Xue, W., Liu, M., Politzer-Ahles, S., & Tzeng, O. (2024). Verbal effect on the processing of complement coercion: distinguishing between aspectual verbs and psych verbs. *Lingua, 306*, 103754. DOI: 10.1016/j.lingua.2024.103754

Verbal Effect on the Processing of Complement Coercion: Distinguishing Between Aspectual Verbs and Psych Verbs

Abstract

This study examined whether entity-denoting complements of *psych verbs* and *aspectual verbs* engender identical processing profiles. Previous literature has considered both types of verbs to require an event-denoting complement and 'coerce' an underspecified event sense when combined with an entity-denoting complement. The present study, including three norming tests and a self-paced reading experiment, recorded reading times of Chinese speakers on entity complements preceded by three types of verbs (*aspectual verbs*, which require an eventive complement; *psych verbs*, the complement constraints for which have been subject to debate recently; and *control verbs*, which select an entity complement), as in *zuòjiā kāishǐ/xiǎngshòu/zhuànxiě zhè-běn xiǎoshuō* 'The author started/enjoyed/ wrote the novel.' The entity complement elicited longer reading times when following aspectual verbs than psych and control verbs, particularly at the two words immediately after the complement. The results confirm the processing cost yielded by complement coercion, and more importantly, contribute evidence to constrain the mechanism of complement coercion to aspectual verbs only.

Keywords: Enriched composition, complement coercion, aspectual verb, psych verb, reading time

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1. Introduction

The meaning of an expression is composed in part based on the meanings of its constituents and the syntactic and semantic operations through which they combine (Frege, 1892; Janssen and Partee, 1997; Partee et al., 1990). Comprehenders sometimes need to go beyond what is explicitly expressed to retrieve implicit meanings.

One linguistic phenomenon involving information not explicitly expressed is complement coercion. It involves a repairing of type mismatch between an event-selecting verb (EventV) and an entity-denoting noun phrase (EntityNP) object/complement (Jackendoff, 1997; Pustejovsky, 1991, 1995). This phenomenon is found in expressions such as (1a) below. The verb *start* appears to be an EventV, which semantically takes an eventive complement, as *writing the book* in (1b). But this verb can also co-occur with an EntityNP, as *the book* in (1a). Noticeably, in (1a) there is a type mismatch between the verb and its complement. To repair the mismatch, the complement *the book* is assumed to be *coerced*/type-shifted into an event like 'the process of writing the book' to satisfy the selectional constraints of the verb. Note that the added event information is not explicitly stated either by any individual lexical item or the syntactic structure of the sentence, but it still can be obtained by readers during real-time comprehension. In the present work, we will refer to verbs that trigger complement coercion when paired with entity-denoting NPs as 'coercion verbs'.

1. (a) The author started the book.
   (b) The author started writing the book.

Expressions that require complement coercion have been reported to incur processing cost compared with those no need of complement coercion. This has been examined with a variety of empirical methods, including self-paced reading (e.g., McElree et al., 2001; Traxler et al., 2002; Zarcone et al., 2017; Author 1 and Author 2, 2021; Author et al., 2021), eye-tracking while reading (Frisson and McElree, 2008; Lowder and Gordon, 2016; McElree et al., 2006; Pickering et al., 2005; Traxler et al., 2005; Traxler et al., 2002), the visual world paradigm (Scheepers et al., 2008), event-related potentials (ERPs) (Baggio et al., 2010; Delogu et al., 2017; Kuperberg et al., 2010), magnetoencephalography (MEG)

(Pylkkänen and McElree, 2007), and functional magnetic resonance imaging (fMRI) (De Almeida et al., 2016; Husband et al., 2011).

While the processing cost has been confirmed by a number of psych/neurolinguistic studies, there is controversy over what types of verbs should be included as coercion verbs. In most previous studies, coercion verbs included a broad set of semantic classes, including aspectual verbs (e.g., *start* and *finish*), psychological verbs (hereafter, psych verbs, e.g., *enjoy* and *endure*), and a group of other verbs without clear semantic categorizations (e.g., *master* and *attempt*) (see Appendix). The Appendix shows a summary of the verbs that were assumed to trigger complement coercion in previous empirical studies (Baggio et al., 2010; De Almeida, 2004; Delogu et al., 2017; Frisson and McElree, 2008; Husband et al., 2011; Kuperberg et al., 2010; Lapata et al., 2003; Lowder and Gordon, 2016; McElree, Frisson, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Pylkkänen and McElree, 2007; Scheepers et al., 2008; Spalek and Tomaszewicz, 2016; Traxler et al., 2005; Traxler et al., 2002).The issue of the heterogeneity of the verbs used in complement coercion studies, however, has recently aroused scholars' attention (Katsika et al., 2012; Lai et al., 2017; Piñango and Deo, 2016). They posited that aspectual verbs and psych verbs, in particular, differ from each other in terms of their argument selection requirements, and thus may yield distinct processing profiles when paired with an EntityNP. Given that the 'other verbs' mentioned above, such as *master* and *attempt*, do not have a straightforward semantic class and have not received a systematic investigation to date, we leave them for future research.

The question we address here is whether aspectual verbs and psych verbs elicit similar processing profiles when combined with an EntityNP. As mentioned above, previous research has often found that entity-denoting NPs elicit a processing cost when combined with aspectual verbs. This pattern has also been shown in Mandarin (Author et al., 2021), the language that will be used in the present study. Building off of the previous findings showing complement coercion processing costs eith aspectual verbs in Mandarin, the present study examines whether a similar processing profile is elicited by entity-denoting NPs combining with *psych* verbs. To make sure we use a design and analysis that is known to be able to detect processing costs for complement coercion, we employed the same methodology (see Section 3) , which may cause a certain degree of similarity

between the two studies. In the next sections, we review the principle literature pertaining to coercion verbs, and then present details of the current study.

2. Complement Coercion Verbs

2.1 The Classical Set of Complement Coercion Verbs: Aspectual and Psych Verbs

As mentioned above, the classical set of verbs used in prior complement coercion studies includes aspectual and psych verbs. Both theoretical and empirical studies have assumed that these two types of verbs, though belonging to different semantic classes, behave similarly in terms of their argument selections, i.e., taking an event-type complement.

Before continuing this section, let us first clarify the category of psych verbs that has previously been considered to be associated with complement coercion. Psych verbs describe mental states (Brennan and Pylkkänen, 2010; Piñango, 2000). They typically take two arguments, characterised as the experiencer (i.e., the individual that experiences the mental state) and the stimulus[1] (i.e., the content or object of the mental state) (Belletti and Rizzi, 1988; Levin, 1993; Pesetsky, 1995; Thompson and Lee, 2009). These verbs are divided into four distinct classes (Levin, 1993: 188-193): Two of the classes include transitive verbs, and the other two classes include intransitive verbs combined with prepositional phrase complements. The transitive verbs further fall into two sub-classes regarding whether the experiencer of the mental state is the subject (e.g., *The kids enjoyed the party*) or the object (e.g., *The comedian amused the audience*). The intransitive verbs also fall into two sub-classes in terms of whether the experiencer is expressed as the subject (e.g., *The young lady worried about her kid*) or the object of the preposition (e.g., *The portrait appeals to Mary*). Given that prior studies considered subject-experiencer transitive verbs to be associated with complement coercion, the current study only focused on this sub-class. Thus, in the rest of this article, we use the term 'psych verbs' to refer to subject-experiencer transitive verbs unless otherwise specified.

In earlier linguistic literature, aspectual verbs and psych verbs are claimed to semantically take an event-denoting complement (Asher and Pustejovsky, 2006;

[1] Also referred to as "target of emotion" or "subject matter of emotion".

