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Passivizability of Idioms: Has the Wrong Tree Been Barked Up?

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Abstract

A growing number of studies support the partial compositionality of idiomatic phrases, while idioms are thought to vary in their syntactic flexibility. Some idioms, like *kick the bucket*, have been classified as inflexible and incapable of being passivized without losing their figurative interpretation (i.e., *the bucket was kicked* ≠ *died*). Crucially, this has never been substantiated by empirical findings. In the current study, we used eye-tracking to examine whether the passive forms of (flexible and inflexible) idioms retain or lose their figurative meaning. Active and passivized idioms (*he kicked the bucket*/*the bucket was kicked*) and incongruous active and passive control phrases *(he kicked the apple*/*the apple was kicked*) were inserted in sentences biasing the figurative meaning of the respective idiom (*die*). Active idioms served as a baseline. We hypothesized that if passivized idioms *retain* their figurative meaning (*the bucket was kicked* = *died*), they should be processed more efficiently than the control phrases, since their figurative meaning would be congruous in the context. If, on the other hand, passivized idioms *lose* their figurative interpretation (*the bucket was kicked* = *the pail was kicked*), then their meaning should be just as incongruous as that of both control phrases, in which case we would expect no difference in their processing. Eye movement patterns demonstrated a processing advantage for passivized idioms (flexible and inflexible) over control phrases, thus indicating that their figurative meaning was not compromised. These findings challenge classifications of idiom flexibility and highlight the creative nature of language.

Keywords

idioms, passive voice, syntactic flexibility, eye-tracking, reading, processing

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Introduction

Broadly speaking, *idioms* refer to phrases whose meaning extends beyond what is literally conveyed by their component words, and they are ubiquitous in everyday communication (Erman & Warren, 2000; Glucksberg, 1989; Pollio, 1977). However, the processing of idioms is far from straightforward. On the one hand, idioms defy compositional models of language processing as their figurative meaning is not fully derived from their component parts (Chafe, 1968; Chomsky, 1993; Fernando, 1978; Katz & Postal, 1965; Weinreich, 1969). For instance, the concept *die* cannot be computed by adding up the individual meanings of *kick, the*, and *bucket*. On the other hand, idioms seem to behave like compositional phrases in many ways: they adhere to basic grammatical rules, such as subject and tense agreement (*he kick**ed** the bucket*) (Schmitt, 2005), and some allow complex syntactic manipulations, including passivization (*the beans were spilled*) (Fraser, 1970).

The degree of compositionality of idioms is disputed in the literature. Some research has demonstrated a certain level of compositionality for idiomatic expressions, thus highlighting the involvement of syntactic processing in the activation of the idiomatic meaning (Cacciari & Tabossi, 1988; Cutting & Bock, 1997; Sprenger, Levelt, & Kempen, 2006). However, idioms are not generally thought to have full syntactic flexibility, meaning that they do not undergo complex syntactic operations as freely as literal compositional phrases. Alongside this, idioms are treated as idiosyncratic so that they vary in the range of syntactic manipulations they can undergo *without* compromising their figurative interpretation. Even structurally identical idioms such as *spill the beans* and *kick the bucket* (V + Det + N) are said to differ in the amount and types of syntactic operations they allow. The former is thought to be passivizable (*the beans were spilled*) (Cutler, 1982; Fraser, 1970), while the latter has been repeatedly labeled as syntactically frozen and incapable of being passivized without being interpreted literally (Fraser, 1970; Gibbs & Nayak, 1989; Langlotz, 2006; Makkai, 2011; Nunberg, 1978; Wulff, 2008). However, as will be discussed below, many of the claims are based on offline judgment tasks, which might not reflect how people comprehend idioms during online processing. The aim of the current study is to explore whether idioms' passivizability is indeed determined or influenced by their hypothesized degree of syntactic flexibility. We will start by looking at the relevant theories about the syntactic flexibility of idioms.

Some early views saw idioms as syntactic anomalies (Katz, 1973), with lexical approaches asserting that the components of idioms were not analyzed, but rather that idioms were stored and retrieved holistically as single lexical units directly from the mental lexicon (Gibbs, 1980; Swinney & Cutler, 1979), or a specified idiom list (Bobrow & Bell, 1973). A consequence of holistic storage was that idiomatic phrases were thought to be syntactically frozen, and the figurative meaning attached to a specific form of the idiom (i.e., the canonical form) (McGlone, Glucksberg, & Cacciari, 1994). This also served to explain why idioms were processed more quickly than matched literal phrases: idioms did not require time-consuming syntactic analyses (Swinney & Cutler, 1979). Many studies have reported faster processing for idioms (*spill the beans*) relative to comparable, compositional phrases (*spill the chips*) (Canal, Pesciarelli, Vespignani, Molinaro, & Cacciari, 2015; Carrol & Conklin, 2014b, 2017, 2019; Colombo, 2014; Conklin & Schmitt, 2008; Gibbs, 1980; Laurent, Denhières, Passerieux, Iakimova, & Hardy-Baylé, 2006; Ortony, Schallert, Reynolds, & Antos, 1978; Siyanova-Chanturia, 2015; Siyanova-Chanturia, Conklin, & Schmitt, 2011; Strandburg et al., 1993; Swinney & Cutler, 1979; Tabossi, Fanari, & Wolf, 2009; Underwood, Schmitt, & Galpin, 2004; Vespignani, Canal, Molinaro, Fonda, & Cacciari, 2010). However, this processing advantage may be a by-product of their conventionality, rather than their strictly lexical nature. That is, the tendency of idioms to appear in a certain form may bring factors to play, such

as familiarity, frequency of occurrence, and predictability, to name a few. These factors have been known to influence the processing speed of idioms, as well as other formulaic sequences (see Arnon & Snider, 2010; Burt, 1992; Cacciari, 2014; Cacciari & Tabossi, 1988; Cronk & Schweigert, 1992; Jiang & Nekrasova, 2007; Kim & Kim, 2012; Libben & Titone, 2008; McGlone et al., 1994; Reagan, 1987; Schweigert, 1986; Sosa & MacFarlane, 2002; Tabossi & Zardon, 2014).

Contrary to the predictions of the lexical approaches, syntactically and lexically modified idioms *are* used in their figurative sense, as evidenced by corpus and similar studies (Barlow & Kemmer, 2000; Cacciari & Glucksberg, 1991; Duffley, 2013; Hovhannisyan & Mkrtchyan, 2014; Langlotz, 2006; McGlone et al., 1994; Moon, 1998; Nunberg, Sag, & Wasow, 1994; Schmitt, 2005). Notably, a Google search by Duffley (2013) revealed instances of extreme idiomatic modifications, including examples such as *most of their buckets have been kicked*, where the idiom was both pluralized and passivized. Although one could argue that such instances are rare and, therefore, not representative of typical idiomatic use, they do challenge the assumption that idiomatic meanings are strictly associated with the canonical form of idioms. Additionally, it seems unlikely that separate entries would be stored for every possible idiomatic variant.

Recent empirical findings call into question lexical theories and demonstrate that syntactic analysis is involved during the processing of idiomatic phrases (Holsinger, 2013; Holsinger & Kaiser, 2013; Peterson, Burgess, Dell, & Eberhard, 2001). Structurally similar idioms can cause blending errors in production (Cutting & Bock, 1997), and are susceptible to syntactic priming effects (Snider & Arnon, 2012). The literal meanings of idiomatic words are sometimes found to be activated during idiomatic comprehension and production (Cacciari & Corradini, 2015; Cacciari & Tabossi, 1988; Sprenger et al., 2006). Collectively these findings show that idioms have internal structure and are subject to the same processing mechanisms as literal phrases. This has prompted a turn towards more compositional and hybrid models of idiomatic language processing.

The Configuration Hypothesis (Cacciari & Tabossi, 1988) posits that idioms are processed compositionally (and hence literally) until the recognition point is reached (referred to as the idiomatic "key"). The location of the recognition point is influenced by predictability, with an earlier recognition point for highly predictable idioms, as well as a biasing context accelerating recognition (Cacciari & Corradini, 2015; Cacciari et al., 2007; Fanari, Cacciari, & Tabossi, 2010; Tabossi, Fanari, & Wolf, 2009). After the recognition point, the idiomatic meaning is retrieved, which conflicts with the literal interpretation of the individual words in the idiom. Along similar lines, Cutting and Bock (1997), argued that idioms operate on two levels: the lexical level, where idiomatic meanings are stored as concepts, and the syntactic level, where idioms are analyzed as phrases. Sprenger et al. (2006), extended this model by introducing an intermediary level, called the Superlemma, whereby idiomatic words (*kick, the*, and *bucket*) activate a superlemma (*kick the bucket*), which in turn activates the idiomatic concept (*die*).

These models embrace the (partial) compositionality of idioms, but this has not been accompanied by a belief that idioms are *fully* syntactically adaptable. The Configuration Hypothesis (Cacciari & Tabossi, 1988) predicts that as long as a configuration is recognizable, the idiomatic meaning should be accessed regardless of any syntactic modifications. The Superlemma Theory (Sprenger et al., 2006), although underspecified about how modified idioms are processed,[1] could be used to explain the activation of modified idioms: an idiomatic concept could be activated due to spreading activation from the lemmas to the concept level, despite syntactic alterations. Neither model makes specific claims about potential processing costs because of syntactic modification. Importantly, an underlying assumption is that idioms form a heterogenous group of phrases and specific claims have been made about idioms' ability to take the passive voice. For example, certain idioms, such as *kick the bucket*, are considered particularly

resistant to the passive construction (Fraser, 1970; Gibbs & Nayak, 1989; Langlotz, 2006; Makkai, 2011; Nunberg, 1978; Wulff, 2008).

One of the first linguists who attempted to operationalize the syntactic flexibility of idioms was Fraser (1970), with his Frozenness Hierarchy—a scale comprised of six levels of flexibility, ranging from 0 (completely frozen), to 5 (fairly flexible). According to this, an idiom could undergo only as many syntactic operations as the ones formally prescribed by its respective level. The passive voice was allowed for idioms of levels 4 and 5. Therefore, a level 1 idiom (*kick the bucket*) could not be passivized and retain its idiomatic meaning, but a level 4 idiom (*spill the beans*) could. This model was developed based on Fraser's intuitions, and idioms were assigned to the various levels without empirical support for their classification.

An alternative proposal held that the flexibility (and therefore passivizability) of idioms was determined by the syntactic properties of the idioms' literal paraphrases (Newmeyer, 1972). For instance, *kick the bucket* and *chew the fat* could not be passivized because their single-word literal paraphrases, *die* and *chat* respectively, are both intransitive verbs. This proposal was refuted on the grounds that idioms like *give up the ghost* and *throw in the towel* are passivizable, despite having intransitive verbs as literal paraphrases (*die* and *resign* respectively) (e.g., Nunberg, 1978). Yet other accounts relied on semantic properties of idioms. Abeillé (1995) argued that the ability of (French) idioms to accept the passive voice was determined by the referential autonomy of the subject and object of an idiom; if the subject was also the patient/experiencer, as in *kick the bucket*, where the person who kicks the bucket is the person who dies, passivization was blocked. In contrast, if the subject was independent, as in the case of *spill the beans*, where one can reveal someone else's secrets, then passivization was permitted. Like Fraser's scale of flexibility, however, this theory has no empirical support. Furthermore, it could be argued that the semantic roles of idioms can be rather fluid. For example, one could imagine a situation where one *spills their own beans* (reveal their own secrets), or willfully *kicks someone else's bucket* (kill them).

