Running-head: Cognitive restructuring in the multilingual mind

Cognitive restructuring in the multilingual mind: language-specific effects on processing efficiency of caused motion events in Cantonese-English-Japanese speakers

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Abstract

The current study explores how multilingual speakers with three typologically different languages (satellite-framed, verb-framed and equipollent-framed) encode and gauge event similarity in the domain of caused motion. Specifically, it addresses whether, and to what extent, the acquisition of an L2-English and an L3-Japanese reconstructs the lexicalization and conceptualization patterns established in the L1-Cantonese when the target language is actively involved in the decision-making process. Results show that multilingual speakers demonstrated an ongoing process of cognitive restructuring towards the target language (L3) in both linguistic encoding (event structures and semantic representations) and non-linguistic conceptualization (reaction time). And the degree of the restructuring is modulated by the amount of language contact with the L2 and L3. The study suggests that learning a language means internalizing a new way of thinking and provides positive evidence for L3-biased cognitive restructuring within the framework of thinking-for-speaking.

1. Introduction

The question of whether language affects cognition has generated vigorous debates in the past decades (Bylund & Athanasopoulos, 2014b; Lucy, 2016). The hypothesis of Linguistic Relativity (Whorf, 1956) postulates that cross-linguistic differences in the semantic encoding affect cognitive processing, even when language is not actively involved in the decision-making process. Empirical evidence demonstrates that on the one hand, cross-linguistic differences in non-linguistic representations have been detected in various conceptual domains such as time (Boroditsky, Fuhrman, & McCormick, 2011; Casasanto & Boroditsky, 2008), color (Athanasopoulos, 2009; Athanasopoulos, Damjanovic, Krajciova, & Sasaki, 2011), objects (Cook, Bassetti, Kasai, Sasaki, & Takahashi, 2006; Pavlenko & Malt, 2011) and motion (Ji & Hohenstein, 2018; Park, 2019); on the other, these effects are task-dependent and obtained in certain conditions. For example, the influence of language on cognitive processing is most likely to appear when language is explicitly used during on-line thinking (Filipovic, 2018; Montero-Melis, Jaeger, & Bylund, 2016; Trueswell & Papafragou, 2010), or when it is used as a strategy to solve a subsequent cognitive task (Lai, Rodriguez, & Narasimhan, 2014; Lupyan, 2012). However, such effects may disappear when the access to language is blocked by task manipulation (Gennari, Sloman, Malt, & Fitch, 2002; Montero-Melis & Bylund, 2017). These varied findings have motivated researchers to explore further how language affects cognition in different conditions. The hypothesis of thinking-for-speaking (Slobin, 1996) emphasizes the effects of language on on-line thinking when speakers are involved in language-driven activities. This approach has generated evidence that speakers of different languages demonstrate different non-linguistic patterns during the engagement in language comprehension or production. In line with the explicit use of language, other studies propose that speakers may use language as a strategy to solve a high-level cognitive task, especially when the task lacks an objective answer or with a time limitation (Finkbeiner, Nicol, Greth, &

Nakamura, 2002). Such "thinking after language" effect, as termed by Wolff and Holmes (2011), emphasizes the spontaneous recruitment of linguistic resources to aid working memory and facilitate answer formulation.

The investigation of language learning on cognitive processing mainly focuses on monolingual speakers, although recent studies start to extend the scope with bilingual speakers or L2 learners of various types (Athanasopoulos, Damjanovic, Burnand, & Bylund, 2015; Bylund & Athanasopoulos, 2014a; Cook & Bassetti, 2011; Pavlenko & Volynsky, 2015). Bilingualism research on language and cognition mainly focuses on the extent to which learning a new language reshapes one's thinking. Studies to date have demonstrated that conceptual representations within the bilingual mind are flexible and dynamic, such that the internalization of L2-specific associations may give rise to cognitive restructuring of L1-specific categories. This process is likely to be modulated by various predictors such as age of acquisition (Lai et al., 2014), language proficiency (Athanasopoulos, Damjanovic, et al., 2015), and frequency of language use (Bylund & Athanasopoulos, 2014a).

With the exception of Bylund and Athanasopoulos (2014a) and Bylund, Athanasopoulos, and Oostendorp (2013), from a grammatical perspective, very little attempt has been done to address how speakers of more than two languages (i.e., multilingual speakers) conceptualize motion events from a lexical perspective. The current study takes a first step towards investigating how Cantonese-English-Japanese multilingual speakers with three typologically different languages (equipollent-framed, satellite-framed, and verb-framed) encode and gauge event similarity in caused motion. Specifically, we examine multilinguals' linguistic and non-linguistic behaviours in the lexicalization and conceptualization of caused motion with a boundary crossing situation where the target motion contains a categorical change of location. Their processing efficiency in the decision-making process is measured by reaction time. In addition, the study also addresses whether the amount of language contact with each language affects their performance while controlling for the speakers' language proficiency in the target language.