Briscoe et al., 1990; Jackendoff, 1997; Pustejovsky, 1991, 1995). Aspectual verbs (e.g., *start*, *continue*, and *finish*) describe the initiation, continuation, or termination of an event (Levin, 1993; ter Meulen, 1990). The event can be expressed with a gerund or an infinitival clause, as in *The author started writing the book/to write the book*, or with an event-denoting NP, as in *The boy started the fight*. Psych verbs (e.g., *enjoy*) describe an experiencing relation, defining that someone experiences enjoyment caused by some stimulus or event (Pustejovsky and Bouillon, 1995). The object of the verbs contributes information to the interpretation of what kind of experiencing activity the experiencer is involved in, which is realized with a progressive verb phrase or an eventive noun phrase (Briscoe et al., 1990), as in *The lady enjoyed wearing the dress/the party*. Thus, when aspectual or psych verbs are combined with an entity complement, as in *The author started/enjoyed the book*, the composition is supposed to call for a change of the type of the complement (i.e., from an entity to an event) to meet the selectional restrictions of the verb (i.e., coercing the meaning of *the book* into something like 'performing certain activity with the book') (Jackendoff, 1997; Pustejovsky, 1991, 1995).

Empirical literature has presupposed such an event-selecting property for both aspectual and psych verbs, and mixed them together into the class of coercion verbs to explore their processing behaviors (see Appendix) (Baggio et al., 2010; De Almeida, 2004; Delogu et al., 2017; Frisson and McElree, 2008; Husband et al., 2011; Kuperberg et al., 2010; Lapata et al., 2003; Lowder and Gordon, 2016; McElree, Frisson, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Pylkkänen and McElree, 2007; Scheepers et al., 2008; Spalek and Tomaszewicz, 2016; Traxler et al., 2005; Traxler et al., 2002). Most studies have reported that coercion expressions are more taxing to process than non-coercion counterparts (but see De Almeida, 2004), which was reflected mainly at the EntityNP complement and/or the subsequent one or two words.

The taxing processing is commonly attributed to the enriched composition on the complement (i.e., reconstructing the EntityNP complement to an event type), which is triggered by the type mismatch between the EventV and the EntityNP (e.g., Frisson and McElree, 2008; McElree, Frisson, et al., 2006; McElree, Pylkkänen, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Spalek and Tomaszewicz, 2016; Traxler et al., 2005; Traxler et al., 2002). One may wonder whether the cost

may derive not from the reconstruction process itself, but rather from noticing the type mismatch. According to Traxler et al. (2005: 4), this is less likely to be true for two reasons. First, although the interpretive processing can be disrupted when an expression does not make sense, it is not clear whether the disruption closely aligns with the delayed and sustained effects found in previous studies. For example, reading time (RT) slowdowns of coercion expressions are usually found not at the complement noun but rather at the subsequent words and on measures associated with 'integrative processing' in eye-tracking data (see Pickering et al., 2004). Second, complement coercion cases have been found invoking different patterns of brain activity than cases involving semantic mismatch between the verb and its complement (e.g., *The journalist astonished the article*) (De Almeida et al., 2016; Husband et al., 2011; Pylkkänen and McElree, 2007).

2.2 Differences Between Aspectual Verbs and Psych Verbs

The assumption that aspectual verbs and psych verbs exhibit similar processing profiles has been challenged by several recent studies (Katsika et al., 2012; Lai et al., 2017; Piñango and Deo, 2016). These suggested that the two verb types should be investigated independently in terms of their lexical semantic differences, for reasons described below.

Katsika et al. (2012) argue that, while aspectual verbs semantically take an event as their internal argument/object, psych verbs do not require an event argument. Aspectual verbs introduce quantification over an event whose subpart (initiation, continuation, and cessation) is denoted by the VP including the aspectual verb (Levin, 1993; ter Meulen, 1990). The event is supposed to be expressed by the internal argument, and the external argument/subject is an agentive participant in the event. For a sentence such as *The author started the book*, the subject *The author* is a participant in an implicit event performed on the book; the VP *started the novel* denotes the initial part of the event. The implicit event (e.g., writing a book) can be realized through a compositional operation, i.e., embedding the NP *the book* within an event structure.

Unlike aspectual verbs, psych verbs have an experiencer as their external argument, and a target/subject matter of emotion as their internal argument (Pesetsky, 1995: 55-57). The subject matter argument is judged by the experiencer and directed to the experiencer's emotion described by the verb. Thus, psych verbs

entail information about the presence of a state of emotion, acting similar to a state (Brennan and Pylkkänen, 2010). In this sense, the target/subject matter of emotion can be realized by 'different sorts of individuals, such as an entity, an event, or a state-of-affairs' (Katsika et al., 2012: 61). This argument aligns with the claim by Pustejovsky (1995: 135-136) about the selectional requirement of the particular psych verb *like* (which is distinct from *enjoy* that selects an event-type argument, as mentioned in Section 2.1), i.e., it selects an attitude towards any semantic types (e.g., event, individual, and proposition). Furthermore, Piñango and Deo (2016: 364) argued that, although both *The author started the book* and *The author enjoyed the book* can be paraphrased as "The author started/enjoyed writing the book", the meaning relation between the verb and its respective complement are distinct. For the aspectual verb *start*, its complement is construed as an incremental theme that is affected (e.g., created, consumed) in some implicit event, while for the psych verb *enjoy*, its complement is construed as a target of emotion. Psych verbs may allow 'an eventuality-based paraphrase', but they 'do not always require it'. For instance, an expression like *The lady enjoyed the extra lipstick* does not necessarily mean that 'The lady enjoyed using the extra lipstick', as the expression can still be true even if the lady has never used the extra lipstick. Given that, the complement of psych verbs can be an eventive type, but this seems to be not necessarily encoded in their lexical semantics. The derived event meaning is likely to just be an effect of a pragmatic-inferential process (Katsika et al., 2012). Such an inferential process is also applicable to aspectual verbs to retrieve an appropriate event associated with the complement, but it, in the view of Katsika and colleagues, may be independent of the compositional process undertaken in aspectual verbs.

These lexical semantic differences between aspectual verbs and psych verbs challenge the previous assumption that both aspectual and psych verbs trigger similar cognitive processing behaviors when paired with an EntityNP complement.

2.3 The Call for Research on the Processing of Aspectual Verbs vs. Psych Verbs

A close look of the prior empirical studies has shown that, beyond the observation that the presence of an EntityNP complement leads to an eventive inference, there is little evidence provided to support why both aspectual and

psych verbs were included in the set of coercion verbs to build experimental stimuli (Katsika et al., 2012; Piñango and Deo, 2016). It is possible that the eventive inference involved in the two types of verbs is triggered by different cognitive mechanisms. This possibility has been examined by Katsika et al. (2012) and Lai et al. (2017), but the question remains unresolved.

Katsika et al. (2012) monitored participants' eye movements when they read an EntityNP following either an aspectual verb or a psych verb relative to a control verb, as in *Alexandra was completing/enjoying/shelving a sci-fi book when the secretary announced the meeting*. These sentences were preceded by a context sentence, such as *The new interns, Alexandra and John, loved to read novels*. Compared with control verbs, only aspectual verbs took longer RTs, but not psych verbs. While teasing apart the two verb classes, Katsika et al. (2012) did not rule out the possibility that the divergent processing behaviors may result from different predictability of the NP complements following the two classes of verbs, as readers are highly sensitive to relative differences in predictability of words (Smith and Levy, 2013).

