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Adam Cameron Coppala April 12, 2016

Making heads or tails of idiom processing: Semantic transparency, syntactic flexibility, and the lexical representation of idioms

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Abstract

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Idioms are conventionalized, non-compositional phrases with idiomatic meanings different from their literal meanings. Idioms differ in both their degree of semantic transparency and syntactic flexibility, two properties which have previously been assumed to affect the lexical status of idioms in the mind. This thesis examines how these two properties influence idiom processing and draws conclusions about the status of idioms in the lexicon based on these findings. Through a replication of a survey by Gibbs & Nayak (1989) while controlling for methodological concerns in the original study, support was found for the Idiom Decomposition Hypothesis, which states that speakers have shared intuitions about idioms' semantic transparency, and that more transparent idioms tend to be more syntactically flexible. Next, processing was examined via lexical decision task, a paradigm that had not yet been applied to idiom comprehension. Results showed that in general, when an idiom is encountered, the literal meaning of each individual word is accessed, and then the figurative meaning is accessed shortly after this compositional meaning is computed. Further, these results did not seem to differ systematically when comparing transparent, opaque, flexible, or inflexible idioms, suggesting that these properties have minimal influence on processing method. Implications for the lexical status of idioms in the mind are discussed. Finally, idiom frequency is examined as a potential variable of interest, and directions for future study are suggested.

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Making Heads or Tails of Idiom Processing: Semantic Transparency, Syntactic Flexibility, and the Lexical Representation of Idioms

Traditionally, meaning is thought to be communicated through language via small units of meaning (morphemes) that combine to form the speaker's overall meaning—that is, a sentence consists of words, which consist of morphemes, and the meanings of these morphemes are combined to produce the overall meaning of the sentence. However, this traditional view of language processing falls short of explaining how we understand the meanings of non-literal utterances, including idioms. For our purposes, an idiom can be defined as a standardized phrase—i.e., one which is conventionalized in the language and is not generated spontaneously by different speakers—that has a compositional meaning different from its actual meaning. For example, in the idiom *kick the bucket*, the individual meanings of *kick, the,* and *bucket* cannot combine to form the idiom's actual meaning 'to die'. How is it, then, that we are able to easily process and understand idioms in everyday conversation? To date, this is a question that has received surprisingly little attention, and the studies that have attempted to demystify idiom processing have reached conflicting conclusions. One of the primary complicating factors in this area is that idioms vary widely in terms of different properties, two of the most prominent being semantic transparency and syntactic flexibility.

Idioms differ in their degree of semantic transparency, or the level of correspondence between an idiom's actual meaning and the meanings of its component words:

1. Hit the road
2. Shoot the breeze

In (1), the idiomatic meaning ('to set out on a trip, usually by car') connects very closely to the individual meanings of *hit* and *road*. This can be contrasted with an idiom like (2) in which the

meanings of *shoot* and *breeze* have no discernable relationship to the idiom's meaning ('to chat'). This relationship between an idiom's figurative meaning and the meanings of its component words can be referred to as an idiom's semantic transparency; whereas (1) would be said to be relatively semantically transparent, (2) would be considered semantically opaque. It is also important to recognize that semantic transparency occurs across a continuous spectrum rather than as these two discrete categories, meaning that many idioms fall somewhere between these two extremes.

In addition to variations in basic syntactic structure, idioms can also differ in syntactic flexibility, or the degree to which they can be syntactically manipulated while still retaining their grammaticality and idiomatic meaning. For example, some idioms can be passivized, whereas others cannot:

3. Clear the air:
    a. Mary cleared the air at dinner.
    b. The air was cleared at dinner.
    c. The air was cleared by Mary at dinner.
4. Kick the bucket:
    a. John kicked the bucket yesterday.
    b. *The bucket was kicked yesterday.
    c. *The bucket was kicked by John yesterday.

In (3), the idiom *clear the air* can be passivized while still remaining grammatical and retaining its idiomatic meaning, both with and without the agent of the action omitted. Example (4), on the other hand, completely loses its idiomatic meaning when passivized. As we will see, passivization is certainly only one of many ways to assess an idiom's syntactic flexibility. In this

thesis, I will use the term *syntactic flexibility* to refer to an idiom's overall ability to be syntactically manipulated.

Together, these two variable properties make our question of how idioms are processed much more difficult to answer. At first, it might seem tempting to simply claim that we process idioms multimorphemically, meaning that we process each idiom word-by-word. This explanation seems valid when applied to semantically transparent idioms, such as *hit the road*—it is easy to imagine that we first process *hit*, *the*, and *road* separately, then combine their individual meanings to produce the overall meaning of the idiom. But how would this explanation account for semantically opaque idioms, such as *kick the bucket*? It seems impossible to argue that we somehow combine the isolated meanings of *kick*, *the*, and *bucket* to obtain the overall meaning 'to die.' Taking this into account, an alternative hypothesis might state that we process idioms monomorphemically—that is, we process each whole idiom as a single unit, as if the entire idiom were stored in our lexicon as one word. Under this hypothesis, the individual meanings of the idiom's component words would never even be accessed. But how might a model like this account for the syntactic flexibility some idioms display, and how would we then explain why some idioms are syntactically rigid, while others are highly flexible?

To be clear, I am not the first person to take notice of these properties and consider their influence on how we represent idioms in the mind. In one particularly influential study on this relationship between semantic transparency and syntactic flexibility, Gibbs & Nayak (1989) proposed a hypothesis regarding the nature of the relationship between these properties, coined the Idiom Decomposition Hypothesis.

5. The Idiom Decomposition Hypothesis states:

   (a) Speakers have shared intuitions about the decomposability (semantic transparency) of idioms.

   (b) Idioms that are more decomposable tend to be more syntactically flexible, and idioms that are less decomposable tend to be less syntactically flexible.

If the Idiom Decomposition Hypothesis is assumed to be true, it follows that there is likely an underlying explanation that could explain this relationship between transparency and flexibility. A possible explanation that others have proposed is that this relationship is created by the status of different idioms in the lexicon. More specifically, idioms that are opaque will be lexicalized (stored and accessed in the lexicon as a single entry), causing these idioms to be more syntactically fixed rather than flexible. On the other hand, transparent idioms would not be lexicalized, allowing them to have more flexible internal syntax.

Clearly, this question of how we understand idioms is much more complex than it may initially seem, and we must consider variations in semantic transparency and syntactic flexibility when attempting to answer it. In this thesis, I will first investigate the nature of the relationship between transparency and flexibility for a list of English idioms, half of which have never been tested in previous studies on the topic, in order to discover whether there is evidence to support the claims of the Idiom Decomposition Hypothesis. I will then apply my findings from this first section to investigate how idiom processing varies according to the idiom's transparency and flexibility using a lexical decision task experiment—a novel paradigm that has not yet been used to investigate this specific relationship. Finally, I will introduce a previously uninvestigated variable, idiom frequency, as a potential complicating factor in investigating this relationship.

Previous Studies

Before diving into these questions, it will be beneficial to understand some of the foundational literature concerning idiom syntax, semantics, and mental representation. Chomsky (1981) devised an early, basic theory regarding how idioms might be represented and stored in the mind, claiming that VP-based idioms are simply lexicalized verbs. Under his analysis, all idioms of this type are stored as individual entries in the lexicon with information attached to each specifying that it functions as a verb syntactically, exactly the same way that a verb like *run* or *write* would be stored in the lexicon. Similarly, Swinney (1979) applies the Lexical Representation Hypothesis of lexical access to idioms, analyzing learned idiomatic phrases as being stored as independent lexical entries. As a result of each idiom being stored as a single lexical entry, this hypothesis also dictates that upon encountering an idiom, its figurative meaning is retrieved before its literal meaning is computed (Bobrow & Bell, 1973). A third model, the Direct Access Hypothesis, makes essentially a stronger version of the same claim as the Lexical Representation Hypothesis: idioms are stored as single lexical items, and when an idiom is encountered, its figurative meaning is accessed. Under this model, however, a literal meaning is never computed for cases in which the idiom is highly familiar and/or there is no contextual evidence supporting a non-figurative interpretation (Gibbs, 1980).

