table 9. The final three responses in the table were judged as showing both types of retrieval. These demonstrated awareness of the red panda species but their concepts were clearly compositional, indicating a lack of encyclopaedic knowledge to inform their concept.

	Describe your concept of this	Explain how you know this concept
SOUP KNIFE	Someone who's a bit socially awkward and who doesn't make for the easiest friend. I guess they're called a soup knife because they're quite hard work, and having a knife to eat soup with is a bit tricky.	I have no idea, and I'm not sure my explanation of why is correct... I may have made that up.
BLUE GRAPEFRUIT	An idiom for odd one out	Grapefruits aren't usually blue so an idiomatic use like this seems the most likely
HAMMER SANDWICH	A food where two pieces of bread are placed around an implement used to knock nails into walls. **Possibly a metaphor for a punch.**	The thing contained within the sandwich precedes the word sandwich, hence this sandwich contains a hammer. As this would be unlikely i [sic] conflated it with the term knuckle sandwich, a metaphor for a punch/fight

Table 7 Idiomatic responses in category -F.

Across all three compound categories, some concept descriptions made no reference to one of their constituents. This was seen to the greatest extent for RUBBER DUCK as 45% of the responses described them as being made of plastic, three of which acknowledged this discrepancy, and 20% made no reference at all to the material the duck was made from. Table 10 contains the four other occurrences of this exclusion.

4 Discussion of Results

4.1 Compositional units

Before addressing what the results mean for compositionality, they must first be looked at in terms of the structure of the simple concepts being composed. The responses demonstrating productive compositionality support a pluralist approach to concepts. This can be seen clearly in the responses for TREE STATION since many participants defined both the compositional and complex concepts for the compound, as shown in Table 11.

The first and second responses described STATION as being where transport stops to exchange contents and as where people wait respectively, neither of which would suffice as a Classical concept. The participants' different concepts for STATION further support the view that concepts vary between people, but similarities between these concepts, shared extensions that the concepts have been abstracted away from and context allow communication to occur unimpeded. The participants' differing focuses on transport and people as the salient elements of STATION fed into their complex concepts, indicating that non-necessary features are part of the composing unit. The first participant described TREE STATION in terms of tree transportation,

	Describe your concept of this	Explain how you know this concept
SOUP KNIFE	a knife used for soup	a butter knife is a knife used for butter, a bread knife is a knife used for bread, so I would assume that a soup knife is a knife for soup
BLUE GRAPEFRUIT	a new kind of grapefruit with blue flesh	there are pink, red and yellow grapefruits so i guess one day somebody will breed blue ones.
HOSPITAL BICYCLE	A bicycle belonging to a hospital	I have heard similar terms like 'hospital bed' or 'hospital room' and know them to mean objects or places belonging or within a hospital.
RAT LIZARD	A strange and terrifying amalgamation of a rat and a lizard.	I have no concept of these two words as a phrase so have combined their two meanings, in the same way I have heard with phrases like 'ninja turtles'
	A type of lizard with rat characteristics, whether that be physically or characteristically.	I figured a 'brown lizard' would be a lizard that is like the first word (brown), so a rat lizard might be a lizard that's like a rat. A complete guess.
	a lizard that resembles a rat	an X Y animal is usually an animal of type Y that has the external features of animal X. alternatively it could be a rat that eats lizards (same as bird spider)
ROLLER-COASTER DINNER	A particularly eventful dinner, filled with emotional turbulence for all involved.	rollercoaster is often used to describe a 'rollercoaster of emotions'; a dinner with this amount of emotional excitement seems more likely than a dinner atop a literal rollercoaster
	The final meal of the day, filled with various different food items and experience in a very quick way.	The term rollercoaster x generally refers to something occurring very fast with a variety of different events as occurs on the fairground attraction it refers to. Hence a rollercoaster dinner, i suppose, would be this but for a dinner.
TREE STATION	a retreat in a woody area; a large house. usually in hot countries, designed and placed to keep out hot weather	I'm combining the term with the meaning behind 'hill station' since the only hill station i've seen was in a forest

Table 8 Responses in category -F where compositionality is achieved through analogy.