Likewise, Lai et al. (2017) recorded participants' self-paced reading times (Experiment 1) for EntityNP objects preceded by either aspectual verbs or *enjoy*-verbs in relation to another group of psych verbs, i.e., *love*-verbs, as controls. The slower RTs were only detected on the aspectual verbs but not the *enjoy*-verbs. Like Katsika et al. (2012), Lai et al. (2017) also did not control the cloze probability of the NP complements following the two types of target verbs. In addition, this study did not rule out the possibility that both the *enjoy*-verbs and *love*-verbs may require demanding processing but just with less magnitude compared with the aspectual verbs. As the *enjoy*-verbs and *love*-verbs both belong to subject-experiencer transitive psych verbs, they are equally expected to take a target of emotion or a subject matter of emotion (Pesetsky, 1995), and thus are expected to elicit equal interpretive cost. Especially, some of the *love*-verbs, such as *love* and *hate*, were classified as coercion verbs in Delogu et al. (2017) and Lapata et al. (2003) (see Appendix), and were considered to require more processing efforts when paired with an EntityNP complement. In other words, if both *love*-verbs and *enjoy*-verbs are psych verbs, then this study does not rule out the possibility that both aspectual verbs and psych verbs may involve complement coercion compared to entity-selecting control verbs.

Given the limitations of the studies by Katsika et al. (2012) and Lai et al. (2017), the current study aims to revise the experimental design to capture a clearer picture of processing behaviors exhibited by aspectual verbs and psych verbs separately, with the research question: Do psych verbs and aspectual verbs trigger identical processing patterns when paired with an EntityNP complement?

3. The Current Study

This study aims to investigate whether or not psych verbs trigger additional cognitive computations in the same way as aspectual verbs do. We recorded participants' self-paced reading times on EntityNP complements preceded by three verb types: (a) *aspectual verbs*, which require an eventive complement, (b) *psych verbs*, which are subject to debate regarding whether or not they inherently take an eventive complement, and (c) *control verbs*, which select an entity complement. An example is shown in (2) below.

(2) 作家 (a) 开始/(b) 享受/(c) 撰写**这**本小**说**……
zuòjiā kāishǐ/xiǎngshòu/zhuànxiě zhè-běn xiǎoshuō
author start/enjoy/write this-CL novel (CL = classifier)
'The author started/enjoyed/wrote the novel…'

The current design differs from Katsika et al. (2012) and Lai et al. (2017) in at least three respects: (1) The predictabilities of complement NPs following aspectual verbs and psych verbs were normed to have little difference. This was done to ensure that any processing discrepancies (if taking place) between the two verb classes did not potentially arise from distinct predictabilities of the complements. (2) The control verbs, instead of using *love*-verbs like in Lai et al. (2017), were those denoting a preferred activity associated with the EntityNP complement. This was to ensure that the lack of processing cost for psych verbs (if observed) was not due to the selection of biased control stimuli. (3) No context sentence was provided before target sentences so as to avoid any potential effect of a semantically revealing context on the comprehension of target sentences (Traxler et al., 2005).

Based on the experimental design, if aspectual verb and psych verb sentences are equally hard to read as opposed to control verb sentences, then the result would support the traditional assumption—aspectual and psych verbs share

uniform selectional properties, and thus exhibit similar processing patterns. In contrast, if aspectual verb sentences show greater RT slowdowns than psych verb and control verb sentences, and there is no significant RT difference between psych and control verb sentences, then the result supports the recent assumption—psych verbs entail distinct selectional property from aspectual verbs, and thus behave distinctly during real-time comprehension.

All stimuli, data, as well as R scripts for analyses are available at: https://osf.io/m4pdb/?view_only=f58c4b53275e4de0be853f2ddc573d1f.

Following Traxler et al. (2002), three norming tests were taken first to determine the experimental stimuli used in the subsequent self-paced reading experiment, namely, *preference norming*, *cloze norming*, as well as *acceptability norming*.

3.1 Preference Norming

The preference norming served to determine control verbs of the experimental stimuli.

3.1.1 Participants

25 native Mandarin Chinese speakers (20 women and 5 men age: *mean* = 25 years; *range* = 19-30) were invited to take the norming test. They were living in mainland China while participating in the experiment. They provided informed consent, and received a monetary reward after completing the test.

3.1.2 Materials

Before the preference norming, 135 pairs of subject-object pairs (e.g., 作家-**这**本小**说** *zuòjiā–zhè-běn xiǎoshuō* 'author-this-CL novel') were made to fit an aspectual verb and a psych verb (e.g., 开始/享受 *kāishǐ/xiǎngshòu* 'start/enjoy'). The subjects were created by using more informative subjects, such as 作家 *zuòjiā* 'author', to facilitate the selection of a preferable control verb inserted in the subject-object strings. The objects refer to concrete entities, composed of a demonstrative **这**/那 *zhè/nà* 'this/that', an entity-type classifier (CL), and an entity-type noun, such as **这**本小**说** *zhè-běn xiǎoshuō* 'this-CL novel' .

Five aspectual verbs were selected, same as those in Author et al. (2021): 开始 *kāishǐ* 'begin/start', **继续** *jìxù* 'continue', 完成 *wánchéng* 'finish', **结**束 *jiéshù* 'end', 停止 *tíngzhǐ* 'stop'. They were determined with linguistic diagnostics for

raising verbs. Referring to Rochette (1999), aspectual verbs can be considered as raising predicates with two properties: First, they do not impose selectional restrictions on their surface subject; the subject, instead, is restricted by the embedded predicate. For instance, in a sentence like 作家开始撰写**这**本小**说** *zuòjiā kāishǐ zhuànxiě zhè-běn xiǎoshuō* 'The author started writing the novel', the surface subject 作家 *zuòjiā* 'author' can also be interpreted as the subject of the embedded predicate, e.g., 撰写 *zhuànxiě* 'write', such that the sentence has the meaning like 'it is the author (but not someone else) who wrote the novel'. Second, these verbs do not introduce an independent event; they, instead, serve as 'aspectual modifiers' to modify the event denoted by the embedded verb and its argument. The sample sentence above does not involve two events expressed by *start* and *writing the novel*; rather, they introduce only one single event described by *start writing the novel*. The aspectual verbs have been argued to have similar usages (Cao, 1996), and thus were selected as target verbs here.

Five psych verbs were selected to match the number of aspectual verbs: 享受 *xiǎngshòu* 'enjoy', 忍受 *rěnshòu* 'endure', **爱**好 *àihào* 'keen on', 抗拒 *kàngjù* 'resist', **厌恶** *yànwù* 'detest'. Following Pustejovsky (1991, 1995) and Jackendoff (1997), the selected psych verbs meet the requirement that they select an experiencer as subject, and can elicit an event sense when combined with an EntityNP object. For instance, for an expression like 患者抗拒**这**种**药**品 *huànzhě kàngjù zhè-zhǒng yàopǐn* 'The patient resisted this kind of medicine', an implicit eventive interpretation of 'taking this kind of medicine' is available.

3.1.3 Procedure

135 subject-object pairs were presented as 作家__**这**本小**说** *zuòjiā __ zhè-běn xiǎoshuō* 'The author __ the novel'. Participants were asked to complete the pairs with a two-character verb. Two examples were given at the beginning of the test, such as 小文公布**这**份名**单** *xiǎowén gōngbù zhè-fèn míngdān* 'Ms. Wen announced the list.'

3.1.4 Results

A total of 130 subject-object pairs were selected such that the dominant verb for each pair occurred six or more times among the responses of the 25 participants (24%). These verbs were considered the control verb candidates (e.g., 撰写 *zhuànxiě* 'write'). If the dominantly responded verb was an aspectual verb or

a psych verb, then the verb was removed, and the second most frequently responded verb was selected. The cloze frequency of the selected control verbs was 10.33 times (out of 25) on average, ranging from 6 to 23 times.

After the preference norming, 130 triplets of expressions were made with the matrix verb varied only, such as 作家开始/享受/撰写**这**本小**说** *zuòjiā kāishǐ/xiǎngshòu/zhuànxiě zhè-běnxiǎoshuō* 'The author started/enjoyed/wrote the novel'.