An influential semantic account was proposed by Gibbs and Nayak (1989), which was based on Nunberg's (1978) theory of decomposition. According to Gibbs and Nayak, the components of semantically decomposable idioms, like *pop the question*, carry figurative meaning as a result of a direct mapping between their idiomatic and literal meanings. Thus, *pop* maps onto the meaning of *suddenly propose*, and *question* maps onto *marriage*. The figurative meaning of *propose marriage* can be conveyed even if the idiom is passivized (*the question was popped*). Conversely, nondecomposable idioms, such as *kick the bucket*, are nonpassivizable because the individual words are semantically empty; neither *kick* nor *bucket* maps onto the figurative meaning *die*. Thus, decomposable idioms are syntactically more flexible, whereas nondecomposable idioms are frozen. While Gibbs and Nayak found that people consistently rated decomposable idioms as more flexible, a study with Italian idioms by Tabossi et al. (2008) did not replicate this finding. An online study measuring reaction times to modified idioms (*he let the fat cat out of the bag*) also failed to find an effect of decomposition (Van de Voort & Vonk, 1995). Interestingly, Libben and Titone (2008) found that semantic decomposition only affected offline judgement tasks, where participants were asked to make a conscious decision on the compositionality of idioms, but not online measures, where the focus was on comprehension.

The flexibility of an idiom has also been associated with its degree of transparency, with transparent idioms being more flexible than opaque ones (Cacciari & Glucksberg, 1991; Nunberg et al., 1994). The idiom *spill the beans*, for example, has a transparent metaphorical correspondence between its literal and figurative meanings; one can easily identify an association between spilling beans from a container and revealing secrets. It is important to note that transparency and semantic decomposition are not necessarily overlapping concepts, as a transparent idiom may not be decomposable. For instance, *saw logs* (to snore) is transparent, due to the metaphoric relation between the

sound of snoring and the sound of sawing logs, but it is not decomposable as the component words *saw* and *logs* do not map onto *snore*. However, idioms like *kick the bucket* can be both nondecomposable and opaque, due to an absence of direct mapping as well as a lack of a metaphoric correspondence. Nunberg et al. (1994) hypothesized that in addition to decomposability and transparency, conventionality is an important factor in idiomatic flexibility. He defined conventionality as the possibility of predicting an idiom's figurative meaning in isolation, based solely on the idiom's component words. He claimed that highly conventionalized, opaque, and nondecomposable idioms like *kick the bucket* and *saw logs* "lose their idiomatic interpretation when they are deformed, as in the passive" (Nunberg et al., 1994, p. 507).

From the above discussion, we see that syntactic flexibility is attributed to some idioms, rather than being a property of idioms in general. A number of theories have attempted to operationalize the flexibility of idioms, and particularly their ability to be passivized, without empirical findings to adequately support any of them. To our knowledge, there is no evidence showing that passivizing idioms, be that flexible or frozen, prohibits their idiomatic interpretation from being activated during online language comprehension and especially when idioms are embedded in a facilitative context. Findings from a few studies have shown that a facilitative context can speed up the reading of both canonical (Carrol & Conklin, 2017; Siyanova-Chanturia et al., 2011) and modified idioms (*he didn't spill a single bean*) (Cacciari & Glucksberg, 1991; McGlone et al., 1994), and may increase the acceptability ratings of modified idioms in judgement tasks (Tabossi, Wolf, & Koterle, 2009). Glucksberg (2001) proposed that any syntactic operation should be available for idioms, provided that the component words are preserved and that a plausible communicative intent can justify the manipulation (e.g., using the passive voice to place the focus on the object of the phrase).

The present study uses eye-tracking to explore whether passivized idioms, embedded in idiomatically biasing contexts, retain their idiomatic interpretation. More specifically, it aims to test (a) whether participants can retrieve the figurative meaning of passivized idioms during sentence comprehension, and (b) whether factors believed to affect idiomatic processing (i.e., familiarity, frequency, and predictability) and syntactic flexibility (i.e., decomposability/transparency) might contribute to this. We hypothesized that a biasing context would be strong enough to prime the figurative meaning regardless of voice, but naturally, due to the low frequency, familiarity, and predictability of the passivized forms, as opposed to the canonical forms, we anticipated that passivized idioms would take longer to process than active ones. Finally, we expected that decomposability/transparency would not affect the online processing of idiomatic phrases.

Before turning to the study, it is important to define what we mean by idiom. We take idioms to be formulaic sequences, whose meanings are not entirely predictable from the literal meanings of the individual words that constitute them. In particular, we focus on three-word idioms having the structure V+NP. Further, for the sake of clarity, from this point onwards we will use the term transparency as an umbrella term for transparency, decomposability, and conventionality, since these factors overlap to a certain degree and are, therefore, difficult to distinguish in norming studies. More specifically, we take transparency to mean how obvious or guessable the meaning of an idiom is in isolation.

2 Methodology

2.1 Participants

Sixty native speakers of English, all first-year undergraduate students at the University of Nottingham (Mean age = 18.53, range 18–20; nine males and 51 females), participated in the eye-tracking study and received course credit for their participation.

Table 1. Summary of idiom characteristics.

	Mean	Std dev.	Variance
Frequency	3.36	0.69	0.48
Familiarity	4.30	0.77	0.59
Transparency	3.97	0.68	0.46
Active voice predictability	0.38	0.33	0.11
Passive voice predictability	0.28	0.25	0.06

2.2 Materials

Eighty-four idioms were drawn from the Collins COBUILT Idioms Dictionary (2011). To enable the passive transformation, all idioms were comprised of a transitive verb (V) plus a noun phrase (NP) (see list of idioms in Appendix 1). A series of norming procedures were followed to account for the (a) frequency, (b) familiarity, (c) transparency, and (d) predictability of the idioms.

2.3 Norming

Ninety-two participants from the same population, but different from those in the eye-tracking study, took part in the norming studies. In four separate questionnaires, participants provided ratings of frequency ($n = 16$), familiarity ($n = 16$), and transparency ($n = 16$) for the idioms. The idioms along with filler phrases were judged on a scale from 1 to 5—1 always being the most negative pole (least frequent/familiar/transparent) and 5 being the most positive (very frequent/familiar/transparent). The filler items were literal expressions and, in the case of familiarity, other idiomatic expressions accompanied by an incorrect definition (*The straw that broke the camel's back* means to treat animals poorly).

The predictability of both active and passivized idioms was assessed via cloze tests both with and without accompanying context by 44 different participants. For the with-context condition, participants were presented with the stimuli sentences used in the eye-tracking study, leading up to the final idiomatic word which was replaced by a blank, and participants were asked to fill in the blank with the first word that came to mind. There were four versions of this test, so that voice (active/passive) was counterbalanced with the context and no-context conditions. Only the scores from the with-context condition were included in the analyses, since the without-context condition almost never had "correct" completions.

Independent sample *t*-tests were conducted to compare the ratings for idioms and filler items for frequency, familiarity, and transparency, whereas for predictability a paired-samples *t*-test was used. The descriptive statistics are presented in Table 1. Idioms were rated significantly more familiar ($M = 4.30$, $SD = 0.77$) than fillers ($M = 2.27$, $SD = 0.82$); $t(196) = -18.472$, $p < 0.001$, more frequent ($M = 3.36$, $SD = 0.69$) than fillers ($M = 2.00$, $SD = 0.68$); $t(156) = -12.27$, $p < 0.001$, as well as more transparent ($M = 3.97$, $SD = 0.68$) than fillers ($M = 3.34$, $SD = 1.09$); $t(156) = -4.41$, $p < 0.001$. The final words of active idioms in context (nouns) were predicted correctly approximately one-third of the time ($M = 0.38$, $SD = 0.33$), and they were significantly more predictable than final words of passivized idioms in context (verbs) ($M = 0.28$, $SD = 0.25$); $t(83) = 2.44$, $p = .04$. Overall, the norming shows that the idioms were familiar, frequent, and transparent, but of relatively low predictability.

Table 2. Example of an idiom in the active and passive voice and its matched controls in the active and passive voice.

No.	Condition	Stimulus example
1	Idiom active	Old John seemed to respond well to the new treatment at first, but eventually **he kicked the bucket** and his daughters needed to plan his funeral.
2	Idiom passive	Old John seemed to respond well to the new treatment at first, but eventually **the bucket was kicked** and his daughters needed to plan his funeral.
3	Control active	Old John seemed to respond well to the new treatment at first, but eventually **he kicked the apple** and his daughters needed to plan his funeral.
4	Control passive	Old John seemed to respond well to the new treatment at first, but eventually **the apple was kicked** and his daughters needed to plan his funeral.

2.4 Main study

All 84 idioms were paired with a control phrase by substituting the final word of the idiom with another noun that matched in frequency and word-length (*kick the apple* for *kick the bucket*). There were overall four conditions in a 2 x 2 design: (1) idiom active, (2) idiom passive, (3) control active, and (4) control passive (see Table 2 for an example). All phrases were embedded in a sentential context, intended to bias the figurative meaning of the respective idiom (e.g., *die* for *kick the bucket*). Thus, the control phrases as in (3) and (4) were *always* incongruent with the meaning of the sentence. For instance, one can kick an apple, since apples are potentially kickable objects, but the phrase *kick the apple* is pragmatically anomalous in a context about death. Active idioms (1), on the other hand, were always congruent, since their figurative meaning conveyed the intended meaning of the sentence. Crucially, we were mostly interested to see how passivized idioms, as in (2), would be processed. Their contextual congruency should be solely dependent upon the phrase retaining or losing its figurative interpretation: if *the bucket was kicked* were to retain the figurative meaning *die*, then the meaning of the phrase would be congruous in the sentence, but if the phrase were to be interpreted literally (*the bucket was literally kicked*), then the (literal) meaning of the phrase would be incongruous, just like the meanings of the active and passive control phrases. Therefore, we hypothesized that in the former case passivized idioms should be easier to integrate in the context and this should be reflected by a faster processing, while in the latter case we would expect no difference in the processing of passivized idioms versus active or passive control phrases.

The interest areas (IAs) (idiomatic/control phrases) were never placed at the end of a sentence or a line break to avoid wrap-up effects and the programming associated with saccades. The length of the IAs was largely unaffected by the manipulation due to the inclusion of the copular verb *be* and the exclusion of the subject in the passive voice. For example, *he spilled the beans* and *the beans were spilled* both consist of four words of comparable length. The overall length of the phrases depended on the tense and aspect used; simple past tense yielded four-word phrases (146 items), whereas perfect and continuous aspects yielded five-word phrases (*she had spilled the beans* and *the beans had been spilled*; 22 items). The same was true for the matched control items.

The optional by-phrase of the passive voice was never used for two reasons: (a) to control the length of the phrases, and (b) to avoid unnatural phrasing. For example, in cases where the idioms included body parts or where the subjects were also the patients, by-phrases sound unnatural (*her lips were buttoned by herself*).