2. Background

2.1 Conceptual representations in the bilingual mind: the account of cognitive grammar

The interplay between language and cognition in speakers with more than one language raises many intriguing questions. These questions are related to 1) the degree to which bilinguals restructure their conceptualization patterns as a result of L2 acquisition; 2) the transfer phenomena in linguistic and non-linguistic representations; and 3) linguistic or extra-linguistic variables that modulate learner's cognitive behavior during L2 learning.

Empirical evidence shows that learning a new language means acquiring a new way of thinking. When speakers learn an additional language, they need not only acquire new linguistic references or frames, but also associated conceptual distinctions (Jarvis & Pavlenko, 2008; Pavlenko, 2011). This may give rise to restructuring the existing conceptual categories acquired through the L1. This process, termed as conceptual or cognitive restructuring, refers to conceptual changes that bilinguals undergo during learning a new language. It is a gradual process and occurs in bilingual's verbal and non-verbal behaviors (Pavlenko, 2011).

The concept of cognitive restructuring is well discussed within the framework of cognitive grammar, which provides a solid background for the mechanism of language learning and has been successfully applied to explain the relativistic effects and cognitive restructuring in the context bilingualism or L2 learning (Bylund & Athanasopoulos, 2014b; Casasanto, 2008; Ji & Hohenstein, 2018; Kersten et al., 2010). According to cognitive grammar (Langacker, 1987, 1991, 2008), grammatical constructions are form-meaning pairings above the word level. Thus, language-specific ways of selecting and organizing information are directly related to how conceptualizations are represented in cognition. As a result, speakers of different languages construe the same event in conceptually different ways depending on the grammatical devices made available in their language (Athanasopoulos, Bylund, et al., 2015; Bylund & Jarvis, 2011; Flecken et al., 2015; Von Stutterheim et al., 2012; Von Stutterheim & Nuse, 2003). For example, the presence or absence of linguistic devices for grammatical aspect in a language affects the degree to which speakers express and allocate their attention to event trajectory and endpoints (Bylund & Athanasopoulos, 2014a; Flecken, Carroll, Weimar, & Von Stutterheim, 2015; Von Stutterheim, Andermann, Carroll, Flecken, & Schmiedtova, 2012). Speakers of an aspect language (i.e. languages with grammatical means to present aspectual contrast) are less prone to mention the endpoint in lexicalization and focus more on the ongoing phrase of the target event, whereas speakers of a non-aspect language (i.e. languages without grammatical means to encode aspect) tend to express the endpoint of an event more frequently and adopt a holistic perspective in event categorization. The findings can be interpreted by a psycholinguistic model that 'conceptual categories encoded in the grammar of a language play an active role in the cognitive filer set up during attention allocation and information selection when talking about motion (Von Stutterheim et al., 2012, p.863). Thus, the linguistic structures highlighted by grammar (i.e. number, aspect making, and finite verbs) tend to be placed with greater prominence in speakers' mental representations.

For bilingual speakers, continuous exposure to novel events throughout lifetime will facilitate learners to form new form-meaning pairings of the same event based on statistical regularities of the language-specific patterns in different contexts. From the perspective of bilingualism and L2 learning, the main concern is about how the internalization of L2-specific form-meaning pairings interact with the L1-biased patterns, and whether it can trigger the restructuring of the existing categories in the bilingual mind (Athanasopoulos, Damjanovic, et al., 2015). In fact, cross-linguistic differences in conceptual representations are affected by the degree of exposure to language-specific constructions: the more routinized an association becomes, the easier it is to be retrieved from memory and unitized for the purposes of categorization (Langacker, 2008).

As mentioned above, cross-linguistic differences in conceptualization demonstrate a linear and gradual process. This process is context-bound and highly open to individual differences in a learner's trajectory. One key factor is related to the frequency of exposure to a specific form-meaning association. Empirical evidence shows that conceptual representations are subject to constant changes as a function of exposure and language use (Athanasopoulos et al., 2011; Bylund & Athanasopoulos, 2014a; Bylund et al., 2013). In other words, frequent language use will strengthen the language-specific form-meaning associations whereas infrequent language use will weaken the associations. In addition, the degree of cognitive restructuring of language-specific associations can be modulated by other extra-linguistic factors such as age of L2 acquisition (Athanasopoulos, 2009; Boroditsky, 2001; Lai et al., 2014), L2 proficiency (Athanasopoulos, Damjanovic, et al., 2015; Ji, 2017; Park & Ziegler, 2014), language context (Filipović, 2011; Montero-Melis et al., 2016) and length of immersion in an L2-speaking community (Cook et al., 2006; Daller, Treffers-Daller, & Furman, 2011; Park, 2019).