3.2 Cloze Norming

The cloze norming served to measure complement NPs' cloze probability/predictability (the percentage of participants' responses that included the target words) across all three sentence types. More importantly, this test was to ensure that the complements following aspectual and psych verbs had the same magnitude of predictability.

3.2.1 Participants

48 native Mandarin speakers (28 women and 20 men; age: *mean* = 26 years; *range* = 19-30), who did not participate in the preference norming, were invited to take the cloze norming. They were living in mainland China when taking part in the experiment. They provided informed consent to participate, and were paid after completing the test.

3.2.2 Materials

The experimental materials were the 130 triplets of items determined in the preference norming. The number of the items each aspectual verb appeared in is as follows: 开始 *kāishǐ* 'begin/start' (27), **继续** *jìxù* 'continue' (27), 完成 *wánchéng* 'finish' (22), **结**束 *jiéshù* 'end' (21), 停止 *tíngzhǐ* 'stop' (33). The number of the items each psych verb appeared in is as follows: 享受*xiǎngshòu* 'enjoy' (28), 忍受*rěnshòu* 'endure' (26), **爱**好*àihào* 'keen on' (22), 抗拒*kàngjù* 'resist' (29), **厌恶***yànwù* 'detest' (25). As the 130 triplets of items were divided into three lists, as described below, each verb appeared in each list a maximum of 12 times.

3.2.3 Procedure

The 130 sets were presented as strings that included subject, verb, and a demonstrative **这**/那 *zhè/nà* 'this/that', like 作家开始/享受/撰写**这**___

zuòjiā kāishǐ/xiǎngshòu/zhuànxiě zhè__ 'The writer started/enjoyed/wrote this___.' Participants were asked to provide a three-character noun phrase (formed with a one-character classifier and two-character noun) to the strings. Two examples were given in the beginning of the test. The 130 sets of strings were distributed to three lists using a Latin Square design such that none of the three conditions for each item appeared on the same list. Since 130 does not divide evenly into three, the number of strings per condition in each list was not identical, i.e., each list included one more item from a distinct condition. The three lists were randomly distributed to the 48 participants, each with 16 participants.

3.2.4 Results

Before calculating the cloze probability of complement NPs, 21 sets of items were first excluded based on two criteria: (1) No response was the same as the target NP in the control condition of an item, i.e., the cloze probability of the target NP in this condition was zero. For instance, for the item 演奏家停止/爱好/演奏这种乐器 *yǎnzòujiā tíngzhǐ/àihào/yǎnzòu zhè-zhǒng yuèqì* 'The performer stopped/was keen on/played the instrument', as the target NP 乐器 'instrument' did not occur among participants' answers in the control condition of the item 演奏家演奏这___ 'The performer played the___', then the item was removed. (2) There was a large conditional difference (i.e., more than nine) in cloze frequency of the responded NP between the aspectual verb and psych verb conditions of an item. We used 'nine' as the threshold because among all tested items, most of their conditional differences (between the aspectual verb and psych verb conditions) were within nine. A few of the frequency differences were thirteen or above. Thus, we decided to use nine as the threshold, and excluded as outliers those items with the conditional difference above nine. Removing the items with large conditional difference was done to minimize differences in the complement NPs' probabilities between the two conditions.

Of the remaining 109 triplets of items, participants' responses were compared with the items' target NPs. The responses were considered the same as the target NPs based on two criteria: (1) The responded noun was the same as the target noun. For example, responses such as 这种问卷 *zhè-zhǒng wènjuàn* 'this-CL questionnaire' would be considered the same as the target NPs 这类问卷 *zhè-lèi wènjuàn* 'this-CL questionnaire', because the noun of the two phrases was the

same, i.e., 问卷 *wènjuàn* 'questionnaire', even though the classifiers were different (种 *zhǒng* vs. 类 *lèi*). (2) The classifier was an entity type but not an event type, because an event classifier with an entity noun is argued to coerce the noun into an event sense (Huang and Ahrens, 2003). Thus, responses such as 这波代码 *zhè-bō dàimǎ* 'this-CL code' would not be counted as the same as the target NP 这些代码 *zhè-xiē dàimǎ* 'this-CL code', as the classifier 波 *bō* in the first expression is an event type, used to refer to 'staggered event'.

Cloze probabilities of the complement NPs following aspectual verbs, psych verbs, and control verbs were 0.06 (*range* = 0–0.69), 0.08 (*range* = 0–0.56), and 0.59 (*range* = 0.06–1), respectively.

3.3 Acceptability Norming

The acceptability norming served to assess the acceptability of the experimental stimuli. More importantly, this test was employed to ensure that all the experimental stimuli were acceptable to native Mandarin Chinese speakers.

3.3.1 Participants.

48 native Mandarin speakers (29 women and 19 men; age: *mean* = 25 years; *range* = 19-30), who did not participate in either the preference norming or the cloze norming, were invited to rate the acceptability of sentences. They were living in the mainland China when taking part in the experiment. They all gave informed consent prior to the experiment, and were paid after completing the test.

3.3.2 Materials

The remaining 109 triplets of expressions, obtained from the cloze norming, were developed into sentences with 14 to 16 characters. The added post-NP part is with various structures, including clausal structure and prepositional phrase, to avoid participants' awareness of the subsequent words and structures after the complement NPs. The number of the sentences each aspectual and psych verb appeared in is as follows: 开始 *kāishǐ* 'begin/start' (23), 继续 *jìxù* 'continue' (24), 完成 *wánchéng* 'finish' (20), 结束 *jiéshù* 'end' (17), 停止 *tíngzhǐ* 'stop' (25), 享受 *xiǎngshòu* 'enjoy' (27), 忍受*rěnshòu* 'endure' (20), 爱好*àihào* 'keen on' (12), 抗拒 *kàngjù* 'resist' (28), 厌恶*yànwù* 'detest' (22). As the expressions were divided into three lists (as described below), each verb appeared in each list a maximum of 11 times.

3.3.3 Procedure

Participants were asked to rate the acceptability of these sentences based on their intuition on a scale of 6 (1 = completely unacceptable, and 6 = completely acceptable). A scale with an even number of levels was used to avoid over-selection of the midpoint (Weems and Onwuegbuzie, 2001). The 109 sets of stimuli were separated into three lists using a Latin Square design, which ensured that none of the three conditions for each item appeared on the same list. Since 109 does not divide evenly into three, the number of sentences per condition in each list was not identical, and one more sentence from a distinct condition was included in each list. Besides the test sentences, 91 filler sentences were also made with 14 to 16 characters. The three lists were distributed to the 48 participants, with 16 participants per list.

3.3.4 Results.

Items for which at least one of the three conditions received a mean acceptability score lower than 3.5 (the middle of the 6-level scale) were removed, resulting in removal of 46 item triplets. Of the remaining 63 triplets, mean ratings for each condition were 4.22 (aspectual verbs), 4.29 (psych verbs), and 4.81 (control verbs).

Table 1 summarizes the properties of the remaining 63 sets of stimuli, concerning the mean cloze probability of their NP complements and the mean acceptability of the sentences[2]. Their distributions are illustrated in Fig 1 and Fig 2, respectively. Note that the final cloze probability of the NPs in the aspectual verb condition (0.07) has a slight change compared with that reported in the cloze norming test (0.06, see Section 3.2). This is because that 46 items that were included previously in the cloze norming were excluded after the acceptability norming (due to their lower acceptability), which resulted in the change of the result of the EntityNP cloze probability for the final stimuli.