Describe your concept of this	Explain how you know this concept
A species of the panda mammal with a more red coloured fur as opposed to black and white. They are vaguely similar in size and appearance to a bear. They are more rare than black and white pandas. They eat bamboo shoots	I took the typical image of a panda which I know to be black and white and through knowing of other animal species which are red, I guessed this was the same idea.
A bear like animal with four legs which comes from China and probably eats bamboo, but instead of having black and white fur like a normal panda it would have red fur.	I know what a panda is, so assume a red panda is the same thing but red in colour. It could also be a communist panda!
An animal from China coloured red - bit like a black and white teddy bear	I have seen no RED panda, though I suppose it might exist. May require spray paint though
A type of animal which is furry and medium sized with red fur and white fur on its face. Like a normal panda but a different species.	I know what a black and white panda looks like, so imagining one which is a different colour
A panda that is red.	I combined red and panda. I assumed the red is an adjective describing the panda.
A panda is never red. If it were painted or dressed in red that it might be described as a red panda.	I know what a panda looks like, usually being black and white, and I know what colour red is. Some species can be described as red, such as foxes or squirrels, but I have never heard of a red panda
It is a rare species of panda, in a normal panda they have black and white fur but in a red panda they have red & white fur.	I have learnt about them in school.
A particular type of (rare?) panda which is red in colour	I've never seen a panda of the colour before, but don't consider it impossible that there could be a species of this colour and it doesn't seem like a likely idiom
A species of panda. Mammal that may be wild or captive. Rust red in colour and looks like a type of bear.	Educated about them. I am sure I was taught about them in a middle school lesson, many moons ago!
I /believe/ that's a specific breed of panda which is very rare these days as its facing extinction, so called because of their reddy-brown fur (in places).	I think I've heard the term to describe this animal once or twice

Table 9 A selection of compositional responses for the compound RED PANDA.

while the second described it in terms of a place for waiting in trees. These responses favour Prototype Theory, where the simple concepts described appear to be

	Describe your concept of this	Explain how you know this concept
WOODEN SPOON (+F)	A terribly useful kitchen implement. Used to stir - most usually - food substances.	I have just used one…about 30 minutes ago! Used from a young age.
BLUE CHEESE (A)	Blue cheese is a type of cheese and it's smelly.	I have eaten blue cheese before
HOSPITAL BICYCLE (-F)	A stretched [sic] that is used in a hospital to carry disabled people.	Honestly, I have never heard of this. I assume there are not bicycles in a hospital, therefore, the closest thing I can think of is a stretcher.
RED PANDA (A)	it is a breed of bear, small and nimble like a fox	I have read about them on many an occasion

Table 10 Responses where the description of the compound concept makes no reference to one of its constituents.

Describe your concept of TREE STATION	Explain how you know this concept
A tree is a large plant that takes many years to grow and a station is a place where moving modes of transport stop to collect cargo or people, a tree station might be a place to unload or load up the transportation of trees	I do not know this but am guessing based on my knowledge of the individual nouns
Similar to a treehouse, these are found in trees and can be climbed up to to stay in especially in high trees	Unsure however I combined my knowledge of what a tree is to the **concept of a station, generally an area where people stop and wait**
probably a tree where something happens or is relevant as part of an outdoor game - e.g. the winner is the one who reaches the tree station first.	**station means a place or stop of significance. Tree is tree.**
Unsure, but assume it's somewhere where people can buy trees, especially at Christmas	I've never heard the phrase before, but can't imagine why station would be used with tree for any other reason than a place where trees are sold and **Christmas trees are the most commonly type sold**

Table 11 A selection of compositional responses for the compound TREE STATION.

abstracted from the salient and diagnostic typical properties of a station. The third participant's description encompasses these previous two, describing STATION as "a place or stop of significance" and suggesting differing degrees of specification making up individuals' prototypes. What is of possibly greater significance is TREE being described as "tree is tree". This shows a more atomic approach, and follows

the intuition that while we can describe a tree in terms of elements such as branches and leaves, our concept is not understood in relation to them.