2.5 Procedure

The sentences were distributed across four lists using a Latin square design, so that each participant saw each phrase in only one of the four conditions. Care was taken so that the lists were balanced regarding the familiarity, frequency, predictability, and transparency of the idioms. The same 85 filler sentences were used across the lists. These were literal sentences or sentences containing other types of formulaic sequences (binomials, proverbs, etc.). The formulaic sequences in some filler items were also modified in order to distract the participants from the passive voice manipulation (*chips and fish, fed with golden forks, etc.*).

Eye-tracking was carried out with an EyeLink 1000+ desktop-mount eye-tracker (sampling rate 500 Hz). Participants were seated in front of a computer monitor and a chin- and head-rest was used to minimize head movement. The eye-tracker was calibrated using a nine-point grid, and re-calibration was performed as necessary.

Each experimental sentence or filler was triple-spaced and displayed one at a time, in black font (Courier New, size 14) on a white background. Items were always preceded by a drift correction. Participants were given oral and written instructions to read the sentences as quickly as possible but for comprehension and to press ENTER to proceed from one item to the next. Random Yes/No comprehension questions were included for filler items to ensure participants' attention. All trials were randomized across participants.

3 Results

Accuracy on the comprehension questions was high (84%), indicating that the participants had no difficulty with the task. Following visual inspection of the data, one participant was excluded from the analyses due to extreme values across all eye-tracking measures in all conditions. Fixations shorter than 80 ms were removed, as were data compromised due to track loss (4.7% together). No further data were removed.

Analyses were carried out on the phrases (whole idiom/control phrase), and the content words (verbs and nouns), to allow for comparisons of the whole phrase and that of its component parts. Analyses of individual words were split by voice, so that the active idiomatic verbs were compared with the active control verbs, the passive idiomatic verbs with the passive control verbs, and so on. We avoided an analysis of phrase-final words across voice, since that would entail a direct comparison of two distinct grammatical classes: nouns in the active and verbs in the passive conditions. Means for the phrases and individual words can be seen in Table 3 below.

For all IAs, we analyzed the data drawn from three late eye-tracking measures, namely: total reading time (duration of all fixations including re-fixations), fixation count (the total number of fixations), and regressions (the likelihood of re-fixation into the IA after the eye has moved to the right). For verbs and nouns, we also included an analysis of first pass reading time (duration of all fixations before eyes exited to the left/right), which is an early eye-tracking measure appropriate for the analysis of single words (Carrol & Conklin, 2014a, 2014b; Conklin, Pellicer-Sánchez, & Carrol, 2018).

We analyzed the data using linear mixed effect models with the *lme4* package, version 1.1–15, (Bates, Maechler, Bolker, & Walker, 2014) in R, version, 3.4.3, (R Core Team, 2018). Idiomaticity and voice were incorporated in the models as fixed effects, each with two levels: idiom versus control and active versus passive. The idiom level and active level were each set as the baselines (0). We included frequency, familiarity, transparency, and predictability of idioms as additional fixed effects to check whether idiomaticity or voice would interact with any of them.[2] These predictors were included in models where both idioms and controls were analyzed, as well as in

Table 3. Results for phrases and words in the active and passive voice for the idiom and the control.

		Total reading time		*Fixation count*		*Regression likelihood*		*First pass reading time*	
		Mean (ms)	*SE*	Mean	*SE*	Mean	*SE*	Mean (ms)	*SE*
Phrases									
Active	Idiom	603	22.55	3.39	0.11	0.41	0.03		
	Control	745	28.79	4.23	0.15	0.58	0.03		
Passive	Idiom	657	24.43	3.68	0.12	0.39	0.03		
	Control	794	32.16	4.41	0.17	0.56	0.03		
Content words									
Active voice									
Verb	Idiom	252	7.36	1.47	0.04	0.22	0.02	191	3.62
	Control	292	8.40	1.73	0.04	0.35	0.02	192	3.37
Noun	Idiom	227	4.47	1.29	0.03	0.06	0.01	193	3.27
	Control	264	6.85	1.55	0.04	0.18	0.01	194	3.34
Passive voice									
Verb	Idiom	238	6.31	1.36	0.03	0.10	0.01	193	3.37
	Control	275	8.00	1.59	0.04	0.11	0.01	198	3.99
Noun	Idiom	247	6.77	1.43	0.04	0.17	0.01	194	3.82
	Control	281	8.71	1.63	0.04	0.30	0.02	196	3.71

separate models where only idioms were analyzed. Trial sequence number and list were also added as fixed effects. By-subject and by-item random slopes and intercepts were included as random effects (Barr, Levy, Scheepers, & Tily, 2013).

Frequency, familiarity, and transparency were all correlated (with all rs > 0.5 and all ps < 0.05). To avoid issues of collinearity, we orthogonalized these factors by residualizing. Since transparency was more central to our research question, we first residualized transparency against familiarity and frequency, and then familiarity against frequency. The remaining predictors were centered to avoid having a change in slope that might correlate with a change in intercept. The residualized and centered variables were highly correlated with their original variables (all rs $>$ 0.55 and all ps < 0.05).

Model components were added in a stepwise manner and following comparisons of the resulting models, only significant covariates were retained. Additive models were initially fitted, and interactions were only included if they significantly improved the model. Different models were fitted for each eye-tracking measure. For the likelihood of regression (a binary variable), logistic linear models were fitted (Jaeger, 2008), while for fixation count generalized linear models with *poisson* regression were fitted. All durational measures were log-transformed and analyzed using linear mixed effects models. The means of the model outcomes and all pairwise comparisons were calculated using the *emmeans* package (Lenth, 2018).

3.1 Phrasal analysis

Table 4 presents the model outcomes for all phrase-level measures. When both phrase types were considered, idiomaticity and voice were significant factors, with idiomatic phrases being

Table 4. Mixed–effects model estimates for all phrase-level measures.

Pred.	**Total reading time**			**Fixation count**			**Regression likelihood**		
	All phrases			*All phrases*			*All phrases*		
	β	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
Fixed effects									
(Inter.)	6.50***	150.90	0.04	1.33***	31.00	0.04	–0.04	–0.12	0.29
Idiomaticity	0.28***	7.74	0.04	0.29***	7.23	0.04	0.71***	9.62	0.07
Voice	0.10**	2.70	0.04	0.08	1.81	0.04			
Freq.	–0.06**	–2.99	0.02	–0.06**	–3.13	0.02	–0.05	–1.05	0.05
Trial no.	–0.00***	–4.80	0	–0.00***	–4.2	0	–0.01***	–8.58	0
Idiom.* Voice	0	0.09	0.05	–0.01	–0.14	0.06			
Idiom.* Freq.	0.05*	2.39	0.02	0.06**	2.86	0.02			
Idiom.* Trial no.	–0.00*	–2.44	0	–0.00*	–1.99	0			
Voice* Freq.	0	0.17	0.02	0.02	0.81	0.02			
Voice* Trial no.	0	–0.36	0	0	0.11	0			
Idiom.* Voice* Freq.	0.01	0.31	0.03	0	–0.17	0.03			
Idiom.* Voice* Trial no.	0	–0.64	0	0	–0.56	0			
Fam.							–0.18*	–2.39	0.07
Trans.							0.21	1.81	0.11
Pred. act.							–0.16***	–3.31	0.05
Random effects									
σ^2	0.17								
$\tau_{00,item}$	0.02			0.01			0		
$\tau_{00,ppt}$	0.06			0.05			0.89		
ρ_{01}	–0.23			1					
	Active idioms			*Active idioms*			*Active idioms*		
	β	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
Fixed effects									
(Inter.)	6.50***	151.31	0.04	1.42***	31.04	0.04	–0.17	–0.98	0.18
Idiomaticity									
Voice									
Freq.	–0.06**	–2.99	0.02	–0.04*	–3.05	0.02	–0.06	–0.79	0.08
Trial no.	–0.00***	–4.69	0	–0.00***	–3.89	0	–0.01*	–2.26	0
Random effects									
σ^2	0.15								
$\tau_{00,item}$	0.02			0.01			0.07		
$\tau_{00,ppt}$	0.06			0.04			0.83		
	Passive idioms			*Passive idioms*			*Passive idioms*		
	β	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
Fixed effects									
(Inter.)	1.34***	157.78	0.04	1.42***	35.00	0.04	0.07	0.41	0.17
Idiomaticity									
Voice									

Table 4. (Continued)

	Passive idioms			*Passive idioms*			*Passive idioms*		
	β	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
Freq.	–0.06**	–2.92	0.02	–0.04*	–2.30	0.02	–0.21*	–2.52	0.08
Trial no.	–0.00***	–5.61	0	–0.00***	–4.28	0	–0.01***	–3.78	0
Random effects									
σ^2	0.16								
$\tau_{00,item}$	0.02			0.01			0.24		
$\tau_{00,ppt}$	0.06			0.04			0.6		

Notes: *$p < .05$ **$p < .01$ ***$p < .001$.

significantly faster ($M = 629.49$ ms, $SD = 22.95$) than control phrases ($M = 769.851$ ms, $SD = 29.84$, $p < .001$), and active phrases significantly faster ($M = 670.74$ ms, $SD = 24.19$) than passive ones ($M = 722.49$ ms, $SD = 26.67$, $p < .001$). Trial number was a significant predictor, with all phrase types being read faster as trial number increased. Frequency was also significant, and it interacted with idiomaticity: as frequency increased, idiomatic phrases were read faster, while control phrases were read more slowly. The separate analysis of idioms only, replicated the findings of the overall phrasal analysis: there was a significant influence of frequency and trial number for active and passivized idioms with increased frequency and trial number leading to a faster reading time.

The analysis on fixation count also indicated an effect of idiomaticity, with idiomatic phrases eliciting significantly fewer fixations ($M = 3.53$, $SD = 0.11$) than control phrases ($M = 4.32$, $SD = 0.15$, $p < .001$). While active phrases also elicited fewer fixations ($M = 3.79$, $SD = 0.12$) than passive ones ($M = 4.03$, $SD = 0.13$, $p < .001$), the overall effect of voice was only marginally significant ($p = .07$). Trial number was significant with all phrase types eliciting fewer fixations as the experiment progressed. Frequency was significant, and it significantly interacted with idiomaticity: as frequency increased, idiomatic phrases yielded fewer fixations, while control phrases had more. The idioms-only analysis replicated this pattern.

Idiomaticity was also significant in the analysis of regressions, with idioms being less likely to elicit a regression ($M = 0.40$, $SE = 0.02$) than controls ($M = 0.57$, $SE = 0.03$, $p = < .001$), but voice was not significant in this measure. There was a significant effect of familiarity and predictability, which affected both idioms and control phrases alike: the more familiar and predictable the canonical (active) idiom was, the less likely it was for regressions to be elicited by both idioms and control phrases. There was also a marginal effect of transparency ($p = .07$), by which increased transparency led to fewer regressions for idioms and control phrases. The analysis on idioms only highlighted some differences between active and passive idioms. Active idioms were less likely to elicit a regression with increased familiarity, predictability and trial number, while passive idioms were less likely to do so with increased frequency and trial number. That is, the more frequent the canonical active form of an idiom was, the less likely it was for its passivized form to elicit a regression.

There was no interaction between voice and idiomaticity in any measure, but pairwise comparisons indicated significant contrasts between active idioms, passive idioms, active control phrases, and passive control phrases. As can be seen in Tables 3 and 5, active idioms were read significantly faster than all other types of phrases, passivized idioms were read faster than both control phrases, and active control phrases were read faster than passive control phrases. The same pattern was

Table 5. Summary of pairwise comparisons between phrases.