As can be seen from Fig 1 and Fig 2, there is not a robust difference between aspectual and psych verbs with respect to the two properties in question. Thus,

[2] A reviewer expressed concern whether the control sentences with higher acceptability rates and NP predictability could be a confound for the hypotheses tested in this study. We believe this is not a significant issue because, as the baseline for comparison to aspectual and psych verb sentences, it is crucial to employ natural and well-formed sentences in which the words are easily predicted, and the sentences are highly acceptable. This helps to eliminate any potential influence of these two properties so that any observed processing differences between aspectual and control conditions, or between psych and control conditions, can be attributed to the different argument selectional requirements of the paired verb types.

this is a relatively ideal manipulation to eliminate potential effects (if any) triggered by the complement NP predictability and sentence acceptability.

Table 1. Properties of 63 triplets of experimental stimuli

Verb Type	NP Probability	Sentence Acceptability
Aspectual verbs	0.07	4.22
Psych verbs	0.08	4.29
Control verbs	0.59	4.81

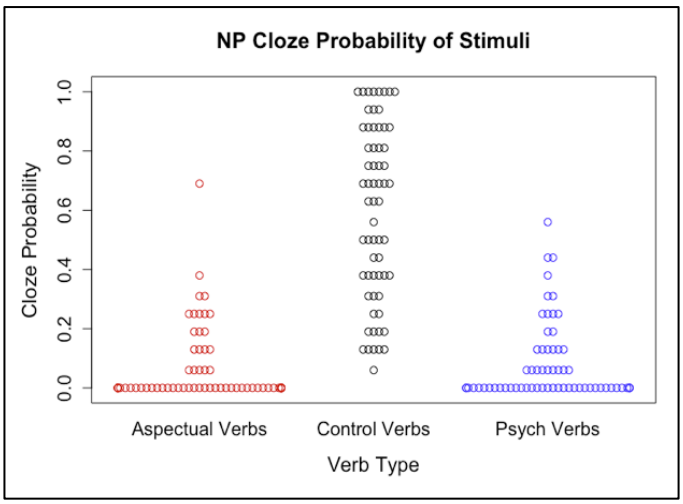

Fig. 1 Distributions of cloze probabilities of NP complements

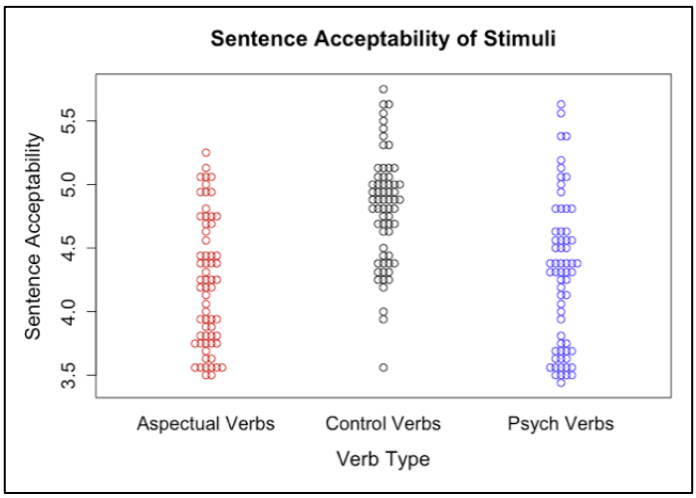

Fig. 2 Distributions of acceptability scores of sentences

Based on this experimental design, several possible outcomes can be anticipated. If slower RTs are detected for the NPs in aspectual verb and psych verb sentences relative to the NPs in control verb sentences (aspectual = psych > control), then two explanations are available: one is that aspectual and psych verbs both require an event-type object, and they may undergo similar cost-engendering mechanisms; the other is that neither of the two verb types takes an event-type object, and they are read slower just because both have lower acceptability and have object NPs with lower cloze probability. On the other hand, if NPs after aspectual verbs yield longer RTs than those after psych and control verbs, and there is no significant difference between NPs after psych and control verbs (aspectual > psych = control), then aspectual and psych verbs may encode different selectional properties and undergo distinct processing mechanisms.

3.4 Self-paced Reading Experiment

3.4.1 Participants

55 native Mandarin speakers (32 women and 23 men; age: *mean* = 25 years; *range* = 19-35) from <anonymized for peer review> were recruited to participate in this experiment. All participants had normal or corrected to normal vision, and reported no language disorders. All provided written informed consent to take part in this experiment, and received a financial reward after finishing the experiment.

3.4.2 Materials

The experimental stimuli were the 63 triplets of sentences adapted from the acceptability norming test, all with 14 to 16 characters. An example is presented in Table 2. The aspectual verbs, along with the number of items each verb appears in, are as follows: 开始 *kāishǐ* 'begin/start' (9), **继续** *jìxù* 'continue' (7), 完成 *wánchéng* 'finish' (16), **结**束 *jiéshù* 'end' (19), 停止 *tíngzhǐ* 'stop' (12). The psych verbs and the number of items each verb appears in are as follows: 享受*xiǎngshòu* 'enjoy' (18), 忍受*rěnshòu* 'endure' (10), **爱**好*àihào* 'keen on' (8), 抗拒*kàngjù* 'resist' (15), **厌恶***yànwù* 'detest' (12). The 63 triplets of items were randomly distributed in three lists using a Latin Square design, with only one version of each item occurring in each list. Each aspectual or psych verb was repeated in each list eight times maximally. 65 filler sentences with various sentence structures were inserted to prevent participants from becoming aware of the research purpose. Six

497 additional practice sentences were presented at the beginning of the task to help
498 participants familiarize themselves with the procedures. Each list included 134
499 sentences in total. For each sentence, a comprehension question was presented
500 to ensure that participants focused on the task. None of the questions targeted
501 the predicate verbs of the sentences. Half of the answers to the comprehension
502 questions were 'yes' and half were 'no'.
503
504 **Table 2.** A sample set of the stimuli

Verb Type		Verb	Complement NP	NP+1	NP+2	
Aspectual verbs	作家	开始	**这**本小**说**	之前	打开	一扇窗**户**。
	zuòjiā	*kāishǐ*	*zhè-běn xiǎoshuō*	*zhīqián*	*dǎkāi*	*yī-shàn chuānghù*
	author	start	this-CL novel	before	open	one-CL window
	'The author opened a window before starting the novel.'					
Psych verbs	作家	享受	**这**本小**说**	之前	打开	一扇窗**户**。
	zuòjiā	*xiǎngshòu*	*zhè-běn xiǎoshuō*	*zhīqián*	*dǎkāi*	*yī-shàn chuānghù*
	author	enjoy	this-CL novel	before	open	one-CL window
	'The author opened a window before enjoying the novel.'					
Control verbs	作家	撰写	**这**本小**说**	之前	打开	一扇窗**户**。
	zuòjiā	*zhuànxiě*	*zhè-běn xiǎoshuō*	*zhīqián*	*dǎkāi*	*yī-shàn chuānghù*
	author	write	this-CL novel	before	open	one-CL window
	'The author opened a window before writing the novel.'					

505 *Note:* CL = classifier. The complement NP is represented with a composition of
506 [demonstrative + CL $_{\text{entity-type}}$ + noun $_{\text{entity-type}}$] to denote a concrete or specific entity.

507 *3.4.3 Procedure*

508 The experiment was conducted in a language lab. Participants were assigned
509 randomly to one of the three lists and instructed to read sentences at their own
510 pace. The experiment began with written instructions on the screen, followed by
511 the six practice trials and the 128 trials of the experiment proper. The experiment
512 lasted approximately 30 minutes.
513 The sentences were presented phrase-by-phrase (as shown in Table 2) using
514 a moving window procedure. The phrases were displayed in white 14-point Kai
515 font on a black background via DMDX software (Forster and Forster, 2003). Each
516 trial began with a cross sign '+', followed by several sets of dashes. The first

phrase appeared (replacing the first set of dashes) when the participant pressed the space bar. With each subsequent press of the button, the next phrase was presented and the previously presented phrase replaced with dashes. Participants had to press the button repeatedly to read each phrase in turn. After each sentence, they were presented with a yes-or-no comprehension question related to the content. They indicated their response by pressing the Yes or No labelled on the keyboard. The next trial did not start until the response was given. All sentences (other than the practice trials) were presented in a random order. The computer recorded participants' RTs to each phrase and their responses to each question.