The fourth participant diverts from prototype use, modifying first their concept of STATION to be compatible with TREE, then modifying their concept of TREE to befit this concept of STATION. This process is similar to that of Head Primacy Principle (HPP), as proposed in Kamp & Partee (1995). The principle argues that in structures consisting of a modifier (TREE) and a head (STATION), the head is interpreted in the context surrounding the whole compound, after which the modifier is "recalibrated" relative to the local context of the head, within the compound. In the case of this response, the modifier was interpreted relative to the local context, potentially the result of this being the only available linguistic context, but nonetheless reflected the proposal that the head is interpreted first and the modifier interpreted relative to this head. This can tie in with the atomic approach to TREE by viewing concepts as atomic meaning, but from which prototypes, along with less typical subcategories, can be identified and used for composition. In a similar case of atypical concept use, the HAMMER SANDWICH response in Table 12 shows familiarity with the non-prototypical modifier use of 'sandwich' to mark the head as the outer component of the sandwich.

	Describe your concept of this	**Explain how you know this concept**
HAMMER SANDWICH	a finger or similar that gets crushed between a hammer and a hard surface when you are trying to hammer a nail.	It's a sort of joke play on sandwich. The use of "sandwich" in this way is quite common.

Table 12 A responses for the compound HAMMER SANDWICH demonstrating familiarity with a non-prototypical modifier use of 'sandwich.'

This appears to support a pluralist approach to concepts. However, there are several caveats. Firstly, it is unclear at this juncture whether recalibrated composing units are modulated* prototypes (Del Pinal 2016), or distinct subcategories. Additionally, while these responses give the impression of concept recalibration taking place before composition, these responses are from a task which involves participants breaking down a complex concept to explain how they produced it, and as holistic post-lexical modulation would retrospectively appear to change the features contributed by each constituent, the level at which the modulation takes place may be lost.

4.2 The holistic approach to familiar compounds

As predicted, the responses from the familiar compounds confirm that rather than compositionality always being productive as proposed in approaches such as Del Pinal (2016) (see section 2.2.1), familiar and frequently encountered compounds become lexicalised to a degree, standardising certain emergent features. Most familiar complex concepts were described relative to experience rather than constructed from constituent parts, the compound simply being "terminology" in the same

way people would explain their understanding of a single word. This matches the Retrieval stage of the RCA (see section 2.2.2), where complex concepts and their non-compositional emergent features can be stored in the lexicon. The examples in Table 10 (page 98) (excluding -F HOSPITAL BICYCLE) reflect this through the absence of one of the compound constituents in each description. The presence of WOODEN SPOON among these examples questions Prinz's (2012) claim that this concept is retrieved as a result of cross-listed exemplars rather than as a stored lexical whole. Not all responses contained non-compositional emergent features, this in turn corroborating the earlier discussion of interpersonal variation concerning salient features, and the three participants who included being a prize for coming in last place in their concepts for WOODEN SPOON are clear examples of how exposure to different input can shape our concepts differently.

I believe the results indicate a gradient between fully lexicalised and fully compositional concepts within +F compounds, potentially connected to the gradient strength of cross-listed exemplars. Familiar compounds can lose their standardised emergent features and retain the same extension. These concepts have become standardised but they can still be interpreted compositionally, explicitly seen in a response for ICE CUBE which gave both a holistic and compositional explanation for a single concept. Presumably the boundary between complex and simple concepts is when there is sufficient semantic shift of the compound as a whole to lose its semantic transparency, but surely the compound must already be interpreted holistically for this shift to occur. A gradient would allow holistic meaning reinforced by compositional meaning and vice versa.

4.3 The formation of unfamiliar complex concepts

Unlike the familiar concepts, the unfamiliar concepts could not be retrieved holistically, but rather had to be composed. As predicted, the responses for each compound varied greatly between participants, and the explanations revealed that this was not purely the result of variations between the composed concepts, but also the mechanisms of combination and compositional concept selection.