The underlying commonality between these three models is the claim that any VP-based idiom is stored in the lexicon as a single entry, and this entry looks no different from any monomorphemic verb. At first, this may seem like a tempting explanation, particularly for semantically opaque idioms like *kick the bucket* for which it seems impossible to derive the figurative meaning from its compositional parts. However, these theories all fail to account for

the syntactic variability exhibited by many VP idioms, as demonstrated with passivization in (3) and (4), as well as in the following examples of other syntactic manipulations:

6. (a) I couldn't believe Mary **let that nasty little cat out of the bag**. (adjective insertion)

   (b) He chose not to fill out college applications this year, **missing the boat entirely.** (present participle transformation)

   (c) **John's spilling the beans** a couple days before the surprise party really made me upset. (action nominalization)

We would not expect idioms stored as single lexical items to be able to undergo internal syntactic manipulation. This is because no syntactic information for the individual morphemes in the idiom would be stored in the idiom's lexical entry. Additionally, one would expect that if all idioms were truly stored monomorphemically—in exactly the same manner as any verb—that idioms would follow the same morphological affixation rules as other English verbs, which clearly is not the case:

7. Open a can of worms:

   (a) Sam really opened a can of worms with his comment at dinner.

   (b) *Sam really [open a can of worms]-ed with his comment at dinner.

   (c) You're opening a can of worms you don't want to deal with.

   (d) *You're [open a can of worms]-ing you don't want to deal with.

Clearly, in these cases, tense morphemes must be affixed to the verb contained within the idiom rather than to the idiom in its entirety, suggesting that we do not totally abandon the recognition of the individual words that compose the idiom, as the three aforementioned models would lead us to believe.

To address these concerns about the syntactic and morphological variability exhibited within VP idioms, Nunberg (1978) presents a theory in which not all idioms are represented in the same manner in the lexicon. He contends that idioms are represented differently in the mind based on the degree to which the idiom's figurative meaning can be mapped to the meanings of its constituent words, which he refers to as an idiom's degree of decomposability (I refer to the same concept as semantic transparency, a term which I believe more accurately conveys this idea). He argues that decomposable (transparent) idioms, which have a close semantic correspondence between each word and the idiom's figurative meaning, are syntactically flexible and are not lexicalized, whereas nondecomposable (opaque) idioms are syntactically rigid, and are lexicalized. However, the existence of nondecomposable but syntactically flexible idioms (8), as well as decomposable but inflexible idioms (9), present a problem for this theory:

8. Open a can of worms:
    a. I tried to divert the conversation to another topic, but it was too late: the can of worms had been opened.
9. Hit the road:
    a. *As soon as the luggage was loaded up, we piled into the car, and the road was hit.

Nonetheless, this concept of decomposability was incorporated by others into their own theories of idiom representation. Jackendoff (1995) addresses decomposable and nondecomposable idioms within his framework of a phrasal lexicon. Under this theory, each lexical entry, rather than simply consisting of a phonological form and its definition(s), consists of phonological, morphological, syntactic, and semantic information. Under his analysis, different types of idioms simply have different types of lexical entries: decomposable idioms

have entries in which the syntactic and semantic information in the entry is co-indexed, whereas in nondecomposable idioms, the NP in the syntactic representation of the idiom is not co-indexed with any part of the semantic representation, so the whole VP idiom is syntactically frozen (Maher, 2013; Jackendoff, 1995). However, Jackendoff's explanation suffers from the same issue as the theory proposed in Nunberg (1978): the existence of idioms that are decomposable but syntactically inflexible (9), as well as idioms that are nondecomposable but syntactically flexible (8).

Building off of this issue, Gibbs & Nayak (1989) suggest that perhaps idioms do not all fit neatly into this binary (decomposable vs. nondecomposable), and that those idioms exhibiting unexpected syntactic flexibility/inflexibility may belong to a third category, abnormally decomposable idioms. This category is intended to capture idioms for which there is not a clear literal mapping of each component word's meaning to the idiom's overall meaning, but for which there is a figurative or metaphorical mapping. A prototypical example of an idiom of this type would be *spill the beans* ('reveal a secret'), where *beans* has no literal relation to *secret*, but one intuitively sees a metaphorical relation between the two in the context of the idiom. Incorporating this new idea about a spectrum of decomposability rather than two polar opposites, Gibbs & Nayak (1989) introduce the Idiom Decomposition Hypothesis (5), which states that idioms that are semantically transparent tend to be more syntactically flexible, while idioms that are semantically opaque tend to be less syntactically flexible. To test this, they first conducted a survey in which participants were presented with a list of English idioms, each accompanied by a literal paraphrase of the idiom's meaning, and participants were asked to categorize each idiom as either decomposable (transparent), abnormally decomposable (semi-transparent), or nondecomposable (opaque). Additionally, participants were asked to judge the grammaticality of

a number of syntactic manipulations performed on each idiom. The claims of the Idiom Decomposition Hypothesis were found to be supported in their series of experiments. Because I am also investigating the validity of the Idiom Decomposition Hypothesis, the first part of my study closely follows some of their methodology; however, I have introduced some modifications to address potential methodological problems present in the original study. These modifications will be discussed in more detail in the Method section.

All of the theories discussed above rely on the notion that at least some idioms are stored in the lexicon as individual entries, and that there is some kind of fundamental representational difference between different types of idioms in the lexicon. However, an alternative hypothesis named the Configuration Hypothesis was presented originally by Cacciari & Tabossi (1988). Under this model, idioms are *not* lexicalized, and semantic transparency plays no role in idiom recognition or comprehension. Essentially, the Configuration Hypothesis states that idiomatic meanings, rather than being contained directly in a lexical entry for that idiom, are simply associated with particular configurations of words that frequently co-occur in similar contexts. Idioms are initially processed word-by-word (are processed literally) up until the point that there is enough contextual information to conclude that the string of words is a learned idiomatic expression, at which point the figurative meaning associated with this configuration can be accessed. This theory's claims are assumed to be in direct opposition to those of the Idiom Decomposition Hypothesis: whereas the Idiom Decomposition Hypothesis relies on semantic transparency being a vital component of our mental representation of an idiom, the Configuration Hypothesis explicitly rejects the idea that idioms are represented in any special way in the lexicon and that there exist distinct types of idioms with unique properties. Importantly, because it is assumed to oppose the Idiom Decomposition Hypothesis, under the Configuration

Hypothesis, it is assumed that we would not observe a consistent relationship between semantic transparency and syntactic flexibility because all idioms, regardless of transparency and flexibility, would be recognized and processed identically. However, through this thesis, I will be showing that the claims of these hypotheses may not be entirely mutually exclusive, and that perhaps a reinterpretation of their assumptions should be considered.

Method

Part 1: Online survey

The aim of Part 1 was to semantic transparency and syntactic flexibility judgements for a list of idioms. This was done using an online survey. Section 1 of the survey consisted of questions about semantic transparency judgements for each idiom, and Section 2 consisted of a questions about the syntactic flexibility of each idiom.

Online survey, section 1. Section 1 of this study consisted of a survey designed to replicate Gibbs & Nayak (1989) with a small number of changes to address potential methodological problems in the original experiment. Broadly, this section involved questions first designed to gather information about semantic transparency judgements for a list of idioms, as well as questions designed to assess the syntactic flexibility of each idiom.

Part 1 participants were recruited from Emory University's Linguistics 101 and 201 classes, and the survey was administered via SurveyMonkey, an online survey administration website. After eliminating data from non-native English speakers, data from 53 participants remained. A total of 17 idioms were included in this survey (see Appendix A for the complete survey). As in Gibbs & Nayak (1989), all idioms had a V+NP syntactic structure. Of the 17 idioms, 8 were idioms originally included in Gibbs & Nayak (1989), and 9 were new idioms that had not yet been investigated. I chose to use this mix of both idioms from Gibbs & Nayak (1989)

and novel idioms in order to test whether the same relationship between syntactic flexibility and semantic transparency is found when applying their methodology to this novel list of idioms. Using idioms from Gibbs & Nayak (1989) in addition to novel idioms allows me to directly compare my results to those of the previous study and verify that any difference in results was not simply due to the list of novel idioms tested. One concern in applying their idiom selection to my study, however, was the familiarity of the idioms chosen. Some of their idioms are not commonly used today (e.g., *hit the sauce*, 'to drink alcohol'; *give the bounce*, 'to get rid of') and may be unfamiliar to today's undergraduate students, though it is unclear if these idioms would have been viewed as similarly unfamiliar by the participants in Gibbs & Nayak's original study. For this reason, idioms for my study were selected in part to ensure that most idioms would be familiar to undergraduate students today.

I also selected idioms based on my own preliminary judgements about their semantic transparency. Just as in Gibbs & Nayak (1989), idioms were chosen with the goal of equally representing 3 different categories of semantic transparency: semantically transparent, semi-transparent, and semantically opaque. In these initial judgements about transparency, Gibbs & Nayak's idioms were considered to belong to the same categories into which they were originally sorted by their participants.