3.4.4 Data Analyses

Statistical analyses were performed on RTs of four regions: the verb region, the critical EntityNP complement region, and the two post-NP regions (i.e., NP+1 and NP+2). We examined the verb region to determine whether there was any processing difference that might affect comprehension of the upcoming NP. Effects of interest (related to complement coercion) were expected to emerge at the EntityNP region or one of the following spillover regions.

Before the statistical analyses, data were cleaned according to two separate measures (Author et al., 2021). First, participants were excluded entirely if their accuracy across all comprehension questions was less than 75%. After this measure, one participant was excluded for low accuracy. Second, RTs of the four regions in each target sentence were excluded from analysis if they were over 2,000 ms or less than 100 ms. This resulted in a loss of 170 data points (1.25%).

The remaining data were analyzed in R (R Core Team, 2018). We first calculated mean RTs for each type of sentences at the four regions and difference-adjusted 95% (percentile) mixed-effect-model-based intervals (Author 3, 2017). The intervals provide a rough indication of significant differences between conditions: when one condition's interval range does not include another condition's mean and vice versa, these two conditions are likely to be significantly different in a mixed-effect model. Results are reported in Table 3 and illustrated in Fig 3.

Following Author et al. (2021), statistical analyses were conducted by performing separate linear mixed-effects models with *lme4* package (Bates et al.,

2015) on the data from each of the four regions. Employed as the dependent variable, the RTs were log-transformed to obtain a model with approximately normal residuals. For all four regions, a linear mixed model was constructed, which included the categorical fixed effect of Verb Type, the continuous fixed effect of NP Predictability, and their interaction[3]. Verb Type was dummy-coded (with aspectual verb as baseline). The reasons why NP Predictability was included in the model but Sentence Acceptability was not was that the study focused on examining the processing patterns of EntityNP complements preceded by different types of verbs, and the NPs' predictability was more likely to affect its processing patterns. As for the sentence acceptability, it was rated to just make sure that all the experimental stimuli were linguistically acceptable to the participants, so as to minimize the possibility that the processing difficulty (if any) may result from the unacceptability of the experimental stimuli.

We began with the maximal structure of random effects supported by the present design, which included crossed random intercepts for both participants and items, as well as random slope parameters for the main effects of Verb Type, NP Predictability, and their interactions [formula: RT ~ VerbType * NPPredictability + (1 + VerbType * NPPredictability | Subject) + (1 + VerbType * NPPredictability | Item)]. Then, we simplified the random effects structure via model comparisons to get the maximal fitting model for all regions, using $\alpha = 0.2$ (Matuschek et al., 2017) [formula: RT ~ VerbType * NPPredictability + (1 + VerbType + NPPredictability | Subject) + (1 + VerbType + NPPredictability | Item)]. The main effects of Verb Type, NP Predictability, and their interaction were tested using likelihood ratio tests (comparing a model with one fixed factor to the same model but without that fixed factor). The results of these tests are reported in Table 4. Comparisons corresponding to each pair of conditions were made by summarizing the maximal fitting model and then releveling the baseline condition (with control verb as baseline). Results can be found in Table 5. Note that *df* and

[3] Since the object NP had not been seen yet when the verb was read, a reviewer suggested that we may remove the interaction from the statistical models specifically for the verb region (see e.g., Gattei et al., 2015 which used only relevant predictors for different sentence regions). However, we thought that 'NP predictability' may also be affected by earlier parts of the sentence. In other words, there may be something different about sentences which eventually had high-predictability NPs versus sentences that had low-predictability NPs, and that difference might even be apparent before the NP was encountered (e.g., certain sentences may create more constraining contexts than others). Since the interaction did not change our conclusion, we reported it for the reference of future research.

p-values in this table were calculated based on the lmerTest package (Kuznetsova et al., 2017), which was loaded at the beginning of the script.

3.4.5 Results

Comprehension Question Accuracy

Mean accuracy of comprehension questions for all critical sentences was 90.56%, indicating that participants paid attention to the task. Mean accuracy for sentences containing aspectual, psych, and control verbs were 92.68% (*range* = 76.19%-100%), 92.59% (*range* = 66.67%-100%), and 91.45% (*range* = 76.19-100%), respectively. There were no significant differences in accuracy rates across the conditions.

Reading Times

Mean RTs for the three sentence types at the four regions are reported in Table 3 and illustrated in Fig 3. As presented in Table 4, the main effects of Verb Type and NP Predictability were found at different regions, and there was no interaction effect detected.

Table 3. Mean reading times (in milliseconds)

Verb Type	Verb	Complement NP	NP+1	NP+2
Aspectual verbs	411 [386, 432]	448 [417, 473]	474 [451, 493]	453 [431, 475]
Psych verbs	408 [383, 432]	435 [408, 456]	449 [428, 467]	441 [419, 460]
Control verbs	415 [392, 433]	434 [415, 448]	439 [422, 453]	434 [416, 448]

Note: Mean reading times and difference-adjusted 95% [percentile] mixed-effect-model-based intervals (Author 3, 2017) in the square brackets.

Xue, W., Liu, M., Politzer-Ahles, S., & Tzeng, O. (2024). Verbal effect on the processing of complement coercion: distinguishing between aspectual verbs and psych verbs. *Lingua, 306*, 103754. DOI: 10.1016/j.lingua.2024.103754

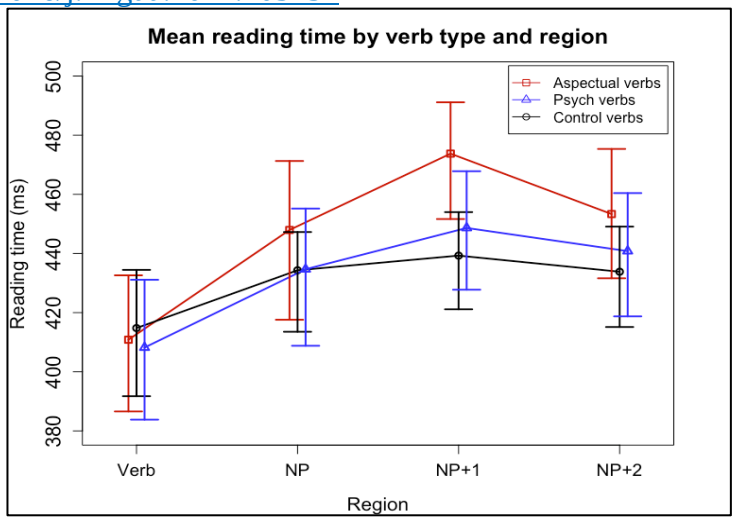

Fig. 3 Mean RTs by verb type and region. The error bars indicate the difference-adjusted 95% [percentile] mixed-effect-model-based intervals (Author 3, 2017).

The main effect of Verb Type was not significant at the verb or NP regions, but was significant at the two post-NP regions (see Table 4).

At the NP+1 region, the analysis revealed a significant effect of Verb Type (χ^2 (2) = 11.366, p = .003). Aspectual verbs yielded much longer RTs than control (35 ms) and psych verbs (25 ms), and the latter two had a relatively small RT difference (10 ms). Pairwise comparisons showed that the RT differences were significant between aspectual and control verbs (*Estimate* = -0.096, *SE* = 0.031, *t* = - 3.056, p = .003), and between aspectual and psych verbs (*Estimate* = -0.050, *SE* = 0.022, *t* = - 2.316, p = .023), but not between control and psych verbs (*Estimate* = 0.046, *SE* = 0.031, *t* = 1.461, p = .147) (see Table 5).