4.3.1 Variation in responses

The variation in responses could indicate a lack of a universal mapping system. One place where this surfaces is the compositional responses to RED PANDA. The mapping of RED to PANDA is particularly interesting because pandas' colouring is a highly diagnostic feature. Responses (seen in Table 9 (page 97)) vary between: red with no mention of black and white; red instead of black and white; red and white instead of black and white; simultaneously described as red, and black and white; and black and white but painted or clothed in red. This appears to be an intersection of participants giving different values of importance to a panda's black and white colouring (a prototypical feature in the narrow sense with red being exceptional (Schurz 2012), or a necessary feature (Hampton 1987)), and different colour distribution during composition. Responses for SOUP KNIFE varied between

limiting the scope of KNIFE to cutting the soup, which lead to the assumption of chunks in the soup or comments about how a spoon would be adequate, and expanding the scope of the knife's function over the ingredients for the soup or butter on bread eaten with the soup. These follow individuals' differing methods of accommodating for conflict between concepts, and the problem is that it is impossible to know exactly whether this is the result of differences in underlying reasoning or speakers' experiences shaping the concept. No composition exists in isolation.

Wisniewski & Wu (2012) discuss types of interpretation, where relation interpretations are the most likely, property interpretations less so and hybrid interpretations least likely. All three can be seen in the responses for RAT LIZARD, property being the most common and followed by hybrid, which raises the question of how an interpretation of the constituents' relationship is selected. While some responses explain this as sources in the participant's life guiding their interpretation, others vary between a type of rat, a type of lizard, and a hybrid simply as the output of strict compositionality. My issue with Wisniewski & Wu's similarity-based mapping interpretation of ROLLERCOASTER DINNER (see section 2.2.5) is reflected in the results, where only two responses refer to varying food quality. The predominant responses were either dinner eaten on a rollercoaster, or the metaphorical interpretation of a dinner with emotional ups and downs. Those with the 'dinner eaten on a rollercoaster' interpretation made no reference to prior experience, presumably making this more strictly compositional, but this was significantly less popular a response than the metaphorical one, one participant saying that the literal interpretation was impossible because "dinners are sedate sit down affairs." For the emotional interpretations, Wisniewski & Wu's similarity-based mapping and Lakoff & Johnson's (1980) cognitive metaphor, which similarly maps from one concept to another, would both require an emotional aspect to the concept of DINNER that ROLLERCOASTER can map onto. Instead, several participants' responses indicate familiarity with the expressions 'rollercoaster of emotions' as the force behind their concept. This emergent feature is less the result of compositional metaphor, and moreso analogy with a familiar expression containing 'rollercoaster'. The variation in interpretation is further seen in two responses describing it as post-rollercoaster vomit, and one as a dinner that made you feel sick, both different applications of the effect that going on a rollercoaster can have. Presumably, productive compositionally during language use comes with sufficient situational and linguistic context for this variation not to prevent communication.

Variation could also, however, indicate that compositionality is not the only process involved in the production of unfamiliar complex concepts; or rather that the features of the compound are drawn from the world experienced by the participant as opposed to from the combination of concepts. In Recanati's (2004) terms (see section 2.3), the formation of complex concepts is a bottom-up and top-down process. Table 13 presents examples of participants' experiences providing the compound concept, and this idea that the participants prioritise the world in filling out their concepts is seen again in Table 14.

	Describe your concept of this	Explain how you know this concept
TREE STATION	A checkpoint/area up in the trees on a high ropes course where you can stand on solid ground for a brief period of time.	I went on a high ropes course and there were 3 tree stations along the way to reach - sort of like checkpoints. I think there might be other meanings but this is the one I've heard of. If I hadn't done a high ropes course I wouldn't have much of a concept of a tree station.
HOSPITAL BICYCLE	A bicycle use to serve the needs of a hospital.	I have seen people on bikes who are paramedics.

Table 13 Two responses in category -F demonstrating the participants' experiences informing their complex concept formation.

	Describe your concept of this	Explain how you know this concept
RAT LIZARD	A type of animal characterised as a reptile , likely with cold blood, tail, scales and carnivorous appetite, which either resembles or feeds upon rodents.	The common name given to different animals is often based on first impressions of the scientist, i know this from my course and from reading. **If a new lizard was discovered and found to have rodent like qualities or eat them, it would be logical to name it as such**
BLUE GRAPEFRUIT	A grapefruit is a type of fruit which is you can buy in supermarkets. It's a citrus fruit. Blue is a colour and so **a blue grapefruit would be a grapefruit which most people would describe as being blue**. It round [sic]	My granddad eats grapefruit for breakfast eat morning so I know what the fruit is and I know the colour from being told by teachers and parents as a child

Table 14 Responses in category -F that characterise the concept in terms of applicability to a potential real-world counterpart.