The survey itself consisted of 51 questions split into two sections, and took approximately 10 minutes to complete in total. In the first section, participants were asked to judge the semantic transparency of each of the 17 idioms in order to establish empirically the category to which each idiom belonged in light of the finding that transparency judgements are not necessarily constant across speakers (Tabossi, Fanari, & Wolf, 2008). For this reason, I collected this data to allow for categorizing the idioms based on participant perceptions, as well

as to investigate whether there is significant variation across speakers in their transparency judgements. Participants were presented with a list of the 17 idioms and directed to indicate on a scale of 1-5 the degree to which they thought the meanings of the words in each idiom related to the idiom's overall meaning, with a score of 1 being defined as "all words in the idiom are closely related to the idiom's meaning", 3 being defined as "some words in the idiom are literally or figuratively related to its actual meaning, but not all of them", and 5 was defined as "none of the words in the idiom are related to its actual meaning". The use of this scale is also a modification to Gibbs & Nayak's (1989) original methodology, as they asked participants to directly categorize idioms into transparent, semi-transparent, and opaque categories. A Likert scale rating system was added because it is difficult to clearly classify some idioms into one of these 3 categories, so the 5-point transparency scale was thought to be more able to capture people's true intuitions about transparency. A 5-point scale allows for both a neutral option, as well as two degrees of extremity in either direction. This was done in order to preempt the possibility of participants having fuzzy judgements about each idiom and choosing the neutral option for most of the idioms as a result. The 5 point-scale allowed participants to at least indicate whether they think the idiom is closer to being transparent or opaque, even if they don't think the idiom is completely transparent or opaque. Participants were also given the option of indicating that they did not know an idiom's meaning. This was provided in order to address a potential concern with Gibbs & Nayak's (1989) methodology. In their study, each idiom was paired with a paraphrase of the idiom's meaning, so it would have been impossible to know how many of the participants were unfamiliar with the idiom's meaning prior to being presented with the paraphrase. The presence and phrasing of these paraphrases could have easily influenced

participant judgements about transparency, so paraphrases were eliminated in the present study and replaced with the option to indicate unfamiliarity with an idiom.

Online survey, section 2. The second section of the survey was designed to investigate the syntactic flexibility of each idiom. Participants were presented with a series of brief paragraphs, each one ending in a bolded phrase, and were asked to judge the grammaticality of each bolded phrase. Each paragraph occurred twice: once, the bolded phrase completing the paragraph was a passivized version of one of the 17 idioms being investigated, and once the bolded phrase was a literal passive structure similar in meaning to the idiom:

10.

a. Things have been really tense with my roommate lately. After a week of not talking, our friend finally sat us both down and made us discuss what the problem was. Surprisingly, the discussion went well: **the air was cleared** and peace was restored to the apartment.
b. Things have been really tense with my roommate lately. After a week of not talking, our friend finally sat us both down and made us discuss what the problem was. Surprisingly, the discussion went well: **the tension was relieved** and peace was restored to the apartment.

The order of the questions was randomized for each participant, and questions were split across two pages. The survey was structured such that, although the questions were randomized, each context only appeared one time on each page, and participants were not allowed to edit their responses on the first page after advancing to the second page. This structuring was to prevent participants from directly comparing the idiomatic and non-idiomatic passive completion of each paragraph and modifying their grammaticality judgements based on this comparison. . Each page

contained the same number of idiom-completed and non-idiom-completed paragraphs. Similarly to section 1, participants were asked to judge the bolded phrase's grammaticality on a scale of 1-5, with 1 corresponding to unquestionable ungrammaticality (explained as "I would never say this, and I cannot imagine a native speaker saying this), and 5 corresponding to unquestionable grammaticality (again, see Appendix A for the full list of questions and contexts provided).

Why passivization? The use of only passivization as the indication of syntactic flexibility is another departure from Gibbs & Nayak's (1989) methodology. This decision was made partially to limit the length of the survey to minimize the chance that fatigue and boredom would cloud the participants' grammaticality judgements. Originally, Gibbs & Nayak used a number of different tests proposed by Fraser (1970) to measure each idiom's syntactic flexibility, including adjective insertion, adverb insertion, passivization, and present participle transformation:

11. Lay down the law:
    1. Adjective insertion: The teacher will lay down the school law if the children make too much noise.
    2. Adverb insertion: The boss will quickly lay down the law if anyone shows up late.
    3. Passivization: The law will be laid down when Jane's boyfriend finds out where she's been.
    4. Present participle: Her father's laying down the law prevented her from going to the dance.

    (all of the above examples are taken directly from Gibbs & Nayak, 1989).

However, Gibbs & Nayak (1989) did not justify the reasons for their use of these specific tests, and subsequent studies have also failed to question or explain why these particular tests were

thought to be a strong measure of syntactic flexibility (Maher, 2013). However, there are numerous potential problems with the use of some of these tests across all idioms.

Adverb insertion may not truly measure syntactic flexibility because the adverb, in many of the cases, is placed outside of the idiom itself and/or outside of the VP that contains only the idiom (e.g. *quickly hit the road*), and therefore does not necessarily indicate the syntactic flexibility of the idiom itself, but rather its ability to be modified by an adverb outside of the phrase. Additionally, the adverbs inserted in these tests vary widely and their successful application depends more on the semantics of the idiom's component words and overall meaning rather than the idiom's structure itself. Eventive semantics may also come into play in determining the success or failure of adverb insertion. For example, *kick the bucket* cannot be used in the continuous aspect, so using an adverb like *slowly* being applied to the idiom would result in an ungrammatical sentence, whereas an adverb like *unfortunately* would be acceptable. Similarly, adjective insertion is also dependent on the meanings of the semantics of the individual words and the meaning of the idiom itself. Some idioms can accept adjective insertion when the adjective is related to the literal meaning of the noun but not the idiomatic meaning, and vice versa. This makes it a poor metric for measuring an idiom's ability to be syntactically modified, as successful insertion of an adjective seems to depend more on an idiom's semantics than its structure.

Putting the idiom in the present participle form creates a similar problem in which again, the idiom's eventive semantics are more likely to be behind the success or failure of the transformation rather than the actual structure of the idiom. For example, in *kick the bucket,* although its meaning *to die* can occur continuously, *kick the bucket* cannot be used in a continuous sense. Because of this, we wouldn't expect *kick the bucket* to be able to be put in

present participle because it simply would not make sense semantically (e.g., *John, kicking the bucket, said he had no regrets about life*). Because this test cannot be applied equally to all idioms for semantic reasons, it is not an appropriate test for measuring syntactic flexibility across a varied list of idioms.

This leaves passivization as the final remaining test from Gibbs & Nayak (1989). In my study, passivization was ultimately selected as the metric for syntactic flexibility. Unlike adjective and adverb insertion, passivization does not add any additional elements carrying semantic meaning to the phrases, eliminating this as a variable in grammaticality judgements. Finally, passivization is the most drastic syntactic transformation of the 4 tests proposed, as results in a surface structure that is significantly different from the idiom's deep structure, rather than simply involving the insertion of a constituent or change of tense or aspect. Because it was decided to only use one test to assess syntactic flexibility, passivization judgements are most likely to yield the clearest results—if there truly is an effect of syntactic flexibility on processing or on semantic transparency, we would expect to be able to detect it using passivization as our measure of syntactic flexibility because sets the highest bar for qualifying as syntactically flexible.

Finally, it is important to note that passives are most commonly used when there is no clear agent in the sentence. When possible, this was taken into consideration in the construction of the text paragraphs by setting up the context in such a way that there was no clear agent of the idiom and that the idiom occurred in a place in which a literal passive would be entirely grammatical. To ensure this was the case, identical paragraphs ending in a passivized literal paraphrase of the idiom in question were also included and judged for grammaticality. This

allowed us to verify that if an idiom in that location was judged as being ungrammatical, it was not due to the structural context in which the idiom was placed or due to the idiom's meaning.

Part 2: Lexical decision task

In part 2, a new set of participants performed a lexical decision task experiment. The lexical decision paradigm has not previously been used to investigate this facet of idiom processing. The decision to use this paradigm to investigate idiom processing is the result of studies performed using lexical decision tasks to investigate noun compound processing. In noun compounds, it has been found through lexical decision studies that transparent compounds (e.g., *beanpole*) involve access to the lexical entries of both nouns in the compound, whereas opaque compounds (e.g., *butterfly*) do not involve access of the lexical entries for the nouns forming the compound (Marslen-Wilson, Tyler, Waksler, & Older, 1994). In light of these findings, it seemed that a lexical decision paradigm would let us similarly examine whether or not semantic transparency plays a role in idiom processing as well. Participants were recruited from Emory University's Linguistics 201 class and were rewarded with extra credit for participation in the experiment. Although data from 18 participants was collected, 6 were eliminated due to being non-native English speakers, leaving 12 participants.