	Total reading time			Fixation count			Regression likelihood		
	Ratio	*SE*	*p*	*Ratio*	*SE*	*p*	*Ratio*	*SE*	*p*
Comparisons									
Idiom active * control active	0.80	0.01	<.001	0.80	0.01	<.001	0.50	0.03	<.001
Idiom active * idiom passive	0.91	0.01	0.001	0.92	0.01	0.001	1.05	0.08	1.00
Idiom active * control passive	0.75	0.01	<.001	0.76	0.01	<.001	0.50	0.06	<.001
Control active * idiom passive	1.13	0.02	<.001	1.14	0.02	<.001	2.08	0.20	<.001
Control active * control passive	0.93	0.01	0.01	0.95	0.02	0.24	1.05	0.08	1.00
Idiom passive * control passive	0.82	0.01	<.001	0.83	0.01	<.001	0.50	0.03	<.001

observed in the number of fixations, although in this case there was no significant difference between the control conditions. Active and passive idioms were also significantly less likely to elicit a regression than both control phrases, but they did not differ between them. Control phrases also did not differ for this measure. The *p*-values for all pairwise comparisons were adjusted using the Bonferroni correction.

3.2 Lexical analysis

Table 6 presents the model outputs for the word-level analyses across measures. Idiomaticity and voice were not significant factors in first pass reading time, so they were removed from the models. Verbs in active phrases (*he **kicked** the bucket/apple*) were read faster as a function of increased trial number, while nouns in active phrases (*he kicked the **bucket/apple***) were read faster as a function of increased frequency (of the respective active idiom), regardless of idiomaticity. Verbs in passive phrases (*the bucket/apple was **kicked***) were read faster when an active idiom was predictable (again regardless of idiomaticity), whereas nouns in passive phrases (*the **bucket/apple** was kicked*) were not influenced by any predictors.

The separate analysis on idiomatic words only showed that the verbs in active idioms (*he **kicked** the bucket*) were read faster when the predictability of their passive forms increased. Though seemingly counterintuitive, it must be remembered that the predictability of the passive idioms was based on the predictability of the verb (*kicked*), as this was the final word elicited by the cloze task (*the bucket was* ____). Thus, the more predictable the idiomatic verb (in the passive form), the faster it was read in the active form. The nouns in active idioms (*bucket*) were affected by frequency: the more frequent the idiom was, the faster its noun was read, while the nouns in passive idioms were affected by the predictability of active idioms. Again, this is not surprising, since the predictability of the active idioms was measured by the predictability of their noun (*bucket*), and therefore, the more predictable the idiomatic noun, the faster that noun was read when encountered in the passivized form.

The output for total reading time demonstrates that idiomaticity was highly significant: nouns and verbs in both active and passive conditions were read significantly faster when they were parts of idiomatic phrases as opposed to control phrases. There was a significant speed up from increased trial number for active phrase verbs, but there was only an interaction between idiomaticity and trial number for the remaining conditions, indicating that this effect only affected the verbs and nouns in control phrases, as opposed to in idioms. Frequency was significant, and it interacted with idiomaticity: idiomatic nouns in active idioms (*bucket*) were read significantly faster than the control nouns in active phrases (*apple*) as a function of the frequency of the

Table 6. Model outputs across measures for word analyses split by voice and idiomaticity.

Pred.	**First pass reading time**			**Total reading time**			**Fixation count**			**Regression likelihood**		
	Active phrase			*Active phrase*			*Active phrase*			*Active phrase*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
	Verb			**Verb**			**Verb**			**Verb**		
Fixed effects												
(Inter.)	5.22 ***	263.74	0.02	5.59 ***	161.62	0.03	0.48 ***	11.31	0.04	–0.88 ***	–5.96	0.14
Idiom.				0.15 ***	6.53	0.02	0.16 ***	4.76	0.03	0.71 ***	6.15	0.11
Trial no.	0.00 *	2.45	0.00	–0.00 **	–3.27	0.00	–0.00 **	–3.21	0.00	–0.01 ***	–5.08	0.06
Freq.												
Pred. act.										–0.24 ***	–3.78	0.06
Pred. pas.												
Idiom.*Freq.												
Idiom.*Trial no.												
Idiom.*Pred. act												
Fam.												
Trans.												
Random effects												
σ2	0.09			0.22			0.00			0.18		
τ00, item	0.00			0.01			0.02			0.40		
τ00, ppt	0.02			0.03						–0.65		
ρ01												

(Continued)

Table 6. (Continued)

Pred.	**First pass reading time**			**Total reading time**			**Fixation count**			**Regression likelihood**		
	Active phrase			*Active phrase*			*Active phrase*			*Active phrase*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	z	*SE*	*β*	z	*SE*
	Noun			**Noun**			**Noun**			**Noun**		
Fixed effects												
(Inter.)	5.26 ***	342.89	0.02	5.46 ***	156.82	0.03	0.36 ***	8.27	0.04	–2.49 ***	–8.99	0.27
Idiom.				0.22 ***	5.52	0.04	0.18 ***	4.84	0.04	0.00	–0.86	0.00
Trial no.				0.00	–1.28	0.00	–0.00 **	–3.27	0.00	1.28 ***	4.33	0.29
Freq.	–0.02 **	–3.04	0.01	–0.06 ***	–3.56	0.02						
Pred. act.										–0.64 ***	–3.66	0.17
Pred. pas.												
Idiom.*Freq.				0.06 **	–1.28	0.02						
Idiom.*Trial no.				–0.00 *	–2.12	0.00				0.00	–0.52	0.00
Idiom.*Pred. act										–0.46 *	2.54	0.18
Fam.										–0.39	–1.75	0.22
Trans.												
Random effects												
σ2	0.10			0.20			0.00			0.53		
τ00, item	0.00			0.01			0.01			0.74		
τ00, ppt	0.01			0.02						–0.87		
ρ01	1.00			1.00								

Table 6. (Continued)

	Passive phrase			*Passive phrase*			*Passive phrase*			*Passive Phrase*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
	Verb			**Verb**			**Verb**			**Verb**		
Fixed effects												
(Inter.)	5.26 ***	313.86	0.02	5.48 ***	279.42	0.04	0.34 ***	6.35	0.05	−1.95 ***	−11.20	0.17
Idiom.				0.27 ***	6.66	0.04	0.29 ***	4.16	0.07			
Trial no.				0.00	−0.49	0.00	0.00	−0.54	0.00	−0.01 **	−2.99	0.00
Freq.												
Pred. act.	−0.02 *	−2.29	0.01									
Pred. pas.												
Idiom.*Freq.												
Idiom.*Trial no.				−0.00 ***	−3.49	0.00	−0.00 *	−2.21	0.00			
Idiom.*Pred. act												
Fam.												
Trans.												
Random effects												
σ2	0.10			0.19			0.00			0.66		
τ00, item	0.00			0.02			0.01			0.26		
τ00, ppt	0.01			0.02						−0.35		
ρ01												
	Noun			**Noun**			**Noun**			**Noun**		
Fixed effects												
(Inter.)	5.24 ***	238.05	0.02	5.53 ***	149.93	0.04	0.39 ***	7.40	0.05	−1.10 ***	−7.02	0.16
Idiom.				0.25 ***	5.77	0.04	0.26 ***	3.59	0.07	0.80 ***	6.05	0.13
Trial no.	0.00	1.42	0.00	0.00	−0.96	0.00	0.00	−0.68	0.00	−0.01 ***	−5.73	0.00
Freq.												

(Continued)

Table 6. (Continued)

	Passive phrase			*Passive phrase*			*Passive phrase*			*Passive Phrase*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
	Noun			**Noun**			**Noun**			**Noun**		
Pred. act.				–0.06 **	–2.98	0.02				–0.20 **	–2.84	0.07
Pred. pas.												
Idiom.*Freq.												
Idiom.*Trial no.				–0.00 **	–3.14	0.00	–0.00 *	–1.98	0.00			
Idiom.*Pred. act				0.03	1.60	0.02						
Fam.												
Trans.												
Random effects												
σ2	0.10			0.21			0.00			0.29		
τ00, item	0.00			0.01			0.01			0.35		
τ00, ppt	0.02			0.02			–1.00			–0.67		
ρ01												
	Active idiom			*Active idiom*			*Active idiom*			*Active Idiom*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
	Verb			**Verb**			**Verb**			**Verb**		
Fixed effects												
(Inter.)	5.25 ***	2.33	0.02	5.53 ***	193.25	0.03	0.39 ***	13.62	0.03	–1.01 ***	–5.63	0.18
Idiom.												
Trial no.										–0.01 *	–2.34	0.00
Freq.				–0.04 *	–2.09	0.02	–0.05 *	–2.13	0.03	–0.18 *	–2.08	0.09
Pred. act.												
Pred. pas.	0.02 *	2.33	0.01									
Idiom.*Freq.												

Table 6. (Continued)

	Active idiom			*Active idiom*			*Active idiom*			*Active Idiom*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	*z*	*SE*	*β*	*z*	*SE*
	Verb			**Verb**			**Verb**			**Verb**		
Idiom.*Trial no.												
Idiom.*Pred. act												
Fam.												
Trans.												
Random effects												
σ2	0.09			0.20			0.00			0.17		
τ00, item	0.00			0.01			0.01			0.40		
τ00, ppt	0.02			0.03								
ρ01												
	Noun			**Noun**			**Noun**			**Noun**		
Fixed effects												
(Inter.)	5.26 ***	314.68	0.02	5.43 ***	241.03	0.02	0.26 ***	9.13	0.03	–2.91 ***	–14.27	0.20
Idiom.												
Trial no.												
Freq.	–0.03 *	–2.51	0.01	–0.06 ***	–4.27	0.01	–0.06 *	–2.03	0.03	–0.25	–1.64	0.15
Pred. act.										–0.52 **	–2.60	0.20
Pred. pas.												
Idiom.*Freq.												
Idiom.*Trial no.												
Idiom.*Pred. act												
Fam.										–0.51 *	–2.29	0.22
Trans.										0.74	1.88	0.39
Random effects												
σ2	0.09			0.16			0.00			0.49		
τ00, item	0.00			0.00			0.00			0.72		
τ00, ppt	0.01			0.02								
ρ01												

(Continued)

Table 6. (Continued)

	Passive idiom			*Passive idiom*			*Passive idiom*			*Passive Idiom*		
	β	*t*	*SE*	*β*	*t*	*SE*	*β*	z	*SE*	*β*	z	*SE*
	Verb			**Verb**			**Verb**			**Verb**		
Fixed effects												
(Inter.)	5.25 ***	220.81	0.02	5.48 ***	219.98	0.02	0.34 ***	6.62	0.05	–2.33 ***	–15.42	0.15
Idiom.												
Trial no.	0.00	0.61	0.00									
Freq.										–0.28 *	–2.15	0.13
Pred. act.												
Pred. pas.				–0.04 *	–2.51	0.02						
Idiom.*Freq.												
Idiom.*Trial no.												
Idiom.*Pred. act												
Fam.												
Trans.												
Random effects												
σ2	0.09			0.17			0.00			0.56		
τ00, item	0.00			0.01			0.00			0.27		
τ00, ppt	0.01			0.02								
ρ01												
	Noun			**Noun**			**Noun**			**Noun**		
Fixed effects												
(Inter.)	5.26 ***	270.23	0.02	5.51 ***	210.85	0.03	0.40 ***	7.62	0.05	–1.58 ***	–13.15	0.12
Idiom.												
Trial no.												
Freq.				–0.01	–0.75	0.02				–0.20 *	–2.06	0.10
Pred. act.	–0.03 **	–2.68	0.01	–0.05 *	–2.55	0.02						

Table 6. (Continued)

	Passive idiom			*Passive idiom*			*Passive idiom*			*Passive Idiom*		
	β	*t*	*SE*	β	*t*	*SE*	β	*z*	*SE*	β	*z*	*SE*
	Noun			**Noun**			**Noun**			**Noun**		
Pred. pas.												
Idiom.* Freq.												
Idiom.*Trial no.												
Idiom.*Pred. act												
Fam.												
Trans.												
Random effects												
σ2	0.10			0.20			0.00			0.24		
τ00, item	0.00			0.01			0.00			0.25		
τ00, ppt	0.02			0.02								
ρ01												

Notes: *$p < .05$ **$p < .01$ ***$p < .001$.

respective (active) idioms. Nouns in passive phrases, on the other hand, benefitted from increased predictability: the more predictable the noun of an active idiom, the faster its respective noun was read in the passive phrases, regardless of idiomaticity. There was no interaction between predictability and idiomaticity.