What connects these two responses for RAT LIZARD and BLUE GRAPEFRUIT is the grounding of the concept in a potential real-world entity to which the compound could be applied. Referring back to section 4.1, the compositional units could be seen as atoms rather than a prototype or subcategory, where the equivalent of features is provided by a top-down process, leaving the complex concept to be shaped by situational context. This is reinforced by holistic explanations for familiar compounds, exemplified clearly in Table 15. The emergent feature of the pacifier-like lid is drawn from recognition of a real-world entity to which the compound can be applied. We can have a concept of a vague relationship between two simple

constituents that is sufficient to recognise an instantiation of that relationship, but this vague complex concept does not develop until it is grounded in the real world.

	Describe your concept of this	Explain how you know this concept
BABY BOTTLE	A plastic bottle which has a top resembling a pacifier. Typically holds milk for babies to consume as they are too small to drink out of glasses, regular bottles etc.	**I have seen many parents using special bottles to feed their babies. I think they are usually called milk bottles though. They may be the same thing.**

Table 15 A responses for the compound BABY BOTTLE demonstrating a concept being shaped by an applicable extension.

Further variation comes from some participants characterising their complex concepts through analogy with similar compounds, exemplified in Table 8 (page 96). The first form this takes corresponds with Wisniewski & Wu's discussion about the use of analogy to establish the relationship between constituents in productive compositionality. In the HOSPITAL BICYCLE response, the participant identifies a relationship between HOSPITAL and the head it modifies, and transfers BICYCLE into this relationship as something that belongs to or is found within a hospital. The second form of analogy is seen in the first ROLLERCOASTER DINNER response, as well as my default concept as discussed in section 2.2.5, and is relevant to the idea of a gradient between compositional and holistic concepts. 'Emotional rollercoaster' is an established idiom, and rather than identifying the up-and-down relationship provided by ROLLERCOASTER in the formation of the idiom, the complex concept is transferred as a whole, indicating that while it can be decomposed, it simultaneously exists as a whole.

4.3.2 Failure and uncertainty in complex concept formation

Some participants were able to demonstrate understanding of the two compositional concepts in question, but fell short at a default complex concept, presumably unable to resolve conflicting concepts as proposed in Prinz (2012) and Hampton & Jönsson (2012). This uncertainty implies that concept modulation takes place post-lexically, as if it were to take place at a lexical level as put forward by Del Pinal (2016), then we would not expect to see cases where the participant can understand the parts but struggles to understand the whole. This supports the discussion in section 4.1, outlining how despite initial indication of concept recalibration at a lexical level, this may be purely retrospective.

This inability to always form a complex concept suggests different levels of compositionality: the recognition of a link between the concepts of words appearing together, and a deeper compositionality that allows someone to form a complex concept, akin to the compositionality of Recanati (2004) and Jaszczolt (2010) in section 2.3. Taking a description of SOUP KNIFE where this occurs, the participant's response demonstrated they were aware that it referred to something involving a

relationship between the distinct concepts of SOUP and KNIFE, but lack of real-world experience prevented this relationship from being shaped and the compound being understood as a complex concept. This seems to be compositionality in a truly null context, with no access to relevant information sources such as world knowledge or useful analogy to form a complex concept.

While the rest of the respondents were able to describe their concepts of the given compounds, many responses were notably uncertain in their concepts and explanations, as seen in Table 4 (page 93). Rather than being default concepts resulting from subconscious compositional processes, the complex concepts given are similar to guesses about what could be described by the compound. This is not limited to emergent features arising from reasoning, or even noun-noun compounds which are likely to have more complex composition processes, as demonstrated in Table 16.

	Describe your concept of this	**Explain how you know this concept**
BLUE GRAPEFRUIT	a blue circular citrus fruit	I don't know, however I can recognise the object that one imagines when they imagine a grapefruit and I understand the colour blue so I can only a assume that the two combined leads to a blue fruit.
	A citrus fruit which is blue in colour?	I don't really know but I know what a grapefruit is so imagining this as blue

Table 16 Two responses demonstrating uncertainty in the formation of adjective-noun compound BLUE GRAPEFRUIT.