The NP+2 region exhibited a similar processing pattern to the NP+1, with a significant main effect of Verb Type (χ^2 (2) = 8.968, p = .011). Compared with aspectual verbs, both control and psych verbs were processed relatively faster (-19 ms, -12 ms). Pairwise comparisons showed that the RTs differences reached a significant level between aspectual and control verbs (*Estimate* = -0.065, *SE* = 0.030, *t* = - 2.151, p = .036), and between aspectual and psych verbs (*Estimate* = -0.048, *SE* = 0.018, *t* = - 2.741, p = .008), but not between control and psych verbs (*Estimate* = 0.017, *SE* = 0.029, *t* = 0.564, p = .575) (see Table 5).

The effect of NP Predictability was significant at the NP (χ^2 (1) = 11.138, p = .001) and the NP+1 regions (χ^2 (1) = 9.125, p = .003) (see Table 4). This effect is expected to be present in any theory of sentence processing, and was included as a nuisance covariate in the present analysis. The significant effects for Verb

Type in the model show that there is a slowdown in the aspectual verb condition over and above what can be explained by NP predictability.

In sum, entity-denoting triggered slower reading times (in spillover regions) when they followed aspectual verbs, compared to when they followed psych or control verbs, and their reading times after psych and control verbs did not significantly differ from one another.

Table 4. Results of likelihood ratio tests

Region	VT * NPP		VT		NPP	
	$\chi^2(df)$	*p*-value	$\chi^2(df)$	*p*-value	$\chi^2(df)$	*p*-value
Verb	7.429 (2)	.024	0.377 (2)	.828	0.658 (1)	.417
NP	0.684 (2)	.710	2.588 (2)	.274	11.138 (1)	.001 ***
NP+1	2.418 (2)	.299	11.366 (2)	.003 **	9.125 (1)	.003 **
NP+2	4.645 (2)	.098	8.968 (2)	.011 *	1.75 (1)	.186

Note: VT = Verb Type, NPP = NP Predictability.

$p \leq .001$ '***', $.001 < p \leq .01$ '**', $.01 < p \leq .05$ '*'.

Table 5. Results of pairwise comparisons to examine the main effect of Verb Type

	Comparison	*Estimate*	*Std.Error*	*df*	*t*	*p*
Verb	AspV vs. ConV	0.032	0.032	62.400	0.979	.332
	AspV vs. PsyV	0.000	0.020	103.716	0.019	.985
	ConV vs. PsyV	- 0.031	0.034	48.606	- 0.919	.363
NP	AspV vs. ConV	- 0.041	0.035	72.468	-1.173	.245
	AspV vs. PsyV	- 0.018	0.022	68.504	- 0.842	.403
	ConV vs. PsyV	0.023	0.035	63.437	0.644	.522
NP+1	AspV vs. ConV	- 0.096	0.031	159.793	-3.056	.003 **
	AspV vs. PsyV	- 0.050	0.022	85.285	-2.316	.023 *
	ConV vs. PsyV	0.046	0.031	114.474	1.461	.147
NP+2	AspV vs. ConV	- 0.065	0.030	53.466	-2.151	.036 *
	AspV vs. PsyV	- 0.048	0.018	67.037	-2.741	.008 **
	ConV vs. PsyV	0.017	0.029	72.336	0.564	.575

Note: AspV = Aspectual Verb, ConV = Control Verb, PsyV = Psych Verb.

$p \leq .001$ '***', $.001 < p \leq .01$ '**', $.01 < p \leq .05$ '*'.

Xue, W., Liu, M., Politzer-Ahles, S., & Tzeng, O. (2024). Verbal effect on the processing of complement coercion: distinguishing between aspectual verbs and psych verbs. *Lingua, 306*, 103754. DOI: 10.1016/j.lingua.2024.103754

4. Discussion

This study examined whether aspectual verbs and (subject-experiencer) psych verbs, both previously considered verbs triggering complement coercion, engender identical processing profiles. We contrasted processing behaviors of an EntityNP complement preceded by either an aspectual verb or a psych verb, relative to a control verb. The main finding is that aspectual verbs induced much longer RTs than psych and control verbs, respectively, at the two post-NP regions (i.e., NP+1 and NP+2), and the latter two verb types had no significant differences through the regions of interest. Overall, the results are within our expectations.

The observation that aspectual verb sentences were processed more slowly than control verb sentences indicates that the former is more challenging to comprehend than the latter. The result is closely compatible with Author et al. (2021), which found RT slowdowns for Chinese complement coercion expressions (with aspectual verbs) as opposed to two types of non-coercion equivalents. The present result also aligns with most of the prior psycho/neurolinguistic studies, which found that sentences requiring complement coercion engendered more processing cost than those without complement coercion (Baggio et al., 2010; Frisson and McElree, 2008; Husband et al., 2011; Kuperberg et al., 2010; McElree, Frisson, et al., 2006; McElree, Pylkkänen, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Traxler et al., 2005; Traxler et al., 2002; Author et al., 2020; Author et al., 2021). The extra interpretive cost has been suggested to arise from the enriched composition on the complement (i.e., reconstructing the EntityNP to an event type), which is triggered by the type mismatch between the EventV and the EntityNP (e.g., Frisson and McElree, 2008; Jackendoff, 1997; McElree, Frisson, et al., 2006; McElree, Pylkkänen, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Pustejovsky, 1991, 1995; Spalek and Tomaszewicz, 2016; Traxler et al., 2005; Traxler et al., 2002).

The lack of reading time difference between psych verb and control verb conditions suggests that the two types of expressions exhibit comparable processing patterns, and can be interpreted with similar ease. Most previous empirical studies presupposed that psych verbs entail the selectional constraints of taking an event-type complement, and thus included them into the set of coercion verbs to examine the processing of complement coercion expressions

(see Appendix) (Baggio et al., 2010; Delogu et al., 2017; Frisson and McElree, 2008; Husband et al., 2011; Kuperberg et al., 2010; Lapata et al., 2003; Lowder and Gordon, 2016; McElree, Frisson, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Pylkkänen and McElree, 2007; Scheepers et al., 2008; Spalek and Tomaszewicz, 2016; Traxler et al., 2005; Traxler et al., 2002). However, if psych verbs encode the selectional restrictions similar to coercion verbs do, the psych verbs in the present study should incur reading time slowdowns as opposed to the control verbs. This, however, is not the case. It is worth noting that in the previous empirical studies, there was no solid evidence provided to support why psych verbs were considered coercion verbs, except the observation that they trigger an implicit event sense when paired with an entity-type complement (Katsika et al., 2012; Piñango and Deo, 2016).

Furthermore, our results that readers processed psych verb sentences more quickly than aspectual verb sentences at the two post-NP regions posit that there may be a difference in how the two types of verbs are represented; the mechanisms underlined in their expressions may also be distinct. The result is incompatible with the previous theoretical and empirical literature. Theoretically, psych and aspectual verbs were assumed to share a uniform selectional constraint of taking an event-denoting argument as their complement. When they are combined with an entity-denoting argument, a semantic operation is assumed to occur on the argument to coerce/shift its entity type into an event type (Jackendoff, 1997; Pustejovsky, 1991, 1995). Empirically, previous studies presupposed such an event-selecting property encoded in the two types of verbs, and conflated them to explore the processing of complement coercion (see Appendix) (Baggio et al., 2010; De Almeida, 2004; Delogu et al., 2017; Frisson and McElree, 2008; Husband et al., 2011; Kuperberg et al., 2010; Lapata et al., 2003; Lowder and Gordon, 2016; McElree, Frisson, et al., 2006; McElree et al., 2001; Pickering et al., 2005; Pylkkänen and McElree, 2007; Scheepers et al., 2008; Spalek and Tomaszewicz, 2016; Traxler et al., 2005; Traxler et al., 2002). The current evidence seems to not support the earlier assumption, but rather imply that these two types of verbs encode distinct semantic representations.