When examining the total reading time for idiomatic verbs and nouns only, we found a facilitative effect of frequency, which extended to both verbs and nouns of active idioms. There was also a facilitative effect of predictability on the nouns and verbs of passive idioms: passive idiomatic verbs were read faster when there was increased predictability of the passive idiom (the final verb), and nouns were read faster when there was increased predictability of the active idiom (the final noun).

Analysis on fixation count indicated a strong effect of idiomaticity for verbs and nouns in active and passive phrases: verbs and nouns elicited fewer fixations when they were part of idioms versus control phrases. Verbs and nouns in active phrases elicited fewer fixations as trial number increased, regardless of idiomaticity. However, only the verbs and nouns in passive control phrases exhibited this pattern: verbs and nouns in passive idioms were not affected by trial number. The idioms-only analysis demonstrated an effect of phrase frequency for both verbs and nouns in active idioms: the verbs and nouns of more frequent idioms yielded fewer fixations. No effects were noted for verbs or nouns in passive idioms for fixation count.

Finally, the regression analysis indicated an effect of idiomaticity for verbs and nouns of active phrases, whereby verbs and nouns found in idioms were significantly less likely to elicit a regression than the equivalents in controls. This also held for the nouns of passive phrases, but not for the verbs of passive phrases. There was an overall effect of trial number with verbs and nouns in active and passive phrases eliciting fewer regression as the trial number increased. The nouns and verbs in active and passive phrases were also facilitated by the predictability of the idiomatic nouns (in the active voice). There was also an interaction between idiomaticity and predictability for the nouns of active phrases, with nouns of active idioms being significantly more likely to yield a regression than nouns of active controls. There was no interaction between idiomaticity and predictability for the verbs of active phrases, suggesting that idiomatic and control verbs (*kicked*) did not differ in this respect.

When only idioms were considered, there was an effect of phrasal frequency for verbs in active idioms, as well as for verbs and nouns in passive idioms. The more frequent the (active) idiom was, the less likely it was for a regression to occur to the respective words. Nouns of active idioms, on the other hand, were influenced by familiarity and predictability. The more familiar and predictable the (active) idiom was, the less likely it was for a regression to occur on the noun of the active idiom.

4 Discussion

The present study examined two main questions. First, we explored whether passivized idioms, inserted in idiomatically biasing contexts, activate their idiomatic meaning during online reading comprehension, or whether they are reduced to compositional strings that as such are not idiomatic and therefore do *not* make sense in the context. Second, we were interested in whether familiarity, frequency, transparency, and predictability influence the processing of passivized idioms. To this end, we compared eye movement patterns to active (canonical) and passivized idioms to those of active and passive control phrases.

We start by considering the first question. We see that the total reading time for the whole phrase demonstrated an effect of both voice and idiomaticity. Active phrases were read significantly faster than passive ones and idiomatic phrases were read significantly faster than control ones. Active and idiomatic phrases also elicited significantly fewer fixations than passive and control phrases

respectively, but only idiomatic phrases were significantly less likely to elicit a regression. Unsurprisingly, active idioms (*he kicked the bucket*) were the fastest and elicited the fewest fixations. Crucially, passivized idioms (*the bucket was kicked*) were read faster and elicited fewer fixations than both active and passive control phrases (*he kicked the apple*/*the apple was kicked*). Passive control phrases were also slower to read than active control phrases, but they did not differ in the number of fixations. Active and passive idioms alike were significantly less likely to elicit a regression compared to active and passive control phrases.

At the word-level (*kick* and *bucket/apple*), idiomaticity did not modulate the first pass reading time of either the verbs or nouns, but it significantly influenced total reading time, fixation count, and regressions in most conditions. More specifically, verbs and nouns in idiomatic phrases were read faster and elicited fewer regressions than verbs and nouns in control phrases, regardless of voice. Idiomatic verbs in passive voice and idiomatic nouns in both voices were also less likely to yield a regression compared to control verbs and nouns respectively.

The overall findings from both phrase- and word-level analyses show that passivized idioms and their component words had an advantage over active and passive controls and their respective components. This suggests that passivized idioms did retain their figurative meaning: the fact that they were faster to process (as evidenced by fewer and shorter fixations) indicates an easier integration in the context, which also required less reanalysis (as evidenced by the reduced likelihood of regression) in comparison to controls. Therefore, it appears that the faster processing observed for passivized idioms (and their component words) can *only* be attributed to the idiomatic meaning being activated, which rendered the phrases contextually congruous. If passivized idioms were understood (only) literally, then their literal meaning would have been just as incongruous as the meaning of both control phrases and hence no difference should have been noted in their processing.

In general, though, our findings demonstrate a processing cost associated with the passive construction, which affected idiomatic and control phrases alike. Literature on the processing of the passive voice often ascribes a delaying effect to the violation of the agent-first bias, as the passive subject is the experiencer or patient and not the agent (Kamide, Scheepers, & Altmann, 2003; Knoeferle, 2007; Knoeferle, Crocker, Scheepers, & Pickering, 2005; Mack, Meltzer-Asscher, Barbieri, & Thompson, 2013; Meyer, Mack, & Thompson, 2012). In the current study, the longer processing time could have also been due to the passive construction being more infrequent than the active in English (Hopper & Thompson, 1980; Williams & Colomb, 1990), as well as to the relative novelty of the passivized idioms and contextual incongruency of the passive controls respectively.

The advantage observed for active idioms (*kick the bucket*) versus control phrases (*kick the apple*) aligns with previous findings showing that idioms are processed faster than equivalent, nonidiomatic phrases (Carrol & Conklin, 2014b, 2017; Gibbs, 1980; Siyanova-Chanturia et al., 2011; Swinney & Cutler, 1979; Underwood et al., 2004; Wolter & Yamashita, 2015), although of course in the present study the active idioms were always congruous in the context, while the active control phrases were not. Nevertheless, research shows that idioms are processed faster than literal phrases, even when both phrase types are plausible in their respective contexts (Conklin & Schmitt, 2008).

The most important finding was that passivized idioms were not contextually inappropriate. It should be stressed that while we are arguing that idioms can be passivized *without* losing their figurative meaning, we are not rejecting the possibility that their literal interpretation is also activated, at least at some point during comprehension. After all, passivized idioms were slower to process than active ones and although this could have been caused by the unfamiliarity of the passivized forms, or the lower frequency of the passive voice in general, it could also reflect an obligatory

activation, processing, and subsequent suppression of the literal meaning. This is particularly likely for idioms that have a literal and figurative interpretation (*kick the bucket*), compared to those that can only be interpreted figuratively (*stay the course*). The current study was not designed to test this question and is an avenue for future research.

We will now consider our second question regarding the involvement of familiarity, frequency, transparency, and predictability on the processing of idioms. These factors were included in models where both idioms and controls were analyzed, as well as in models where active idioms and passive idioms were analyzed separately. In the former case, all of the conditions were assigned the frequency, familiarity, and transparency values of their respective (active) idioms, as well as the predictability of the idioms in the active and passive voice. This was done to assess whether any of these factors influenced the processing of the phrases in the different conditions. However, because these values are in fact only related to the idioms, we carried out separate analyses on the idioms (active and passive forms).

Idiom frequency was a significant predictor in total reading time and fixation count across all phrases in all analyses. The more frequent an (active) idiom, the faster reading time and fewer fixations were noted for both its active and passive form. Interestingly, the reverse effect was true for controls—that is, the more frequent an (active) idiom was, the reading time slowed down and fixations increased for both active and passive forms of the control phrase. This pattern was also observed in the reading time of active idiomatic nouns (*bucket*) versus active control nouns (*apple*). Furthermore, increased phrase frequency led to faster total reading times and to fewer fixations to both nouns and verbs of active idioms, to fewer regressions to verbs of active idioms, as well as to fewer regressions to nouns and verbs of passive idioms. Passivized forms of frequent idioms were also less likely to elicit a regression.

Frequency is a "fundamental shaper of a lexical system always dynamically responsive to experience" (Monsell, 1991, p. 150). This should be true for individual words and sequences of words like idioms, which is in agreement with usage- and exemplar-based models of language processing (Abbot-Smith & Tomasello, 2006; Bybee, 1985, 1995, 1998, 2006; Goldberg, 1995, 2006; Tomasello, 2003). Thus, our findings lend support to the view that the frequency with which idioms are encountered influences their processing—that of both their active and passive forms. Interestingly, increased frequency slows the processing of controls. It might be that in a biasing context, higher idiom frequency increases the activation of the idiom itself, making the control more challenging for the processing system when it appears—that is, a stronger expectation is built, resulting in greater processing effort when the expectation is not met.

Crucially, the frequency of an idiom is almost exclusively from its active form, but we found that the passive form of these idioms demonstrates a significant processing advantage due to the active form's frequency. A few possibilities arise from this finding. First, it appears that the frequency of an idiom is not strictly associated with its canonical form and, therefore, encountering its components (in any order) is enough to activate the idiom and its figurative meaning. Second, it is possible that because of the biasing context there was already some activation of the idiom; thus when the component words were encountered (regardless of their order), the idiom and its meaning were quickly activated. Therefore, an important question for future research is the role of context in the activation of a figurative meaning for passivized idioms. Third, because an idiom's components (*bucket* and *kick*) are frequently encountered in close proximity, it might be these co-occurrence probabilities that speed up processing. Again, additional research would be needed to explore this possibility.