Theories such as the Selective Modification Model (Smith et al. 1988) would not predict difficulties forming a complex concept for BLUE GRAPEFRUIT and yet the participants clearly expressed uncertainty. This could be for multiple reasons. The first is that this is a similar case to that in the multiple modifier experiment carried out by Connolly, Fodor, Gleitman & Gleitman (2007), where adding an adjective not typically associated with the noun leads to doubts concerning the features of the noun itself. In terms of Schurz (2012), the participants lack the world knowledge needed to know whether the exceptional adjective BLUE would shift any attributes other than colour. Secondly, this could be a consequence of trying and failing to identify previously encountered entities that could be recipients of this compound, meaning the participant had to invent the type of entity the compound could describe. These appear to be potential concepts that, judging from the aforementioned reliance on experience, require more support from the world to guide compositionality. The question is whether we should distinguish between descriptions of concepts consciously created to accommodate the compound, and concepts which are default, shaped by external influence. The linguistic and discourse context of language use cannot be compared with the isolated context of a questionnaire, and likely contributes to how a listener shapes complex concepts using relevant linguistic

content, physical entities and concepts in the discourse. An unsure response given in this questionnaire does not entail difficulties forming a concept in an informative context.

4.3.3 Compounds and metaphor

Table 7 (page 95) contains three responses where the whole unfamiliar concept was interpreted metaphorically: an idiomatic interpretation preferred over a literal compositional one. The concept of HAMMER SANDWICH was reached through analogy with a standardised metaphor 'knuckle sandwich', the concept of BLUE GRAPEFRUIT was a potential idiomatic interpretation, and the concept of SOUP KNIFE was a standardised but uncommon slang term that the participant did not seem consciously aware of and explained in terms of productive metaphor. What is particularly interesting for BLUE GRAPEFRUIT is the participant's assumption of such an idiom. Perhaps this calls for a Gricean explanation, where the participant was unable to conceive of a situation where the compound 'blue grapefruit' would be literally relevant, and favoured an idiomatic interpretation.

The preference for holistic interpretations over compositional ones, even when the holistic interpretation is more semantically opaque, is reflected in the results for the ambiguous compounds. As predicted and shown in Table 3 (page 92), holistic responses greatly outnumbered compositional ones. The number of compositional readings of BIG CAT as opposed to BLUE CHEESE could be connected to the greater likelihood of its use and extensional existence; or could be interpreted in terms of Schurz (2012), treating BIG as a non-exceptional modifier and so facilitating a compositional interpretation.

4.3.4 Complex concept formation in an individual participant

All preceding analysis has compared individuals' answers, showing how they have differed in their concepts and compositional methods, and the lack of compositional consistency in an isolated context. However, it is also useful to look for consistency within a single randomly selected participant P, whose responses are in Table 17.

	Describe your concept of this	**Explain how you know this concept**
PET FISH	a fish that is kept in a domestic situation for the comfort amusement and diversion of the keeper who keeps it in a container	I have seen examples in life and in illustrations. I understand the concept of pet and of fish
WOODEN SPOON	spoon that is made of wood. Spoon	I know what a spoon is and what wood is what am I supposed to say?
YELLOW DUCK	Artificial duck used as a toy	a tyerm [sic] used but thay [sic] are usually plasytic [sic] now from what I've seen so a dated term from pre plastics age