The lexical decision task was designed such that in each trial, the participant was first presented with an idiom, which acted as a prime. Immediately following the idiom, the participant saw a letter string and was asked to indicate whether that string formed a real English word.

Stimuli and target selection. Because this was intended to be a pilot experiment, only 6 of the 17 idioms from Part 1 were chosen as stimuli for the lexical decision task. Idioms were chosen to provide the clearest examples of idioms belonging to each category (semantically

transparent/opaque, syntactically flexible/non-flexible). Mean transparency and flexibility scores from Part 1 were used to determine what constituted the clearest examples. Idioms were chosen to ensure that each category combination was represented (i.e., transparent/flexible, transparent/non-flexible, opaque/flexible, and opaque/non-flexible).

Each idiom was also followed by different types of target strings across trials. Strings belonged to one of five categories:

- Target semantically related only to first word of the idiom
- Target semantically related to only the last word of the idiom
- Target semantically related to only the overall figurative meaning of the idiom
- Target unrelated to any words in the idiom or the overall meaning
- Non-word

A full list of the idioms used and each target used for each idiom can be found in Table 1.

Degree of semantic relation was determined using the University of South Florida's Free Association Norms database (Nelson, McEvoy, & Schreiber, 1998). This database includes responses from 6,000 participants for over 5,000 stimulus words, and was collected by asking each participant to write the first word that came to mind that was "meaningfully related or strongly associated" with the word shown. The database is organized alphabetically by target word; under each target word, there is a list of the primes that produce that target in free association in order of strength of the priming effect. Because the primes in this study were the idioms used, the USF database was used backwards to select targets. For example, in searching for a target semantically related to *pop* in *pop the question,* the database was manually searched for all instances of *pop*. Out of all occurrences, *pop* was primed the most strongly by *soda,* so this word was selected as the target. Each target was also checked to ensure that it was not also

primed by any of the other words in the idiom or the overall meaning of the idiom. In such cases, the strongest prime that did not prime any other words in the idiom or its overall meaning was chosen as the target. Finally, control words were chosen randomly using a random word generator, then were checked to ensure that they were not primed by any part of the idiom.

Procedure. For each idiom, participants saw a total of 8 targets: a word semantically related to the first word of the idiom, a word semantically related to the last word, a word semantically related to the overall meaning of the idiom, an unrelated control word, and 4 non-words. Four non-words were included for each idiom (as opposed to just one non-word) to ensure an equal number of words and non-words. Otherwise, it would have been possible for participants to react more quickly to words than non-words simply because real words would have occurred four times more frequently than non-words.

The experiment was designed using PsychoPy. In each trial, an idiom was presented on the screen for 0.6 seconds. This was followed by a 0.2 second fixation point, then one of the 8 targets for that idiom was presented for an indefinite amount of time. Participants were instructed to press the “A” key to indicate that a target was a real word and to press the “L” key to indicate that a target was a non-word. Participants were all instructed to work as quickly as possible without becoming careless.

Data was subsequently cleaned to remove any response times of less than 0.1 seconds or more than 1.0 seconds. At 0.1 seconds, the participant would have been unable to truly read and judge the target accurately; conversely, responses over 1.0 seconds were thrown out because after that length of time, other kinds of language processing systems were assumed to be involved in the decision-making process, whereas the focus of this study is the initial stage of idiom processing.

Results

Part 1

Online survey, section 1. Survey data was initially cleaned by removing responses for which a participant indicated they did not know the idiom used in the question. A table of the mean transparency ratings and standard deviations for each idiom is provided in Table 2. Again, in the scale, a score of 1 corresponded to an idiom that was entirely transparent, and a score of 5 corresponded to an idiom that was entirely opaque.

A list of all idioms organized by syntactic flexibility score is provided in Table 3. Again, a score of 1 corresponded to an idiom that was extremely rigid, and a score of 5 corresponded to an idiom that was extremely flexible.

Online survey, section 2. Survey data was cleaned by removing responses for which a participant indicated they did not know the idiom used in the prompt. One concern for data analysis in this section was the possibility of a participant not accepting passives of any type (literal and idiomatic), perhaps due to misunderstanding the instructions and adhering to prescriptive grammatical rules in making their judgements. To address this concern, data from participants who rated over 50% of the control sentences as either a 1 or 2 (least grammatical) were removed from the analysis, resulting in the removal of 2 participants' data. Next, control questions were tested for validity to ensure that all of the contexts presented were contexts in which most speakers would accept a literal passive completion. A question set was eliminated if over 50% of the respondents rated the literal completion a 1 or 2 (least grammatical). Based on this criterion, no contexts were identified as problematic, and no question sets were removed from analysis.

Mean syntactic flexibility ratings were obtained for both the control questions and idiom-containing questions. As expected, control sentence flexibility ratings (*M*= 4.096, *SD*= 0.489) were found to be significantly different from idiom flexibility ratings (*M*= 2.718, *SD*= 0.778), $t(32) = -5.989$, $p < 0.001$. To address the hypothesis that semantically transparent idioms would be more syntactically flexible, and semantically opaque idioms less syntactically flexible, a median split was performed based on idiom transparency, yielding 8 idioms categorized as transparent, and 8 categorized as opaque (because there were 17 idioms tested, the idiom with the median transparency score was not included in order to have an equal number of transparent and opaque idioms). Mean flexibility scores for each category were compared using an independent samples t-test. Transparent idioms' flexibility ratings (*M*= 3.098, *SD*=0.776) were not found to be significantly different from opaque idioms' flexibility ratings (*M*=2.467, *SD*=0.697), $t(10)=1.480$, $p=0.170$. Initially, this finding seems to fail to support the hypothesis that semantically transparent idioms are more syntactically flexible, and semantically opaque idioms are less syntactically flexible.

However, a linear regression test found semantic transparency to be a significant predictor of syntactic flexibility. A simple linear regression was calculated to predict flexibility based on transparency, and a significant regression equation was found, $F(1, 15) = 5.636$, $p= 0.031$, with an R^2 of 0.273. A scatterplot of transparency vs. flexibility is shown in Figure 1.

Part 2: Lexical Decision Task

Part 2 analysis examined the results of the lexical decision task experiment. The data was first cleaned by removing the responses for which a participant indicated not knowing the stimulus idiom. Next, response times of over 1 second were deleted, as participants who took this amount of time to respond were likely not following the directions to respond as quickly as

possible, and it is unclear what additional processing methods may occur after this amount of time. Data was first examined holistically, without dividing the data based on idiom transparency or flexibility. This was done because the lexical decision paradigm has not previously been used to investigate idiom processing, so I wanted to see if there were any general significant results before going into deeper analysis. Independent samples t-tests were run to examine the differences in response times for targets semantically related to the first word of the paired idiom, the last word of the paired idiom, and the overall meaning of the paired idiom as compared to control (non-related) targets.

Reaction times for words semantically related to the first word of the idiom (M=0.612 seconds, SD=0.159 sec) were significantly faster than reaction times for unrelated control words (M=0.667, SD=0.136), t(134)= -2.166, p=0.032.

Reaction times for words semantically related to the last word of the idiom (M=0.612, SD=0.161) were also significantly faster than reaction times for unrelated control words (M=0.667, SD=0.136), t(122)= -2.050, p=0.043.

However, reaction times for words semantically related to the overall meaning of the idiom (M=0.650, SD=0.138) were not significantly different from reaction times for unrelated control words (M=0.667, SD=0.136), t(126)= -0.693, p= 0.489. A graph of the results listed above can be found in Figure 2. Interestingly, when response times of over 1 second were *not* eliminated from analysis, the reaction time for the targets related to the overall meaning of the idiom were significantly different from reaction times to the control targets (p=0.036).

When we sort these reaction time results by idiom type (transparent, opaque, flexible, inflexible), however, results become a bit less clear. In general, reaction times for all types of targets were not significantly different from reaction times for control targets.