Transparency did not influence any measures in any condition, although there was a marginal effect on the likelihood of regression in the phrase analysis, with less transparent phrases being more

likely to elicit a regression. This appears to contradict the claim that opaque/nondecomposable idioms (*kick the bucket*) are syntactically frozen and nonpassivizable (Fraser, 1970; Gibbs & Nayak, 1989; Langlotz, 2006; Makkai, 2011; Nunberg, 1978; Wulff, 2008). If they were frozen, we should see an effect of transparency, such that opaque idioms should have an increased processing cost, either in terms of more fixations and regressions or longer fixation times. Two explanations may account for the current pattern of results. First, our idioms were rated as highly transparent and there was not a lot of variability among the items. Second, the term transparency has been used to describe a number of phenomena in the literature: metaphoric transparency, semantic decompositionality, and conventionality. Our use of transparency is most closely aligned with semantic decompositionality, as our ratings asked participants to evaluate how easy they thought it would be to guess the meaning of a phrase if they had never encountered it before (*kick the bucket* means to die). It may be that explicitly manipulating metaphoric transparency or conventionality would yield different results. However, findings from a relevant study suggest otherwise. In their study, Van de Voort and Vonk (1995) included metaphoric motivation (of transparency) and component mapping (of semantic decomposition) as separate predictors, but they found no effect of either in a lexical decision task. Moreover, it has been recently found that judgments of transparency and decomposability are largely influenced by the degree of familiarity with an idiom (Carrol, Littlemore, & Dowens, 2018), thus making it harder to dissociate these factors and their potential effects on idiom processing.

Both familiarity and predictability demonstrated some interesting effects. The more familiar and predictable the active form of an idiom, the less likely it was for there to be regressions in any condition: active and passive idioms, as well as the active and passive control phrases. Similar to our discussion of frequency, because of the biasing context, some activation of the idiom was likely even when the phrase turned out to be nonidiomatic. Encountering any of the component words, for example the word *kicked* in the control condition, could have activated the idiom further. The more familiar or predictable the idiom, the greater its activation, which will lead to fewer and shorter fixations.

On word-level and in the idioms-only models, a facilitative effect of predictability was noted for regressions to nouns of active idioms. When all phrases were considered, the predictability of the passive verbs seemed to speed up their total reading time, but the predictability of the idiomatic noun (of active idioms) minimized regressions to nouns of active and passive phrases *regardless* of idiomaticity (*bucket/apple*). As before, there was no interaction between predictability and idiomaticity. While we cannot definitively explain this, it is possible that less reanalysis was needed for the appropriate meaning of predictable idiomatic nouns (*bucket*) to be integrated and, equally, less reanalysis was needed for the inappropriate meaning of the respective control nouns (*apple*) to be discarded—potentially because the idiomatic meaning was activated.

In addition, the processing of the two control conditions may have varied.[3] That is, active controls may have led to activation of the idiom upon encountering the verb (*kick*)—especially since the prior context favored the idiom. Activation of the idiom then had to be suppressed upon encountering the anomalous word (*apple*). In contrast, passive controls induced longer processing times, not because they led to activation of the idiom, but because reinterpretation was necessary in order to make sense of the phrase. While this explanation is plausible, the fact that the noun of the passive controls (*the **bucket** was kicked*) benefited from predictability suggests *some* activation of the figurative meaning even in the passive control condition. Therefore, the need to suppress the idiomatic meaning even in this case seems likely. However, participants were not explicitly asked how they initially or eventually interpreted the control phrases in the given context, or whether they simply rejected them as meaningless.

All of the findings seem to point to the fact that the figurative meaning of idioms is retrieved even in the passive voice, as the manipulation did not render idioms contextually implausible.

Notably, the analysis of transparency seems to demonstrate that passivization is possible even for opaque idioms. Thus, the present findings contradict theories assuming variability in the syntactic behavior of idioms based on factors such as transparency (Abeillé, 1995; Fraser, 1970; Newmeyer, 1972; Nunberg et al., 1994), as well as the tenets of lexical approaches, which claim that any kind of syntactic manipulation will result in loss of idiomaticity.

In fact, a processing advantage seemed to extend not only to active and passivized idiom phrases, but also to their individual components. This underscores both the compositional and unitary nature of idiomatic expressions and suggests that idioms as a whole and their components separately carry figurative load (or meaning). This fits in well with hybrid models of idiom representation. The Configuration Hypothesis (Cacciari & Tabossi, 1988), for instance, predicts a literal-compositional analysis, until enough input has been gathered so as to render the phrase a recognizable, idiomatic configuration, but certain words (the "keys") are more important to this than others. The position of the key is crucial, as it determines the predictability of an idiom and hence the speed of its recognition. Our cloze tasks showed that the final word of our idioms was not particularly predicable in isolation (actives = 0.95% completion; passives = 0.64%), or in context (actives = 38% completion; passives = 28%), indicating that our idioms were largely unpredictable ("late-key") and hence all of the component words were necessary for the idiomatic configuration to be "unlocked" and the figurative meaning to be accessed. In other words, it seems unlikely that any particular word (e.g., the final word) acted as the idiomatic key per se). This could explain why no facilitation was noted for final idiomatic nouns of active idioms in first pass reading (*kicked the* ***bucket***), in contrast to similar previous studies where an effect of idiomaticity was found in such early measures (e.g., Carrol & Conklin, 2017).

Notably, the differences found between idioms and controls emerge in late measures and therefore may not reflect differences in idiomatic *access* per se, but rather differences in the effort required for *reanalysis*, in which case the data would not be well suited to test current models of idiom access (i.e., Configuration Hypothesis and Superlemma Theory).[4] Passivized idioms may require a certain level of reanalysis due to their (unfamiliar) syntactic frame and both control phrases would need reanalysis in the search for an appropriate interpretation in the context. However, the fact that we do not see a facilitation for final idiomatic words in active idioms (*kick the* ***bucket***) suggests that there was no priming for the second element of the phrase (*bucket*) despite the availability of the first one (*kick*) and the biasing context. This further suggests that the figurative meaning of active idioms was not immediately *accessed*, but retrieved via *reanalyses*.

In light of this, we considered the possibility of the figurative meaning (of active idioms) being accessed at a slight delay, due to the low predictability of the items. As per the Configuration Hypothesis (Cacciari & Tabossi, 1988), access to unpredictable idioms' figurative meaning occurs some time after the phrase offset (around 300 ms) and following the initial processing of the final idiomatic word. We therefore decided to run a post-hoc analysis looking for potential spillover effects: the processing of a word (n) during first pass reading may sometimes carry over to the next one ($n + 1$) (Conklin et al., 2018). We ran two separate models using the same predictors as in the main analyses and spillover was set as the dependent variable (i.e., the duration of the first fixation made on $n + 1$ after the eye has left word n in first pass). We checked for spillover effects, as a function of idiomaticity, from the final words in active phrases (*apple/bucket*) and final words of passive phrases (*kicked*) onto $n + 1$ (the word *and* in this case). Interestingly, the final idiomatic words in active phrases (*kicked the* ***bucket***) led to a significantly shorter fixation of $n + 1$, in comparison to final words in control phrases (*kicked the* ***apple***) ($\beta = 0.08$, $t = 2.21$, $SE = 0.03$, $p = .02$), but no difference in spillover effects was noted for the final words of passivized idioms versus controls (*the apple/bucket was* ***kicked***) ($\beta = 0.01$, $t = -1.24$, $SE = 0.03$, $p = .71$). Therefore, although we failed to notice an effect of idiomaticity during first pass reading time, spillover effects

suggest that the figurative meaning of active idioms was accessed *shortly* after the final word had been encountered—and therefore it was not just constructed through effortful reanalyses. The lack of a similar effect in passivized idioms on the other hand further suggests that some reanalysis took place in this case, as the figurative meaning was not accessed at the same time or in the same way. This finding lends further support to the Configuration Hypothesis (Cacciari & Tabossi, 1988), as it suggests that the literal meaning of the phrases was initially accessed (during first pass reading time, before the idiom was recognized), while the figurative meaning became available a few milliseconds after the phrase offset (i.e., after the eye had moved from the final idiomatic element and landed on the following word $n + 1$). More carefully controlled research designed specifically to address this question about the timing of retrieval of the idiomatic meaning (relative to the idiomatic key) is needed.

Importantly, the current models are underspecified with regards to how idiom modification influences processing. More specifically, models need to explain: the impact of slowed idiom access due to modification; the presumably slower processing due to the competing literal meaning; and resolution of the competition between the two meanings. The Configuration Hypothesis assumes that the order of an idiom's components does not matter as long as the phrase remains a recognizable configuration. However, it does not make any predictions about whether a processing cost is implicated by modifying the canonical form of the configuration. Similarly, the Superlemma Theory does not specify how syntactic modification affects spreading activation in idiom comprehension. Thus, in both models the idiomatic meaning should (eventually) be retrieved, but the time course of the retrieval as well as the processing effort associated with the (delayed) competition needs to be considered.

Our findings demonstrate that the idiomatic meaning of passivized idioms is retrieved, but leaves open important questions for future research and indicates where models need further elaboration. Do the lexical items (*bucket* and *kick*) trigger idiomatic activation regardless of their order, although when the noun precedes the verb (i.e., in the passive) activation is slowed? While our data do not definitively answer this, they indicate that the former is important; the occurrence of the lexical items of an idiom in close proximity contributes to idiom activation. This would explain why passivized idioms benefitted from the frequency, familiarity, and predictability (to a lesser extent) of the active forms.

The current findings also appear to be in line with the Multidetermined Model of idiom processing (Libben & Titone, 2008; Titone & Connine, 1999; Titone & Libben, 2014). According to this, several sources of information are utilized in different time frames when processing an idiomatic expression. For example, a cross-modal priming task reported in Titone and Libben (2014) demonstrated that literal implausibility facilitated idiomatic processing before the phrase offset, higher familiarity (defined as the subjective frequency of encounter, rather than how familiar the meaning of an idiom was) facilitated idiomatic processing at the phrase offset, while decomposability facilitated the processing of idioms following the phrase offset. In the present study, we have similarly observed a strong effect of frequency in reading time and fixation count, which reflect initial lexical retrieval and subsequent meaning integration in the context (Conklin et al., 2018), while predictability affected regressions, suggesting that once integrated, the idiomatic meaning needed less reanalysis. We, however, did not find a strong effect of decomposability in any measure.

In sum, we have provided evidence that idioms are in fact rather flexible, even when their meaning is not transparent, and permit complex reconfiguration such as the passive voice. More precisely, idioms can be passivized without losing their figurative meaning and despite varying in their familiarity, frequency, predictability, and transparency—although some of these factors appear to contribute to how quickly the figurative meaning becomes available. The present findings provide online processing evidence that supports those of corpus- and internet-search studies

demonstrating the existence of a wide variety of idiomatic variants (e.g., Barlow & Kemmer, 2000; Duffley, 2013; Moon, 1998). Further, our results support the view of language use as a creative process, whereby users are not restricted to simple reproduction of linguitic material, but that they also recreate or refashion it in new contexts (Swann & Maybin, 2007). After all, language can be, and *is*, used creatively to convey humour and finer nuances of meaning. Formulaic expressions, in particular, are often the locus of language play or creativity, since one needs to be able to recognize what is "normal" (the canonical form of an idiom), in order to fully appreciate any playful or creative deviation from the norm (the use of an idiomatic variant) (Carter, 2015; Carter & McCarthy, 2004; Crystal, 2001).