Continued on next page

	Describe your concept of this	Explain how you know this concept
BABY BOTTLE	a bottle used to put drink in to feed a baby. Usu [sic] has a teat or spout. Can be used to describe size of bottle.	terminology when people refer to the object.
COFFEE TABLE	low table that is placed convbeniently [sic] to rest drinks and triple noun coffee table books	Terminology in general use
ICE CUBE	Frozen water in a specific shape, not just fragments. water frozen in a mould	seen one and terminology in general use. If you shop you see offers of ice cube tray to make ice cubes.
BIRTHDAY CAKE	flour confectionery, sponge in texture may be iced, traditionally round but may take all sorts of flour confectionery forms may be iced	I'm 54
SOUP KNIFE	something that doesn't make sense.	soup is a liquid cutting it does not make it easier to consume
BLUE GRAPEFRUIT	A GRAPEFRUIT THAT IS [sic] coloured blue but does not exist oin [sic] real life	I only see grapefruit that are coloured in yellow orange red green
HOSPITAL BICYCLE	Nonsense	2 nouns just stuck together. not hgeard [sic] term so don't know what it represents — Might indicate location but that makes no sense
RAT LIZARD	Might be a lizard that has some characteristics of a rat but not heard of it.	Noit [sic] heard of one First word usu [sic] describes a function of second word
HAMMER SANDWICH	Nonsense	random association of 2 nouns so it seems
TREE STATION	don't know might have a meaning but don't recall encountering it before. Styation [sic] is a stopping place of a from of transport trees don'tr [sic] move unkless [sic] cut down or dug up	I know trees and I have seen stations bus train and of the cross.
ROLLER-COASTER DINNER	nonsense phrase unless it is what you throw up after being on a rollercoaster. Not heatrd [sic] phrase before	not heard phrase BEFORE
BIG CAT	it is a description of felines that are larger than domestic cats and are predators such as lion leopard etc. It can also mean a domestic cat that is larger than your typical domestic cat.	I have heard the term being used by naturalists and wildlife tv presenters etc. I know that big desc [sic]

Continued on next page

	Describe your concept of this	Explain how you know this concept
BLUE CHEESE	Cheese that I enjoy eating. Cheese inoculated with mould as part of the maturation process and hAS A DISTINCTR [sic] Taste. Many versions	I eat it
BOX OFFICE	A term used to describe the place metaphorical or actual where ticket sales take place. Or used in that manner	a description uised [sic] in normal speech
AIRPORT GATE	Place where passengers show ticket in order to board plane flying from the airport. Has a unique number for that airport	Have travelled and terminology used as part of that process. Big boards say go to gate 13 or something
RED PANDA	A species of panda different from the giant panda. It has a latin name and a habitat. Reddish brown fur and white.	Seen one in a zoo many years ago and the label described it so
HIGH CHAIR	chair suitable for infant but seat is raised so the adults carers don't have to bend down all the time whaen [sic] feeding infant. Generally has a tray on the front for the 'table' and retraints [sic] to keetp [sic] the chilf [sic] from falling out	life experience. I'm a parent but knew from general tterminologyu [sic]
FAST FOOD	unhealthy easy to eat high fat saturates salt and or sugar calories that people find convenient to eat. Can be healthy but harder to find and usually more expensive	Term in general use. probably oreiginated [sic] in USA when such food became available

Table 17 Responses for the single participant P.

While a few of the complex concepts for the familiar and ambiguous compounds were explained in terms of compositional parts, this was the sole explanation for WOODEN SPOON only, while the rest were also explained in terms of experience and familiarity with the whole "terminology." PET FISH had both explanations and was the only familiar concept attributed this dual explanation. This could be indicative of the gradient lexicalisation discussed in section 4.2. Alternatively, as this was the first question of the questionnaire, P may have decided that an accompanying compositional explanation was unnecessary for familiar compounds after having responded to some of the unfamiliar ones. If the concept given for WOODEN SPOON were strictly compositional, without drawing from experience, we might expect the same for the unfamiliar compounds. However, three unfamiliar compounds produced no complex concept and the four that did all made reference to uncertainty resulting from not having encountered the compound before or the nonexistence of a literal extension. ROLLERCOASTER DINNER is metonymic, RAT LIZARD uses feature

transfer, and BLUE GRAPEFRUIT is analogised from experience with different-coloured grapefruit. Even within one speaker, the method of compositionality varies.