For transparent idioms, no target types were found to have significantly different reaction times when compared to unrelated control target reaction times (first word targets vs. control: $p=0.07$, last word targets vs. control: $p=0.07$, overall meaning targets vs. control: $p=0.34$). The same was true for opaque idioms (first word targets vs. control: $p=0.29$, last word targets vs. control: $p=0.38$, overall meaning targets vs. control: $p=0.84$) and inflexible idioms (first word targets vs. control: $p=0.44$, last word targets vs. control: $p=0.47$, overall meaning targets vs. control: $p=0.94$). The exception, however, was in syntactically flexible idioms. In syntactically flexible idioms, both the targets related to the first word ($p=0.049$) and targets related to the last word ($p=0.039$) were recognized significantly faster than unrelated control words, but targets related to the overall meaning of the idiom were not recognized significantly faster or slower than the unrelated control words ($p=0.18$). Results followed an identical pattern when reaction times of over 1 second were not removed from analysis.

Discussion

To review, this study was conducted in order to investigate the following questions and hypotheses:

A. Investigate the nature of the relationship between semantic transparency and syntactic productivity to discover whether or not there is evidence supporting the claims of Gibbs & Nayak's (1989) Idiom Decomposition Hypothesis (5):
    a. Speakers share intuitions about semantic transparency judgements
    b. Semantic transparency and syntactic flexibility in idioms is positively correlated

B. Apply these findings to investigate how idiom processing varies according to an idiom's transparency and flexibility using a lexical decision task experiment

In testing the Idiom Decomposition Hypothesis, both tenets were found to be supported. Though not identical across all participants, judgements about the semantic transparency of each idiom tended to be similar across all participants, as the standard deviation for each idiom's transparency score tended to be around 1 point on a 5-point scale. This is similar to the results found originally by Gibbs & Nayak (1989); however, my study controlled for potential methodological problems found in the original study: pairing each idiom with a paraphrase, using antiquated idioms, and requiring participants to directly label idioms as transparent, semi-transparent, or opaque. My results show that even in the absence of a presented paraphrase (which could influence a person's transparency judgement based on how closely the syntax and words in the paraphrase match the idiom's), participants still hold consistent judgements about idioms' semantic transparency. Additionally, my study was conducted using idioms that are more familiar to younger speakers and provided the option for participants to indicate that they did not know the meaning of an idiom so their data for that idiom could be excluded from analysis. Finally, my study allowed for participants to use a wider scale to judge transparency in order to detect a wider amount of variability in transparency judgements, if a wider amount of variability in judgements did indeed exist. Thus, though the conclusion from my results is essentially the same conclusion reached by Gibbs & Nayak (1989), my results provide even more convincing support for the idea that speakers truly do share intuitions about idiom semantic transparency.

The second tenet of the Idiom Decomposition Hypothesis—that semantic transparency and syntactic flexibility in idioms are positively correlated—was also found to be supported. My

results showed that transparent idioms tended to be more syntactically flexible, and opaque idioms tended to be more syntactically inflexible, though exceptions to this trend certainly existed. Overall, about 27.3% of the variability in syntactic flexibility scores could be explained by semantic transparency. This result is also similar to that of Gibbs & Nayak (1989); however, my study controlled for potential problems in the tests used to judge syntactic flexibility. Although I only used one test to judge syntactic flexibility—as opposed to the 5 different tests used in Gibbs & Nayak (1989)—this test was carefully selected to limit potential confounds present in the other tests (refer to *Why Passivization?* In Methods for a description of these confounds). The results confirmed that passivization is a valid measure of syntactic flexibility in VP idioms. The use of only passivization, rather than 5 syntactic flexibility tests, in future research would greatly reduce the number of questions and judgements imposed on each participant, which could help reduce the effects of testing fatigue on a participant's responses.

These results indicate that semantic transparency and syntactic flexibility are not independent properties, and instead interact in some way. Many of the existing theories about idiom processing mentioned earlier take this relationship into account when discussing the representation of idioms in the lexicon. Based on the relationship between transparency and flexibility, it seems reasonable to postulate that opaque idioms—which are generally not syntactically flexible—are stored in a fixed, lexicalized manner in the mind, whereas transparent idioms are not lexicalized and are instead analyzed in a more compositional manner, causing them to exhibit more syntactic flexibility. However, the results from Part 2 do not necessarily support this conclusion.

The data from the lexical decision task experiment allowed me to more directly investigate this question of how idioms might be stored and processed, and how this might vary based on transparency and flexibility. There were two primary opposing hypotheses presented:

1. All or some idioms can be lexicalized, and these lexicalized idioms are processed as single morphemes with no literal meaning accessed.
2. No idiom can ever be lexicalized, and all idioms are processed compositionally in a literal manner before the figurative meaning is accessed.

I expanded these hypotheses further by investigating what effects, if any, semantic transparency and syntactic flexibility have on processing method.

Across all idioms, it was found that targets semantically associated with both the first and last words of the idiom were primed after reading the idiom, but targets semantically associated with only the overall meaning of the idiom were not primed. This suggests that the lexical entries for all words in the idiom are accessed upon reading the idiom—otherwise, no priming effect for the first or last words would be observed. Compounded with the fact that words associated with only the overall meaning of the idiom were *not* primed, these results seem to suggest that all idioms are initially processed compositionally, or word-by-word, before any figurative meaning is accessed, supporting the hypothesis that idioms are not lexicalized.

Furthermore, my data provide evidence against the theory that transparency and flexibility influence processing method. In the analysis of the results for each category of idioms (transparent, opaque, flexible, and inflexible), no significant priming effect was observed for any of the target types in the transparent, opaque, or inflexible idioms. Interestingly, for flexible idioms, targets related to the first and last words of the idiom *were* primed, but targets related to the overall meaning were not primed. Given that this result was only marginally significant and

that it also fits the general pattern seen in the data for all idioms, this is not necessarily a surprising finding. Overall, the fact that no idiom type showed strong, clear differences in the priming effects seen across target types provides evidence against the idea that idioms are processed differently based on their transparency and flexibility. This aligns closely with the predictions of the Configuration Hypothesis, which claims that idioms are never lexicalized. Under this hypothesis, all idioms are processed compositionally up until the point at which enough context is present to trigger the retrieval of the additional figurative meaning associated with that particular configuration of words (Cacciari & Tabossi, 1988). As expected under this hypothesis, a priming effect for the overall meaning of the idiom *was* observed when reaction times over 1 second were not eliminated from analysis, suggesting that the figurative meaning of the idiom was only accessed *after* the idiom was processed word-by-word.

Initially, this conclusion that idiom processing method is not influenced by semantic transparency or syntactic flexibility may seem to be at odds with my finding that speakers still do share relatively clear intuitions about idiom transparency and flexibility, and that there is a consistent relationship between transparency and flexibility. This is because it has previously been assumed that if the Idiom Decomposition Hypothesis is true, it must have consequences for the lexicalization and processing of idioms. But why must this be the case? It does not seem preposterous to suggest that, while we may be aware of idiom transparency (or flexibility) and perhaps even store information about these properties in our (non-lexicalized) representation of the idiom's meaning, these properties do not actually have to influence idiom processing at all. Even in literal language, we store a great volume of information about particular words and constructions that may or may not be relevant in any particular instance of use, and may or may not affect processing speed—for example, knowing that a verb is a one-place predicate versus a

two-place predicate does not necessarily affect the speed with which we access the meaning of the verb. We may store the information about an idiom's transparency and flexibility, but it may simply not affect our processing method.

If this is the case, the observed relationship between semantic transparency and syntactic productivity cannot be explained by differences in lexicalization status, as no idioms would be lexicalized. It may simply be the case that transparent idioms tend to be more flexible purely because their usage and meanings are closer to that of literal language, which is syntactically flexible. With a very clear, close mapping between the idiom's component words and its overall meaning, speakers may simply be more likely to be comfortable with innovative syntactic transformations because they feel they can treat the idiom more like literal language. In contrast, when there is no clear mapping between the idiom's component words and its meaning, speakers may not feel as comfortable applying novel syntactic transformations to the idiom because they are unsure of how each word relates to the figurative meaning, resulting in speakers primarily using opaque idioms as fixed, inflexible phrases.

Finally, I would like to introduce one other previously-uninvestigated variable—idiom frequency—as another factor in explaining the relationship between transparency and flexibility. Using the Corpus of Contemporary American English (CoCa), a 520 million word corpus of contemporary American English from a wide variety of spoken and written published sources (including newspapers, newscasts, novels, academic papers, and others), I found the number of occurrences of each idiom in the corpus, giving me an estimate of the frequency with which each idiom is used in today's American English (Davies, 2008). The full results and search strings used to find occurrences of each idiom can be found in Table 4. Through a linear regression analysis, a significant correlation ($p=0.006$, $R^2=0.43$) was found between idiom frequency and

transparency score, as seen in Figure 3. As frequency increases, idioms tend to be more transparent.