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Notes

1. The Superlemma Theory specifies that some syntactic restrictions may apply in idiom production, but not necessarily in comprehension. This could explain, for example, why the majority of idiomatic production is in the canonical (preferred) form.
2. The ratings of frequency, familiarity, transparency, and predictability were obtained for the idioms in the active voice, as well as predictability for passivized idioms. Thus, the familiarity score obtained for the phrase *he kicked the bucket* was associated with *the bucket was kicked, he kicked the apple*, and *the apple was kicked*. This was done to explore whether the familiarity/frequency/predictability/transparency of the active forms would influence the processing of their passivized forms, or their active and passive control equivalents.
3. We would like to thank an anonymous reviewer for this suggestion.
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References

Abbot-Smith, K., & Tomasello, M. (2006). Exemplar-learning and schematization in a usage-based account of syntactic acquisition. *The Linguistic Review*, *23*(3), 275–290.

Abeillé, A. (1995). The flexibility of French idioms: A representation with lexicalized tree adjoining. In M. Everaert, E.-J. Van der Linden, A. Schenk, & R. Schreuder (Eds.), *Idioms: Structural and psychological perspectives* (pp. 15–42). Hillsdale, NJ: Lawrence Erlbaum Associates.

Arnon, I., & Snider, N. (2010). More than words: Frequency effects for multi-word phrases. *Journal of Memory and Language*, *62*(1), 67–82.

Barlow, M., & Kemmer, S. (Eds.) (2000). *Usage-based models of language*. Stanford, CA: CSLI Publications.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). lme4: Linear mixed-effects models using Eigen and S4. *R Package Version*, *1*(7), 1–23.

Bobrow, S. A., & Bell, S. M. (1973). On catching on to idiomatic expressions. *Memory and Cognition*, *1*(3), 343–346.

Burt, J. S. (1992). Against the lexical representation of idioms. *Canadian Journal of Psychology/Revue Canadienne de Psychologie*, *46*(4), 582.

Bybee, J. (1985). *Morphology: A study of the relation between meaning and form* (Vol. 9). Amsterdam, Netherlands: John Benjamins Publishing.

Bybee, J. (1995). Regular morphology and the lexicon. *Language and Cognitive Processes*, *10*(5), 425–455.

Bybee, J. (1998). The emergent lexicon. *Chicago Linguistics Society*, *34*, 421–435.

Bybee, J. (2006). From usage to grammar: The mind's response to repetition. *Language*, *82*(4), 711–733.

Cacciari, C. (2014). Processing multiword idiomatic strings: Many words in one? *The Mental Lexicon*, *9*(2), 267–293.

Cacciari, C., & Corradini, P. (2015). Literal analysis and idiom retrieval in ambiguous idioms processing: A reading-time study. *Journal of Cognitive Psychology*, *27*(7), 797–811.

Cacciari, C., & Glucksberg, S. (1991). Understanding idiomatic expressions: The contribution of word meanings. *Advances in Psychology*, *77*(1), 217–240.

Cacciari, C., & Tabossi, P. (1988). The comprehension of idioms. *Journal of Memory and Language*, *27*(6), 668–683.

Canal, P., Pesciarelli, F., Vespignani, F., Molinaro, N., & Cacciari, C. (2015). Electrophysiological correlates of idiom comprehension: Semantic composition does not follow lexical retrieval. In V. Pirrelli, C. Marzi, & M. Ferro (Eds.), *Proceedings of the NetWordS Final Conference on Word Knowledge and Word Usage: Representations and Processes in the Mental Lexicon* (pp. 98–101). *Pisa, Italy*.

Carrol, G., & Conklin, K. (2014a). Eye-tracking multi-word units: Some methodological questions. *Journal of Eye Movement Research*, *7*(5), 1–11.

Carrol, G., & Conklin, K. (2014b). Getting your wires crossed: Evidence for fast processing of L1 idioms in an L2. *Bilingualism: Language and Cognition*, *17*(4), 784–797.

Carrol, G., & Conklin, K. (2017). Cross language lexical priming extends to formulaic units: Evidence from eye-tracking suggests that this idea "has legs." *Bilingualism: Language and Cognition*, *20*(2), 299–317.

Carrol, G., Littlemore, J., & Dowens, M. G. (2018). Of false friends and familiar foes: Comparing native and non-native understanding of figurative phrases. *Lingua*, *204*, 21–44.

Carrol, G., & Conklin, K. (2019). Is all formulaic language created equal? Unpacking the processing advantage for different types of formulaic sequences. *Language and Speech*, *1*, 1–28.

Carter, R. (2015). *Language and creativity: The art of common talk*. London, UK: Routledge.

Carter, R., & McCarthy, M. (2004). Talking, creating: Interactional language, creativity, and context. *Applied Linguistics*, *25*(1), 62–88.

Chafe, W. L. (1968). Idiomaticity as an anomaly in the Chomskyan paradigm. *Foundations of Language*, *4*(2), 109–127.

Chomsky, N. (1993). *Lectures on government and binding: The Pisa lectures*. Berlin, Germany: Mouton De Gruyter.

Colombo, L. (2014). The comprehension of ambiguous idioms in context. In C. Cacciari & P. Tabossi (Eds.), *Idioms: Processing, structure, and interpretation* (pp. 163–200). New York, NY: Psychology Press.

Conklin, K., Pellicer-Sánchez, A., & Carrol, G. (2018). *Eye-tracking: A guide for applied linguistics research*. Cambridge, UK: Cambridge University Press.

Conklin, K., & Schmitt, N. (2008). Formulaic sequences: Are they processed more quickly than nonformulaic language by native and nonnative speakers? *Applied Linguistics*, *29*(1), 72–89.

Cronk, B. C., & Schweigert, W. A. (1992). The comprehension of idioms: The effects of familiarity, literalness, and usage. *Applied Psycholinguistics*, *13*(2), 131–146.

Crystal, D. (2001). *Language play*. Chicago, IL: University of Chicago Press.

Cutler, A. (1982). Idioms: The colder the older. *Linguistic Inquiry*, *13*(2), 317–320.

Cutting, J. C., & Bock, K. (1997). That's the way the cookie bounces: Syntactic and semantic components of experimentally elicited idiom blends. *Memory and Cognition*, *25*(1), 57–71.

Duffley, P. J. (2013). How creativity strains conventionality in the use of idiomatic expressions. In M. Borkent, B. Dancygier, & J. Hinnell (Eds.), *Language and the creative mind* (pp. 49–61). Stanford, CA: CSLI Publications.

Erman, B., & Warren, B. (2000). The idiom principle and the open choice principle. *Text – Interdisciplinary Journal for the Study of Discourse*, *20*(1), 29–62.

Fanari, R., Cacciari, C., & Tabossi, P. (2010). The role of idiom length and context in spoken idiom comprehension. *European Journal of Cognitive Psychology*, *22*(3), 321–334.

Fernando, C. (1978). Towards a definition of idiom: Its nature and function. *Studies in Language: International Journal Sponsored by the Foundation "Foundations of Language," 2*(3), 313–343.

Fraser, B. (1970). Idioms within a transformational grammar. *Foundations of Language*, *6*(1), 22–42.

Gibbs, R. W. (1980). Spilling the beans on understanding and memory for idioms in conversation. *Memory and Cognition*, *8*(2), 149–156.

Gibbs, R. W., & Nayak, N. P. (1989). Psycholinguistic studies on the syntactic behavior of idioms. *Cognitive Psychology*, *21*(1), 100–138.

Glucksberg, S. (1989). Metaphors in conversation: How are they understood? Why are they used? *Metaphor and Symbol*, *4*(3), 125–143.

Glucksberg, S. (2001). *Understanding figurative language: From metaphor to idioms*. Oxford, UK: Oxford University Press.

Goldberg, A. E. (1995). *Constructions: A construction grammar approach to argument structure*. Chicago, IL: University of Chicago Press.

Goldberg, A. E. (2006). *Constructions at work: The nature of generalization in language*. Oxford, UK: Oxford University Press.

Holsinger, E. (2013). Representing idioms: Syntactic and contextual effects on idiom processing. *Language and Speech*, *56*(3), 373–394.

Holsinger, E., & Kaiser, E. (2013). Processing (non) compositional expressions: Mistakes and recovery. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*(3), 866.

Hopper, P. J., & Thompson, S. A. (1980). Transitivity in grammar and discourse. *Language*, *56*(2), 251–299.

Hovhannisyan, A., & Mkrtchyan, A. (2014). Transformation of idioms and transparency. *Journal of Modern Education Review*, *4*(1), 29–34.

Jaeger, T. F. (2008). Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of Memory and Language*, *59*(4), 434–446.

Jiang, N. A. N., & Nekrasova, T. M. (2007). The processing of formulaic sequences by second language speakers. *The Modern Language Journal*, *91*(3), 433–445.

Kamide, Y., Scheepers, C., & Altmann, G. T. M. (2003). Integration of syntactic and semantic information in predictive processing: Cross-linguistic evidence from German and English. *Journal of Psycholinguistic Research*, *32*(1), 37–55.

Katz, J. (1973). Compositionality, idiomaticity, and lexical substitution. In S. R. Anderson & P. Kiparsky (Eds.), *A festschrift for Morris Halle* (pp. 357–376). New York, NY: Holt, Rinehart & Winston.

Katz, J., & Postal, P. M. (1965). An integrated theory of linguistic descriptions. *Foundations of Language*, *1*(2), 133–154.

Kim, S. H., & Kim, J. H. (2012). Frequency effects in L2 multiword unit processing: Evidence from self-paced reading. *TESOL Quarterly*, *46*(4), 831–841.

Knoeferle, P. (2007). Comparing the time course of processing initially ambiguous and unambiguous German SVO/OVS sentences in depicted events. In R. P. G. van Gompel, W. S. Murray, M. H. Fischer, & R. L. Hill (Eds.), *Eye Movements: A window on mind and brain* (pp. 517–533). Amsterdam, Netherlands: Elsevier Science.

Knoeferle, P., Crocker, M. W., Scheepers, C., & Pickering, M. J. (2005). The influence of the immediate visual context on incremental thematic role-assignment: Evidence from eye-movements in depicted events. *Cognition*, *95*(1), 95–127.

Langlotz, A. (2006). *Idiomatic creativity: A cognitive-linguistic model of idiom-representation and idiom-variation in English*. Amsterdam, Netherlands: John Benjamins Publishing.

Laurent, J.-P., Denhières, G., Passerieux, C., Iakimova, G., & Hardy-Baylé, M.-C. (2006). On understanding idiomatic language: The salience hypothesis assessed by ERPs. *Brain Research*, *1068*(1), 151–160.

Lenth, R. (2018). Emmeans: Estimated marginal means, aka least-square means. *R Package Version 1.2*.

Libben, M. R., & Titone, D. A. (2008). The multidetermined nature of idiom processing. *Memory and Cognition*, *36*(6), 1103–1121.

Mack, J. E., Meltzer-Asscher, A., Barbieri, E., & Thompson, C. K. (2013). Neural correlates of processing passive sentences. *Brain Sciences*, *3*(3), 1198–1214.

Makkai, A. (2011). On redefining the idiom. *LACUS Forum*, *36*, 215–227.

McGlone, M. S., Glucksberg, S., & Cacciari, C. (1994). Semantic productivity and idiom comprehension. *Discourse Processes*, *17*(2), 167–190.

Meyer, A. M., Mack, J. E., & Thompson, C. K. (2012). Tracking passive sentence comprehension in agrammatic aphasia. *Journal of Neurolinguistics*, *25*(1), 31–43.