5 General Discussion and Conclusions

5.1 Theoretical conclusions

In terms of where this leaves a general theory of compositionality, the empirical enquiry directs us to a view of compositionality active at a higher, conceptual level, where syntactic output is one of multiple inputs in the formation of a default complex concept. Context, experience, familiarity and general knowledge all play inextricable roles in the formation of complex concepts, and shape the way in which the constituent concepts are understood to relate and compose. Complex concepts build up from the world where possible, reflecting the imputed nature of simple concepts. This outcome fits into Jaszczolt's (2010) Default Semantics, where pragmatic compositionality is wholly semantic and the theory does not overestimate our ability to form novel complex concepts in an absence to informative context. This is not to say that the more syntactically compositional theories hold no weight. Hampton & Jönsson's (2012) inclusion of general knowledge, Wisniewski & Wu's (2012) similarity-based mapping and Schurz's (2012) compositional preference for non-exceptional modifiers are all reflected at points within the data, but are all subsumed into a compositional theory which operates at a higher level and is not at odds with the high levels of variation within the production of productively compositional compounds.

Regarding the relationship between compositionality and the lexicon, there is support for Prinz's (2012) RCA, allowing for a gradient, or at least intermediate stage of co-occurrence, between familiar complex concepts which are stored in the lexicon and those which are composed. A preference for holistic, non-compositional interpretations is seen particularly in the familiar and ambiguous categories, and it is reflected in the context-sensitivity of compositionality, where real-world wholes are favoured for unfamiliar compounds to map onto. There is a suggestion that with frequency of use, complex concepts which were originally compositional gain co-occurring imputed holistic interpretations which are formed even when the concept can be decomposed. Our ability to decompose wholes allows for productive analogy while our holistic interpretations of decomposable concepts allows for semantic shift of the whole. Looking towards the nature of the compositional parts, this is obscured somewhat by the post-lexical nature of concept modulation but like complex concepts there appears to be a pluralist part/whole duality, with cases of featureless meaning, and cases where the concepts provide features. The evolutionary significance of prototypes as described in Schurz (2012) reinforces a view of concepts as having prototypes, but these are not necessarily used in composition or, following Kamp & Partee (1995) consistent across concepts.

5.2 Expansion and further research

This leaves open many areas for potential further investigation. Firstly, as noted in section 4.3.2, many participants were uncertain in their concept formation. It could be of interest to carry out further systematic studies into the degrees to which this uncertainty exists, its causes, and how it corresponds with compound categories and characteristics. Participants could, for example, be required to rate compounds on a scale of difficulty. Additionally, one of the greatest limitations of this empirical investigation was its lack of opportunity to assess concept formation in different situational and linguistic contexts. Ensuring consistency in contexts between participants would allow for greater attention to be paid to the degree of individuality in differences of concept formation, perhaps linked to individual cognition. In establishing the degree of the roles played by the informational sources in compositionality, this may then help formalise Default Semantics in a way that gives it greater predictive power.

These results could also be expanded by closer investigation into the intermediate stage between a productively compositional complex concept and a lexicalised simple concept through a study of diachronic semantic change. Branching into areas of linguistics beyond semantics, the whole/part duality of both simple and complex concepts is reminiscent of the whole/part debate between compositional and paradigmatic approaches to morphology, particularly derivational morphology. The holistic semantic change of originally compositional compounds reflects the holistic semantic change of originally morphologically complex words, and the decomposition of wholes seen at the level of complex concepts reflects cases of aggressive decomposition such as libfixes at a morphological level. These parallels could provide a starting point for an investigation into a potentially dual approach to morphology, and subsequently an attempt to unify different linguistic modules in a theory of language that builds up from semantics.

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Appendix A

The full list of compounds and their associated category, in the order in which they were presented in the questionnaire:

PET FISH	(+F)
BIG CAT	(A)
SOUP KNIFE	(-F)
BLUE GRAPEFRUIT	(-F)
WOODEN SPOON	(+F)
BLUE CHEESE	(A)
HOSPITAL BICYCLE	(-F)
RAT LIZARD	(-F)
BOX OFFICE	(A)
RUBBER DUCK	(+F)
AIRPORT GATE	(A)
BABY BOTTLE	(+F)
HAMMER SANDWICH	(-F)
COFFEE TABLE	(+F)
ICE CUBE	(+F)
RED PANDA	(A)
BIRTHDAY CAKE	(+F)
TREE STATION	(-F)
HIGH CHAIR	(A)
ROLLERCOASTER DINNER	(-F)
FAST FOOD	(A)