This finding provides additional evidence in support of my interpretation of the relationship between transparency and flexibility. It seems to make sense that a higher degree of transparency would correlate with more frequent use because of the closer similarity between that idiom and literal language—that is, there is a close correspondence between the meaning of each word in the idiom and its figurative meaning. It is my intuition that as the frequency of hearing a particular word or phrase increases, so does a speaker's comfort level in using that construction themselves. This is because the increasing amount of input provides a speaker with more information about the contexts in which that particular construction can be used, how to use it, and potential ways to manipulate it. After hearing the construction frequently and in a wide variety of contexts, a speaker is likely to become more comfortable with using that construction in novel contexts or applying novel syntactic manipulations to it. Of course, this principle could be extended to idioms as well as normal words and phrases: when a speaker hears an idiom used frequently and in a variety of contexts, they would likely become more comfortable with syntactically manipulating that idiom.

To conclude, my findings supported both the Idiom Decomposition Hypothesis *and* the Configuration Hypothesis, which were previously regarded as two mutually-exclusive hypotheses due to the assumption that if speakers have consistent, shared intuitions about transparency and flexibility, these properties also must influence idiom lexicalization and processing. However, I have proposed that this assumption is not necessarily valid, as there is no reason to claim that all information we store about particular constructions (idioms, in this case) necessarily affects processing. The consistent relationship between semantic transparency and

syntactic flexibility, then, is not due to differences in the lexicalization of different types of idioms; rather, the degree to which speakers can match the individual words of the idiom with its figurative meaning affects their willingness to syntactically manipulate the idiom. Idioms that are more transparent are judged to be more similar to literal language, and therefore these idioms tend to be more syntactically flexible, whereas opaque idioms are treated more similarly to fixed phrases.

Of course, this question of how idioms are processed and represented is still not satisfactorily answered. Future research might also improve upon the lexical decision task paradigm used here in regard to the targets assumed to be primed by the overall meaning of the idiom. One significant limitation of this study that may have affected the results was that I had to individually decide on a single word that closely corresponded or related to only the overall meaning of each idiom in order to find targets primed by that word. This was clearly a very subjective decision. In the future, this could potentially be addressed by administering a free association task to a large number of people. In the task, they would be presented with a list of idioms and asked to write the first word they think of that relates to the overall meaning of the idiom. This would allow for the production of a list of the words most strongly primed by each idiom.

Second, in order to further investigate the validity of the Configuration Hypothesis, future research might examine exactly how quickly this priming effect for the overall meaning of an idiom is observed in relation to the idiom's frequency, in addition to whether the speed of this effect differs across transparent/opaque and flexible/inflexible idioms. The Configuration Hypothesis would likely predict that idioms with a higher frequency would have their figurative meanings accessed more quickly due to that particular word configuration's corresponding

idiomatic meaning being more frequently reinforced. However, this hypothesis would also predict no difference in retrieval time across transparent/opaque and flexible/inflexible idioms (because all idioms are processed in the same compositional manner, regardless of these properties), so it would be important to watch for an interaction between frequency and transparency in affecting processing speed.

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Tables

Table 1

Target Selections for Each Idiom in the Lexical Decision Task

Idiom	First word target	Last word target	Overall meaning target	Unrelated target	Example nonword target
Kick the bucket	boot	pail	croak	wacky	smich
Pop the question	soda	answer	wedding	knives	dingees
Open a can of worms	close	earth	problem	smog	briege
Hit the road	miss	street	vacation	throat	croiced
Clear the air	foggy	breathe	tension	jaded	flince
Hit the sack	miss	bag	awake	north	thute

Table 2

Mean Transparency Ratings for Each Idiom

Idiom	Mean transparency	Standard deviation
Bend the rules	2.33	0.94
Hit the road	2.37	1.10
Pop the question	2.56	0.95
Lose one's grip	2.71	1.11
Pick one's brain	2.76	0.85
Crack the whip	2.93	1.20
Clear the air	3.14	1.11
Bring home the bacon	3.41	1.05
Jump the gun	3.45	1.23
Face the music	3.58	0.96
Hit the sack	3.65	1.30
Spill the beans	3.71	1.17
Open a can of worms	4.10	1.06
Cut the cheese	4.29	1.16
Clean one's clock	4.43	0.82
Kick the bucket	4.45	1.07
Chew the fat	4.47	0.94

Table 2. Mean semantic transparency ratings for each idiom. The scale ranged from 1 (most transparent) to 5 (least transparent). The list is ordered from most transparent to least transparent.

Table 3

Mean Syntactic Flexibility Ratings for Each Idiom and Control sentences

Idiom	Mean flexibility	Standard deviation
Clear the air	4.26	0.99
Bends the rules	4.09	0.99
Pick one's brains	3.69	1.16
Pop the question	3.29	1.28
Open a can of worms	3.28	1.39
Spill the beans	3.22	1.20
Crack the whip	3.15	1.27
Jump the gun	2.82	1.24
Cut the cheese	2.52	1.27
Face the music	2.51	1.35
Clean one's clock	2.35	1.39
Lose one's grip	2.23	1.13
Bring home the bacon	2.18	0.98
Hit the road	2.15	1.21
Hit the sack	2.13	1.03
Kick the bucket	1.89	1.02
Chew the fat	1.54	0.73
Average control rating	4.01	1.03

Table 3: Mean syntactic flexibility ratings for each idiom and control sentences. The scale ranged from 1 (least flexible) to 5 (most flexible). The list is arranged from most flexible to least flexible.

Table 4

Frequencies of each idiom in CoCa

Idiom	Search String[1]	Frequency	Transparency Score	Flexibility Score
Hit the road	[hit] the road	882	2.373	2.24
Bend the rules	[bend] the [rule]	165	2.333	3.959
Pick one's brain	[pick] [appge] [brain]	91	2.755	3.58
Hit the sack	[hit] the sack	62	3.65	2.23
Spill the beans	[spill] the beans	145	3.71	3.22
Open a can of worms	[open] a can of worms, [open] up a can of worms	41	4.02	3.2
Bring home the bacon	[bring] home the bacon	96	3.41	2.26
Kick the bucket	[kick] the bucket	54	4.45	1.98
Jump the gun	[jump] the gun	175	3.45	2.84
Clean one's clock	[clean] [appge] clock	17	4.43	2.38
Cut the cheese	[cut] the cheese	2	4.29	2.54
Pop the question	[pop] the question	168	2.56	3.26
Lose one's grip	[lose] [appge] grip	324	2.71	2.31
Crack the whip	[crack] the whip	79	2.93	3.18
Clear the air	[clear] the air	300	3.14	4.13
Face the music	[face] the music	137	3.58	2.59
Chew the fat	[chew] the fat	41	4.47	1.55

[1] In the search strings, brackets are used to search for lemmas of the word (all forms of the word) rather than just the word as it is typed. For example, "[spill] the beans" returns results for *spill the beans, spilling the beans,* and *spilled the beans*. This also applies to nouns, as in "[rule]", which returns both *rule* and *rules*. The string [appge] returns possessive pre-nominal pronouns (*my, your, our, his, her, their,* etc.).

Figures

Figure 1

Moderate Correlation between Semantic Transparency and Syntactic Flexibility

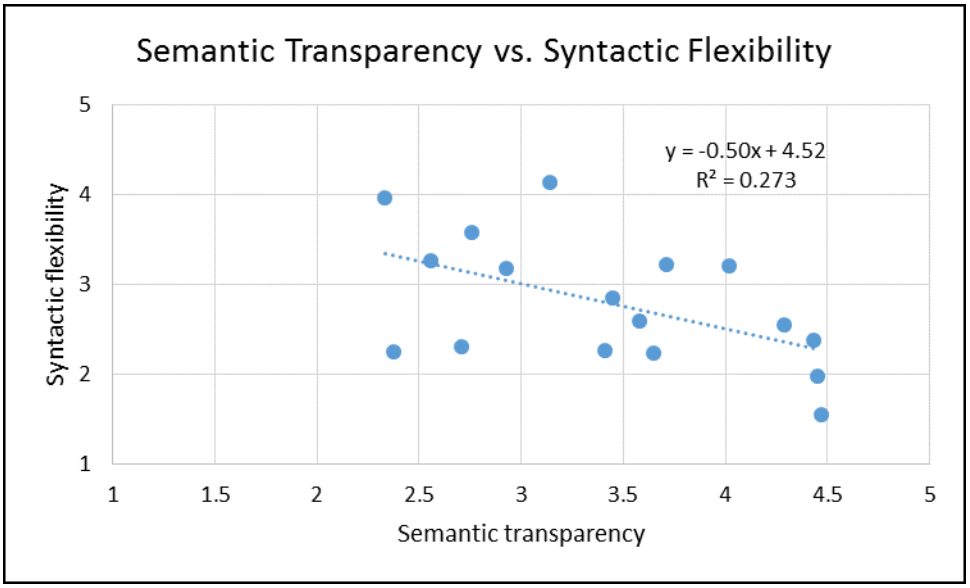

Figure 1: A moderate correlation between semantic transparency and syntactic flexibility. As transparency scores increase (idioms become more opaque), syntactic flexibility scores decrease (idioms become less syntactically flexible). This indicates that transparent idioms tend to be more syntactically flexible, whereas opaque idioms tend to be more syntactically rigid.