As mentioned in Section 2.2, aspectual verbs introduce quantification over an event which is expressed by the internal argument of the verbs (Levin, 1993; ter Meulen, 1990). Given that, when interpreting an expression like *started the novel*,

703 comprehenders may embed the noun phrase *the novel* within an event structure
704 (e.g., *reading the novel*), which is achieved by generating a semantic
705 representation to realize an extended sense. This is a complex compositional
706 operation and may need more time to perform (McElree, Frisson, et al., 2006).
707 Unlike aspectual verbs, psych verbs describe mental states (Belletti and Rizzi,
708 1988; Brennan and Pylkkänen, 2010; Levin, 1993; Pesetsky, 1995; Piñango, 2000;
709 Thompson and Lee, 2009). Their object is characterized as a target/subject matter
710 of emotion (Pesetsky, 1995), which can be realized by various individuals, such as
711 an entity, an event, or a state of affairs (Katsika et al., 2012; Piñango and Deo,
712 2016). In this sense, the object of psych verbs *may* be event-denoting, but it may
713 also not be. The selection of an eventive argument is not lexically encoded in these
714 verbs *per se*. Thus, when interpreting an expression like *enjoy the novel*,
715 comprehenders do not necessarily structure an event representation for the noun
716 *the novel*.
717 Some may wonder how the implicit event meaning is obtained given that psych
718 verb expressions like *enjoy the novel* can also be paraphrased as 'enjoy doing
719 some activity associated with the novel'. From the perspective of Katsika et al.
720 (2012), the derived event meaning is likely to be a result of inferring an activity
721 relevant to the target of emotion, based on a discourse context. Such an inferential
722 process is similar to the one involved in the aspectual verbs to retrieve an
723 appropriate event meaning associated with the complement denotation.
724 Furthermore, Piñango and Deo (2016: 364) argued that although psych verb
725 and aspectual verb expressions can be paraphrased in the same way to derive an
726 implicit event sense, the meaning relations between the predicate and its
727 complement are distinct. For *start the novel*, the complement is construed as an
728 incremental theme that is created, consumed, or affected in some implicit
729 eventuality. For *enjoy the novel*, the complement is construed, instead, as a target
730 of emotion; the target argument is evaluated by the experiencer, and directed to
731 the experiencer's emotion whenever the subject is experiencing the emotion
732 described by the predicate verb (Pesetsky, 1995).
733 Taken together, psych and aspectual verbs may not share uniform argument
734 selectional properties; therefore, their corresponding expressions are processed
735 with different mechanisms. Psych verbs, more like the control verbs in the present
736 study, do not exclusively require an eventive complement. When they are paired

with an EntityNP complement, the expressions involve a simple composition (Brennan and Pylkkänen, 2010; Cupples, 2002), eliciting little processing cost. Aspectual verbs, instead, inherently require an eventive complement. When they are paired with an EntityNP complement, the expressions involve an enriched composition, causing processing cost (Katsika et al., 2012; Lapata et al., 2003; McElree, Frisson, et al., 2006; Pustejovsky and Jezek, 2008).

Instead of the enriched composition account, however, Delogu et al. (2017) attributed the coercion-related processing cost mainly to the relatively unpredictable (thus, high surprisal) EntityNP complements following an EventV. In the present study, we matched the predictability of the EntityNPs following aspectual and psych verbs, and additionally, incorporated the NP predictability to the statistical models, but still found a significant reading time difference between the two verb types. The result suggest that the semantic enrichment quite likely goes beyond the surprisal to influence the interpretation of coercion expressions.

Overall, the current study provides behavioral evidence to show that aspectual verbs trigger complement coercion and a corresponding processing cost whereas psych verbs do not. The findings contribute to theories of complement coercion in at least three aspects. First, our results lend experimental support to the argument that expressions requiring complement coercion incur more interpretive cost. This comes more likely from the complex compositional operation to repair the type mismatch between the verb and the complement. Second, there has been debate over what kinds of verbs should be considered 'coercion verbs'. By isolating psych and aspectual verbs, this study is able to tease apart their distinct processing profiles. Given that psych verbs may not inherently/exclusively select an eventive complement, they cannot be classified into the set of coercion verbs. Third, the findings obtained in Mandarin Chinese—a language outside the Indo-European languages family, offer clear cross-linguistic evidence for the complement coercion literature, where most studies were undertaken on Indo-European languages, such as English and German.

One crucial limitation needs to be kept in mind. As described in Section 3.1, the current study included five aspectual verbs and five psych verbs as target verbs, which appear to be a small size. The relatively small number of target verbs may limit the generalizability of the reported findings. Future research may include

more verbs within the two verb classes to provide more solid evidence for a deeper understanding of the issue under study.

5. Conclusion

This study investigated the time course of enriched composition with complement coercion, with a specific focus on two types of verbs that were previously classified as complement coercion verbs, that is, aspectual verbs and psych verbs. By comparing reading times of their respective expressions, we observed that these types of verbs trigger different processing patterns. Specifically, entity-denoting complements were read significantly slower after aspectual verbs than after psych verbs. This discrepancy was attributed to the specific mechanisms involved in each verb type: aspectual verbs trigger enriched composition, while psych verbs do not. Overall, the findings confirm the processing cost associated with enriched composition in complement coercion. More importantly, this study provides evidence to restrict the phenomenon to aspectual verbs only, which are distinctive in terms of their argument selection and their tendency to invoke a processing cost when combined with an entity-denoting complement. Further research could verify the current findings by including more verbs that represent into these two verb types.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All stimuli, data, and scripts for statistical analyses are available at https://osf.io/m4pdb/?view_only=f58c4b53275e4de0be853f2ddc573d1f.

Appendix: Summary of Verbs Assumed to Trigger Complement Coercion in Previous Empirical Studies

The table below summarizes verbs that were classified as complement coercion verbs in previous empirical studies. Note that only the studies in which a

799 complete list of experimental stimuli was published are included, so that the
800 'complement coercion verbs' can be obtained. '–' represents that no verbs of that
801 type were included.

Study	Aspectual verbs	Psych verbs	Others
McElree et al. (2001)	begin, start, finish, complete	endure, prefer, resist, savor, enjoy, survive	master, attempt, try, expect
Traxler et al. (2002)	start, begin, finish, complete, end	prefer, endure, resist, enjoy	try, attempt, master, expect
Lapata et al. (2003)	begin, postpone	enjoy, prefer, endure, dare, regret, hate, survive	try, avoid,
De Almeida (2004)	begin, start, finish	prefer, savor, enjoy	master, attempt, expect, try
Pickering et al. (2005)	begin, start, finish	prefer, savor, enjoy	master, attempt, try, expect
Traxler et al. (2005)	begin, start, complete, finish	enjoy, resist	master, try
McElree, Frisson, et al. (2006)	start, begin, continue, finish, complete	–	master
Pylkkänen and McElree (2007)	begin, start, finish, complete	endure, enjoy	master, try, attempt
Frisson and McElree (2008)	start, begin, continue, finish, complete	prefer, resist, enjoy, endure	try, attempt
Scheepers et al. (2008)	start, begin, finish	enjoy	attempt, try, master
Baggio et al. (2010)	begin, finish, complete, start	endure, enjoy, resist	try, attempt, master, manage
Kuperberg et al. (2010)	begin, start, finish, complete	endure, enjoy	master, try, attempt

Husband et al. (2011)	start, begin, complete, finish	endure, enjoy	master, try, attempt
Lowder and Gordon (2016)	start, begin, finish	prefer, endure, resist	try, attempt, master
Spalek and Tomaszewicz (2016)	begin, finish, pause, await	endure	–
Delogu et al. (2017)	begin	enjoy, prefer, endure, love, hate	manage, plan, master, try

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