2.2 Motion event descriptions in English, Japanese and Cantonese

The domain of motion serves as an ideal testing ground for the intrinsic interplay between language and cognition as world languages exhibit great variabilities in the semantic encoding. A caused motion refers to a situation where an agent exerts some external forces on an object which causes its direct movement (Talmy, 2000). It is a complex type of motion and contains a number of semantic elements, such as path of motion (into, out of), cause (take, carry), manner of cause (push, pull) and manner of object (roll, slide).

Following Tamly's typological distinctions (1985, 2000), the world's languages fall into two broad categories based on the semantic distribution of path of motion. In satellite-framed languages (S-languages) such as English and German, path is encoded outside of the verb in a satellite whereas cause of motion, like manner, is an external co-event which can be conflated with motion in the main verb. In contrast, for V-languages such as Japanese and French, cause of motion is typically conflated with path in the main verb, leaving manner of cause unexpressed (by default) or via peripheral devices (i.e., subordinations, gerunds, or adverbial clauses). For example, as an S-language, the most prototypical way for English is to conflate manner of cause with motion in the main verb whereas path in the satellite.

(1) The boy pushed [Manner of Cause] a box into [Path] a cave.

On the contrary, as a V-language, Japanese either conflates path in the main verb, leaving manner of cause unexpressed, as shown in example (2a) or via a subordinate form (the *-te* conjunctive marker), as illustrated in (2b).

(2) a. 彼 は 荷を 上げた [Path + Cause] (Yiu, 2013).
Kara wa ni-o ageta
S/he TOP goods ACC ascend PST
'S/he moved up the goods'.

b. 彼 は 荷を 押して [Manner of Cause] 道を 渡りました [Path]
Kara wa ni-o oshite michi-o watalimashita
S/he TOP goods-ACC pushing road-ACC cross PST
'S/he crossed the road pushing the goods'.

Talmy's classification has been useful in analyzing Indo-European languages, but does not easily apply to serial-verb languages such as Chinese, Tai, and other Sino-Tibetan languages. Thus, Slobin introduces a third type, known as equipollent-framed languages, in which "both Manner and Path are expressed by equipollent elements, that is, elements that are equal in formal linguistic terms, and appear to be equal in force or significance" (Slobin, 2004, p. 226). Cantonese, widely spoken in Hong Kong and Guangdong Province of China, is a serial-verb language (Matthews & Yip, 2011). A serial-verb construction in Cantonese usually consists two or more verbs, with each being able to stand alone as an independent element (Matthews, 2006). The most prototypical way in Cantonese to encode caused motion is the disposal construction, which consists of a disposal marker ‘zoeng1’, followed by two or more transitive verbs (Yiu, 2013, 2014). Example (3) shows that in caused motion, manner of cause and path are conflated in the form of a verb compound. In addition, like Japanese, Cantonese also allows the conflation of cause with path in the main verb, leaving manner in the form of subordination or unexpressed at all, as demonstrated in example (4). Given these typological features, Cantonese is classified as an equipollent-framed language incorporating typological features of both S- and V-languages (Lamarre, 2007; Yiu, 2013, 2014).

(3) 佢 將 一架車 拉上 [Manner of Cause+ Path] 一個山 (Yiu, 2014).
Keoi5 zoeng1 jat1 ga3 che1 laai1 soeng5 jat1 go3 saan1
S/he DM a car push-ascend a CL hill
‘S/he pulled a car up a hill.’

(4) 佢 上咗 [Cause+Path] 三箱貨 喺 個架 (度)
Keoi5 soeng5 zo2 saam1 soeng1 fo3 hai2 go3 gaa2 (dou6).
S/he ascend ASP three goods at the CL shelf (Localizer)
‘S/he moved three boxes of goods up onto the shelf.’

The typological status of Cantonese can be attributed to diachronic changes that classical Chinese went through from a V-language to an S-language (Peyraube, 2006), and such typological transformations in some Chinese dialects, such as Cantonese, have not completed yet (Xu, 2006; Yiu, 2013, 2014). Thus, it has been proposed that the typological distinctions between S-and V-languages should not be viewed as an absolute dichotomy, but a continuum with various degrees of manner and path salience (Slobin, 2004; Zlatev & Yangklang, 2004).