Figure 2

Target Word Type vs. Mean Reaction Time

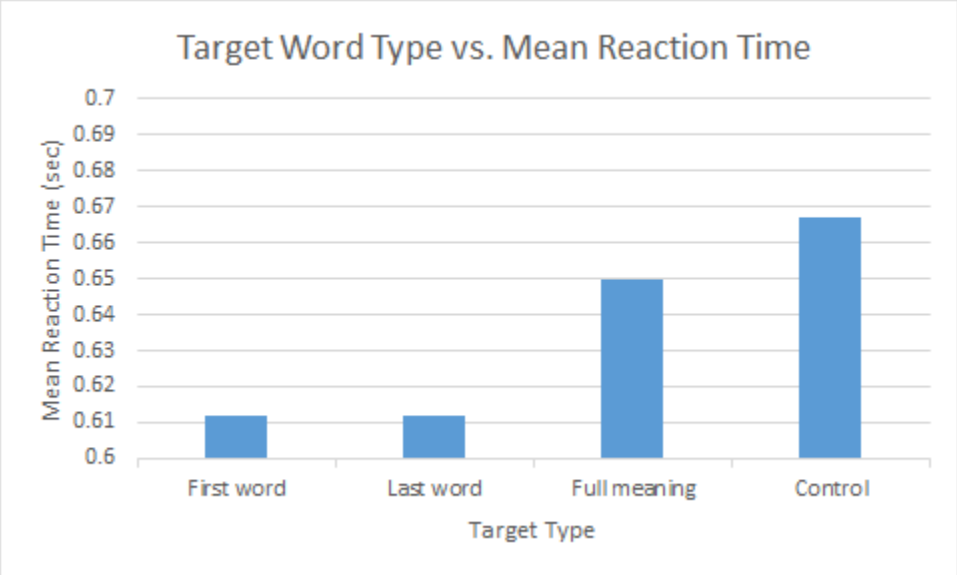

Figure 2: Target word type vs. mean reaction time. Reaction time varies according to target type. The reaction times to recognize targets semantically related to the first word of each idiom and targets related to the last word of each idiom were significantly faster than the time taken to recognize unrelated control words. However, reaction times to recognize words related to the overall meaning of the idiom were not significantly different from that of the control words.

Figure 3

Transparency vs. Frequency

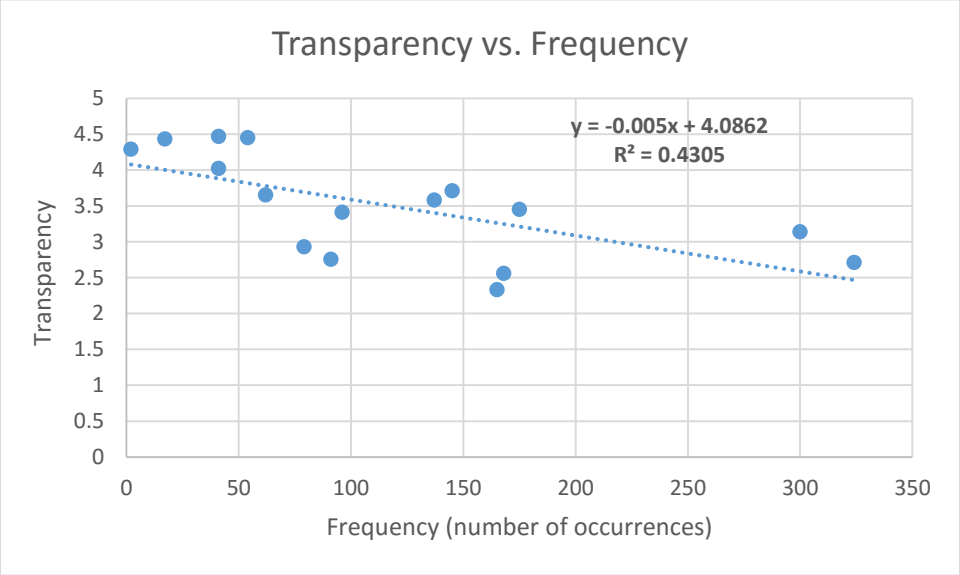

Figure 3: Idiom frequency versus transparency score. As transparency score decreases (meaning the idioms become increasingly transparent), frequency increases. Frequent idioms were more likely to be transparent, and infrequent idioms were more likely to be opaque. This relationship was found to be significant ($p=0.006$, $R^2=0.43$). One outlier, *hit the road*, with 882 occurrences was omitted from analysis.

Appendix A

Full Online Survey

Part 1: For the following questions, you will be asked to judge the degree to which the individual words in an idiom tell you the meaning of the idiom overall. For example, in kick the bucket, neither kick nor bucket are related in meaning to "to die", and you would have no way of guessing what this idiom meant based solely on its words.

On this scale, a score of 1 indicates that all words in the idiom are literally or very closely related to the idiom's overall meaning, whereas a score of 5 indicates that none of the words in the idiom are related to its overall meaning. A score of 3 indicates that some words in the idiom are literally or figuratively related to its meaning, but not all of them.

	1 (all words closely related to idiom's meaning)	2	3	4	5 (no words related to idiom's meaning)	I do not know this idiom's meaning
Chew the fat	○	○	○	○	○	○
Hit the sack	○	○	○	○	○	○
Jump the gun	○	○	○	○	○	○
Pop the question	○	○	○	○	○	○
Clean one's clock	○	○	○	○	○	○
Hit the road	○	○	○	○	○	○
Clear the air	○	○	○	○	○	○
Bend the rules	○	○	○	○	○	○
Pick one's brain	○	○	○	○	○	○
Kick the bucket	○	○	○	○	○	○
Spill the beans	○	○	○	○	○	○
Open a can of worms	○	○	○	○	○	○
Cut the cheese	○	○	○	○	○	○
Crack the whip	○	○	○	○	○	○
Bring home the bacon	○	○	○	○	○	○
Face the music	○	○	○	○	○	○
Lose one's grip	○	○	○	○	○	○

Part 2 [2]: The following are short pieces of text that each includes an underlined phrase. Please rate each bolded phrase according to the following scale:

1: I would never say this, and I can't imagine a native English speaker ever saying this

2

3: I might not say this, but it wouldn't strike me as wrong if someone else said it, or if said in the right context.

4

5: I can easily imagine myself or someone else saying this. It doesn't sound odd.