Monsell, S. (1991). The nature and locus of word frequency effect in reading. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 148–197). Hillsdale, NJ: Lawrence Erlbaum Associates.

Moon, R. (1998). *Fixed expressions and idioms in English: A corpus-based approach*. Oxford, UK: Oxford University Press.

Newmeyer, F. (1972). The insertion of idioms. *Chicago Linguistic Society*, *8*, 294–302.

Nunberg, G. (1978). *The pragmatics of reference*. IN: Indiana University Linguistics Club.

Nunberg, G., Sag, I. A., & Wasow, T. (1994). Idioms. *Language*, *70*(3), 491–538.

Ortony, A., Schallert, D. L., Reynolds, R. E., & Antos, S. J. (1978). Interpreting metaphors and idioms: Some effects of context on comprehension. *Journal of Verbal Learning and Verbal Behavior*, *17*(4), 465–477.

Peterson, R. R., Burgess, C., Dell, G. S., & Eberhard, K. M. (2001). Dissociation between syntactic and semantic processing during idiom comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*(5), 1223.

Pollio, H. R. (1977). *Psychology and the poetics of growth: Figurative language in psychology, psychotherapy, and education*. Hillsdale, NJ: Lawrence Erlbaum Associates.

R Core Team (2018). R: A language and environment for statistical computing. Vienna, Austria. Retrieved from http://www.r-project.org/

Reagan, R. T. (1987). The syntax of English idioms: Can the dog be put on? *Journal of Psycholinguistic Research*, *16*(5), 417–441.

Schmitt, N. (2005). Formulaic language: Fixed and varied. *Estudios de Linguistica Inglesa Aplicada*, *6*(1), 13–39.

Schweigert, W. A. (1986). The comprehension of familiar and less familiar idioms. *Journal of Psycholinguistic Research*, *15*(1), 33–45.

Sinclair, J. (2011). Collins COBUILD idioms dictionary. London, UK: Harper Collins.

Siyanova-Chanturia, A. (2015). On the "holistic" nature of formulaic language. *Corpus Linguistics and Linguistic Theory*, *11*(2), 285–301.

Siyanova-Chanturia, A., Conklin, K., & Schmitt, N. (2011). Adding more fuel to the fire: An eye-tracking study of idiom processing by native and non-native speakers. *Second Language Research*, *27*(2), 251–272.

Snider, N., & Arnon, I. (2012). A unified lexicon and grammar? Compositional and non-compositional phrases in the lexicon. In D. Divjak & S. T. Gries (Eds.), *Frequency effects in language representation* (pp. 127–163). Berlin, Germany: Walter de Gruyter.

Sosa, A. V., & MacFarlane, J. (2002). Evidence for frequency-based constituents in the mental lexicon: Collocations involving the word of. *Brain and Language*, *83*(2), 227–236.

Sprenger, S. A., Levelt, W. J. M., & Kempen, G. (2006). Lexical access during the production of idiomatic phrases. *Journal of Memory and Language*, *54*(2), 161–184.

Strandburg, R. J., Marsh, J. T., Brown, W. S., Asarnow, R. F., Guthrie, D., & Higa, J. (1993). Event-related potentials in high-functioning adult autistics: Linguistic and nonlinguistic visual information processing tasks. *Neuropsychologia*, *31*(5), 413–434.

Swann, J., & Maybin, J. (2007). Introduction: Language creativity in everyday contexts. *Applied Linguistics*, *28*(4), 491–496.

Swinney, D. A., & Cutler, A. (1979). The access and processing of idiomatic expressions. *Journal of Verbal Learning and Verbal Behavior*, *18*(5), 523–534.

Tabossi, P., Fanari, R., & Wolf, K. (2008). Processing idiomatic expressions: Effects of semantic compositionality. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*(2), 313.

Tabossi, P., Fanari, R., & Wolf, K. (2009). Why are idioms recognized fast? *Memory and Cognition*, *37*(4), 529–540.

Tabossi, P., Wolf, K., & Koterle, S. (2009). Idiom syntax: Idiosyncratic or principled? *Journal of Memory and Language*, *61*(1), 77–96.

Tabossi, P., & Zardon, F. (2014). The activation of idiomatic meaning in spoken language comprehension. In C. Cacciari & P. Tabossi (Eds.), *Idioms: Processing, structure, and interpretation* (pp. 145–162). New York, NY: Psychology Press.

Titone, D. A., & Connine, C. M. (1999). On the compositional and noncompositional nature of idiomatic expressions. *Journal of Pragmatics*, *31*(12), 1655–1674.

Titone, D. A., & Libben, M. R. (2014). Time-dependent effects of decomposability, familiarity and literal plausibility on idiom priming: A cross-modal priming investigation. *The Mental Lexicon*, *9*(3), 473–496.

Tomasello, M. (2003). *Constructing a language: A usage-based account of language acquisition*. Cambridge, MA: Harvard University Press.

Underwood, G., Schmitt, N., & Galpin, A. (2004). The eyes have it. In N. Schmitt (Ed.), *Formulaic sequences: Acquisition, processing, and use* (pp. 153–172). Amsterdam, Netherlands: John Benjamins Publishing Company.

Van de Voort, M. E. C., & Vonk, W. (1995). You don't die immecliately when you kick an empty bucket: A processing view on semantic and syntactic characteristics of idioms. In M. Everaert, E.-J. Van der Linden, A. Schenk, & R. Schreuder (Eds.), *Idioms: Structural and Psychological Perspectives* (pp. 283–300). New York, NY: Psychology Press.

Vespignani, F., Canal, P., Molinaro, N., Fonda, S., & Cacciari, C. (2010). Predictive mechanisms in idiom comprehension. *Journal of Cognitive Neuroscience*, *22*(8), 1682–1700.

Weinreich, U. (1969). Problems in the analysis of idioms. In J. Puhvel (Ed.), *Substance and structure of language* (pp. 23–81). Berkeley, CA: University of California Press.

Williams, J. M., & Colomb, G. G. (1990). *Style: Toward clarity and grace*. Chicago, IL: University of Chicago Press.

Wolter, B., & Yamashita, J. (2015). Processing collocations in a second language: A case of first language activation? *Applied Psycholinguistics*, *36*(5), 1193–1221.

Wulff, S. (2008). *Rethinking idiomaticity: A usage-based approach*. London, UK: Continuum International Publishing Group.

Appendix 1. Full list of experimental items.

	Active conditions	Passive conditions
1	he hit the bottle/desk	the bottle/desk was hit
2	he always passes the buck/tart	the buck/tart is always passed
3	she had dropped a clanger/stapler	a clanger/stapler had been dropped
4	he turned the corner/horse	the corner/horse was turned
5	she was counting the cost/data	the cost/data was being counted
6	she hit the deck/pan	the deck/pan was hit
7	she has lost her edge/phone	her edge/phone has been lost
8	he flew the flag/jet	the flag/jet was flown
9	he fanned the flames/soup	the flames/soup were/was fanned
10	she cooked her goose/roast	her goose/roast was cooked
11	she prepared the ground/table	the ground/table was prepared
12	he crossed the line/room	the line/room was crossed
13	she buttoned her lips/sleeves	her lips/sleeves were buttoned
14	he flexed his muscles/legs	his muscles/legs were flexed
15	he turned the page/card	the page/card was turned
16	he had lined his pockets/curtains	his pockets/curtains had been lined
17	he took the rap/ferry	the rap/ferry was taken
18	he bent the rules/board	the rules/board were bent
19	she could settle the score/bet	the score/bet could be settled
20	he had sold his soul/bike	his soul/bike had been sold
21	she pulls the strings/curtains	the strings/curtains are pulled
22	she cut her teeth/fingers	her teeth/fingers were cut
23	he walked a tightrope/footpath	a tightrope/footpath was walked
24	he tipped the balance/bottle	the balance/bottle was tipped
25	he pulled his weight/hair	his weight/hair was pulled
26	she cracked the whip/china	the whip/china was cracked
27	he clipped her wings/nails	her wings/nails were clipped
28	she licked her wounds/stamps	her wounds/stamps were licked
29	he spilled the beans/juice	the beans/juice were/was spilled
30	they chewed the fat/ice	the fat/ice was chewed
31	he dropped the ball/glass	the ball/glass was dropped
32	she had lost her marbles/pins	her marbles/pins had been lost
33	he was pulling her leg/ear	her leg/ear was being pulled
34	we tightened our belts/muscles	our belts/muscles were tightened
35	she caught the sun/ball	the sun/ball was caught
36	she bit the bullet/biscuit	the bullet/biscuit was bitten
37	he broke the ice/cup	the ice/cup was broken
38	she held the fort/spoon	the fort/spoon was held
39	he had jumped the gun/fence	the gun/fence had been jumped
40	he made his mark/dinner	his mark/dinner was made
41	she missed the boat/bus	the boat/bus was missed
42	he picked a fight/card	a fight/card was picked
43	he pushed his luck/chair	his luck/chair was pushed
44	he smelled a rat/flower	a rat/flower was smelled
45	he stole the show/car	the show/car was stolen
46	she broke the bank/glass	the bank/glass was broken

(Continued)

Appendix 1. (Continued)

	Active conditions	Passive conditions
47	they twisted her arm/hair	her arm/hair was twisted
48	he turned the tables/boxes	the tables/boxes were turned
49	she wasted her breath/fuel	her breath/fuel was wasted
50	she cut her losses/fruit	her losses/fruit were cut
51	she hit the roof/tree	the roof/tree was hit
52	he knows the ropes/jokes	the ropes/jokes are known
53	he fought his corner/age	his corner/age was fought
54	he stayed the course/night	the course/night was stayed
55	she played the game/film	the game/film was played
56	he moved the goalposts/billboards	the goalposts/billboards were moved
57	he made the grade/soup	the grade/soup was made
58	he twisted the knife/switch	the knife/switch was twisted
59	he drew the line/picture	the line/picture was drawn
60	she broke the mould/lamp	the mould/lamp was broken
61	he touched a nerve/rabbit	a nerve/rabbit was touched
62	she set the pace/clock	the pace/clock was set
63	she felt the pinch/chill	the pinch/chill was felt
64	she took the plunge/tram	the plunge/tram was taken
65	he primed the pump/pole	the pump/pole was primed
66	he learnt the ropes/lyrics	the ropes/lyrics were learnt
67	she made a splash/vase	a splash/vase was made
68	she stemmed the tide/flower	the tide/flower was stemmed
69	she barely scratched the surface/wall	the surface/wall was barely scratched
70	he covered his tracks/ears	his tracks/ears were covered
71	he mended his ways/fence	his ways/fence were mended
72	he greased the wheels/pots	the wheels/pots were greased
73	he rocked the boat/chair	the boat/chair was rocked
74	she fit the bill/dress	the bill/dress was fit
75	he found his feet/key	his feet/key were found
76	they buried the hatchet/thistle	the hatchet/thistle was buried
77	he changed his tune/shirt	his tune/shirt was changed
78	she picked his brains/roses	his brains/rose were picked
79	he popped the question/balloon	the question/balloon was popped
80	he blew a fuse/feather	a fuse/feather was blown
81	he cooked the books/fish	the books/fish were cooked
82	he faced the music/sea	the music/sea was faced
83	she kept her head/house	her head/house was kept
84	he kicked the bucket/apple	the bucket/apple was kicked