1. I only slept a couple of hours the night before our big school trip to Los Angeles. The next morning, I got on the bus before everyone else, and I fell asleep by accident. When I woke up, much to my surprise, our luggage had been loaded up, all the seats had been filled, and **the road had been hit.**
2. I only slept a couple of hours the night before our big school trip to Los Angeles. The next morning, I got on the bus before everyone else, and I fell asleep by accident. When I woke up, much to my surprise, our luggage had been loaded up, all the seats had been filled, and **the door had been closed.**
3. I got a call after work that my neighbor was in the hospital for something very serious, and I decided that I needed to get there as soon as possible to see her. But traffic was

[2] Questions are presented here as pairs for clarity. In the actual survey, the questions were presented in a random order, but were presented such that each story only appeared on each page once, and that an equal number of idiomatic and literal passive completions appeared on each page. Once the first page was completed, participants were not able to return to that page to edit their answers after seeing the second occurrence of the story.

terrible, and by the time I got there, I was too late: the room had been vacated and **the bucket had been kicked.**

4. I got a call after work that my neighbor was in the hospital for something very serious, and I decided that I needed to get there as soon as possible to see her. But traffic was terrible, and by the time I got there, I was too late: the room had been vacated and **the body had been taken away.**
5. Things have been really tense with my roommate lately. After a week of not talking, our friend finally sat us both down and made us discuss what the problem was. Surprisingly, the discussion went well: **the air was cleared** and peace was restored to the apartment.
6. Things have been really tense with my roommate lately. After a week of not talking, our friend finally sat us both down and made us discuss what the problem was. Surprisingly, the discussion went well: **the tension was relieved** and peace was restored to the apartment.
7. I had to go to a mixer the other day for a club I'm part of. As far as mixers go, I think it was pretty successful: **the fat was chewed**, food was eaten, and a good time was had by all.
8. I had to go to a mixer the other day for a club I'm part of. As far as mixers go, I think it was pretty successful: **strangers were introduced**, food was eaten, and a good time was had by all.
9. I've been at this dumb required business meeting all day. My head hurts and I want to go home so badly, but they said absolutely no one was allowed to leave until we finished all the tasks for the day. Imagine my surprise when Jack disappeared after lunch! I don't

know what happened; all I know is that **the rules were bent** and he was allowed to go home early, and I'm mad about it.

10. I've been at this dumb required business meeting all day. My head hurts and I want to go home so badly, but they said no one was allowed to leave until we finished all the tasks for the day. Imagine my surprise when Jack disappeared after lunch! I don't know what happened; all I know is that **the policy was relaxed** and he was allowed to go home early, and I'm mad about it.
11. I had been planning my friend's huge birthday celebration for over two months. It was supposed to be a surprise party, so she wasn't supposed to have any idea about it. But then, when she arrived and we yelled "surprise," she said she had known about the party for two weeks already! I don't know who did it, but apparently **the beans had been spilled** and the surprise had been ruined**.**
12. I had been planning my friend's huge birthday celebration for over two months. It was supposed to be a surprise party, so she wasn't supposed to have any idea about it. But then, when she arrived and we yelled "surprise," she said she had known about the party for two weeks already! I don't know who did it, but apparently **the secret had been revealed** and the surprise had been ruined.
13. I was at a nice restaurant eating dinner last night, and there was a young couple at the table across from me. The girl looked bored and uninterested the whole time, but her boyfriend seemed to be completely oblivious. Then, as they were finishing their meal, he suddenly got down on one knee in front of her, she looked petrified, and I had the brief idea to pull him aside and tell him not to go through with his plan, but it was too late: **the**

question had been popped, and the poor girl had to turn him down in the middle of a crowded restaurant.

14. I was at a nice restaurant eating dinner last night, and there was a young couple at the table across from me. The girl looked bored and uninterested the whole time, but her boyfriend seemed to be completely oblivious. Then, as they were finishing their meal, he suddenly got down on one knee in front of her, she looked petrified, and I had the brief idea to pull him aside and tell him not to go through with his plan, but it was too late: **the question had been asked**, and the poor girl had to turn him down in the middle of a crowded restaurant.
15. Our old boss was normally pretty lenient, which has led to a lot of us employees becoming a little lazy. But this morning when I came into the office, all of his stuff was gone, and a new guy had taken his place. I'm guessing somewhere higher up in the company, **the whip was cracked** and he got fired for not making us work harder.
16. Our old boss was normally pretty lenient, which has led to a lot of us employees becoming a little lazy. But this morning when I came into the office, all of his stuff was gone, and a new guy had taken his place. I'm guessing somewhere higher up in the company, **some changes were made** and he got fired for not making us work harder.
17. Like a lot of little kids, my 3 year old thinks farts are absolutely hilarious, frequently doing it in some very embarrassing situations. So when **the cheese was cut** in the middle of Grandpa saying the blessing at Thanksgiving dinner, I immediately knew who the culprit was.
18. Like a lot of little kids, my 3 year old thinks farts are absolutely hilarious, frequently doing it in some very embarrassing situations. So when **a fart was heard** in the middle of

Grandpa saying the blessing at Thanksgiving dinner, I immediately knew who the culprit was.

19. After my sister's husband got laid off, her family has really been struggling financially. Her husband looked for work for months with no luck, and with three kids plus another on the way, he started stealing in order to provide for his family. My sister really hates that he has to do this to make ends meet, but it seems **as long as the bacon was brought home,** she wouldn't try to stop him.
20. After my sister's husband got laid off, her family has really been struggling financially. Her husband looked for work for months with no luck, and with three kids plus another on the way, he started stealing in order to provide for his family. My sister really hates that he has to do this to make ends meet, but it seems **as long as an income was brought in,** she wouldn't try to stop him.
21. I recently got to attend a lecture given by one of the most famous anthropologists in the world. When the talk ended, I thought maybe people would be too intimidated to go talk to him, but that turned out not to be the case: immediately afterwards, **his brain was picked** relentlessly by eager students who wanted his opinion on their own studies.
22. I recently got to attend a lecture given by one of the most famous anthropologists in the world. When the talk ended, I thought maybe people would be too intimidated to go talk to him, but that turned out not to be the case: immediately afterwards, **he was bombarded with questions** relentlessly by eager students who wanted his opinion on their own studies.
23. We had our annual family reunion last weekend, and things got a little tense. A few weeks before the reunion, one of my cousins had gotten expelled from her college for

plagiarizing. I thought we all had a tacit understanding to not bring it up, but then of course my big-mouthed uncle just had to ask her about it in the middle of our meal. I tried to quickly divert the conversation to another topic, but it was too late: **the can of worms had been opened**, and everyone started reprimanding her.

24. We had our annual family reunion last weekend, and things got a little tense. A few weeks before the reunion, one of my cousins had gotten expelled from her college for plagiarizing. I thought we all had a tacit understanding to not bring it up, but then of course my big-mouthed uncle just had to ask her about it in the middle of our meal. I tried to quickly divert the conversation to another topic, but it was too late: **the topic had been brought up**, and everyone started reprimanding her.
25. I heard from a friend yesterday that our other friend, Jack, had gotten into a fight that afternoon. Jack's pretty big and strong, so I assumed he was fine, but I was completely wrong. When I saw him the next day, his face was all bruised up, he had some cuts on his face, and his nose was crooked. It looked like **his clock had been cleaned.**
26. I heard from a friend yesterday that our other friend, Jack, had gotten into a fight that afternoon. Jack's pretty big and strong, so I assumed he was fine, but I was completely wrong. When I saw him the next day, his face was all bruised up, he had some cuts on his face, and his nose was crooked. It looked like **his nose had been broken**.
27. At camp, the counselors are all really strict, and we follow a rigid schedule before bed. Pajamas must be on, teeth must be brushed, lights must be out, and **the sack must be hit** by 9:30pm sharp.

28. At camp, the counselors are all really strict, and we follow a rigid schedule before bed. Pajamas must be on, teeth must be brushed, lights must be out, and **eyes must be closed** by 9:30pm sharp.
29. Sometimes students cheat for years without getting caught, faking their way through tests, assignments, and finals. But eventually, they will get caught, and then **the music must be faced.**
30. Sometimes students cheat for years without getting caught, faking their way through tests, assignments, and finals. But eventually, they will get caught, and then **the consequences must be accepted.**
31. My school project partner is completely awful. I've been patient with him, but every day I meet with him, he does more and more things that make me angry. Yesterday, he came over to my house to work on the project, and he saw a portrait of my family hanging on the wall. He started making fun of how my mom looks, and that was the final straw. He quickly realized he had crossed a line and tried to apologize, but it was too late: **my grip had been lost** and his face had been punched.
32. My school project partner is completely awful. I've been patient with him, but every day I meet with him, he does more and more things that me angry. Yesterday, he came over to my house to work on the project, and he saw a portrait of my family hanging on the wall. He started making fun of how my mom looks, and that was the final straw. He quickly realized he had crossed a line and tried to apologize, but it was too late: **my composure had been lost** and his face had been punched.
33. Yesterday, the weather forecast said there was a chance of Atlanta receiving a little snow overnight, and just one hour later, I got an email from Emory saying classes had been

cancelled for the next day. And then it didn't even snow at all! Normally, I'm all in favor of cancelling classes when there's a reasonable chance of snow, but I really think **the gun was jumped** this time.

34. Yesterday, the weather forecast said there was a chance of Atlanta receiving a little snow overnight, and just one hour later, I got an email from Emory saying classes had been cancelled for the next day. And then it didn't even snow at all! Normally, I'm all in favor of cancelling classes when there's a reasonable chance of snow, but I really think **the decision was made rashly** this time.