Encoding manner or cause of motion via peripheral devices is more characteristic for V-language speakers when describing a boundary-crossing movement. According to the boundary-crossing constraint, manner verbs are not supposed to be used in a situation where there is a categorical change of location (Aske, 1989; Slobin & Hoiting, 1994). However, this constraint does not apply to S- or E-languages (Slobin, 2004, 2006). Thus, it is suggested that a boundary-crossing movement serves as the clearest context to address the cross-linguistic differences in motion event cognition (Slobin, 2006).

As reviewed above, the typological contrasts in motion event encoding makes manner of cause less codable in Japanese compared with English and Cantonese as there is no obligatory syntactic slot to encode this information. In addition, as V-languages only license manner subordination in a boundary-crossing event, the high load of cognitive processing tends to prevent V-language speakers from encoding manner as often as S-language speakers. Drawing on the manner salience hypothesis (Slobin, 2004) , speakers' memory and attention are guided by variations in the lexical and grammatical patterns, such that speakers allocate more attention to the element that is made more available and salient by the language (Slobin, 2003, 2006).

2.3. Cross-linguistic differences in motion event encoding

Cross-linguistic research on motion event lexicalization mostly focus on voluntary motion, whereas only few studies have explored caused motion events (Choi & Bowerman, 1991; Hendriks, Hickmann, & Demagny, 2008; Hickmann & Hendriks, 2010; Hickmann, Hendriks, Harr, & Bonnet, 2018; Ji, Hendriks, & Hickmann, 2011; Montero-Melis & Bylund, 2017). Some studies have reported that language-specific features in caused motion encoding are found among English and Korean (Choi & Bowerman, 1991), Spanish and Swedish (Montero-Melis & Bylund, 2017), and English and Chinese (Ji et al., 2011). However, other studies have found no cross-linguistic differences in the linguistic encoding of manner of cause, path, and manner of object between English and French (Hickmann & Hendriks, 2010; Hickmann et al., 2018). The mixed results suggest that it is important to choose optimal languages pairs with clearest typological contrasts when conducting cross-linguistic research.

With respect to L2 acquisition, some studies have demonstrated that bilinguals or L2 learners with typologically different languages may transfer L1-based lexicalization patterns into an L2

(Cadierno & Ruiz, 2006; Daller et al., 2011; Ochsenbauer & Engemann, 2011). However, other studies report that L2 learners are able to restructure their L1-based lexicalization patterns when describing motion events with an L2 (Ji & Hohenstein, 2014). The diverse results indicate that conceptual restructuring is a dynamic process and susceptible to individual differences, such as age of acquisition (Engemann, Harr, & Hickmann, 2012; Hohenstein, Eisenberg, & Naigles, 2006), L2 proficiency (Ji & Hohenstein, 2014; Treffers-Daller & Calude, 2015), and frequency of language use (Daller et al., 2011).

2.4. Cross-linguistic differences in motion event conceptualization

Moving beyond language use, cross-linguistic research on motion event starts to question whether language-specific patterns in lexicalization affect event conceptualization at a deeper level of cognition. These studies have been well-documented in children and adults, with different combination of language pairs, and by a wide range of non-verbal measurements such as similarity judgements, recognition memory, attention allocation, reaction times and gestures (Brown, 2015; Filipović, 2011; Flecken, Carroll, et al., 2015; Montero-Melis et al., 2016; Papafragou, Hulbert, & Trueswell, 2008; Von Stutterheim et al., 2012).

Some studies utilize a triads-matching paradigm to tap into participant's potential bias in event categorization or similarity judgements. Results showed that on the one hand, effects of language on conceptualization were found when language was either explicitly or implicitly involved in the process of decision-making (Gennari et al., 2002; Montero-Melis & Bylund, 2017; Papafragou & Selimis, 2010). However, such effects disappeared when a verbal interference (Ji & Hohenstein, 2017; Trueswell & Papafragou, 2010) or a task distraction was introduced (Filipović & Geva, 2012). Meanwhile, other studies use a recognition memory test to explore whether different degrees of salience language attaches to manner and path affects the memorization and recalling of relevant linguistic elements (Filipović, 2011, 2018; Kersten et al., 2010). Results further illustrate that the effects of language on thought are obtained under conditions when the access to language is not blocked during cognitive processing.

In addition, many studies have applied an eye tracking and preferential looking scheme to examine participants' attention allocation during event perception (Flecken, Carroll, et al., 2015; Papafragou et al., 2008; Soroli & Hickmann, 2010; Von Stutterheim et al., 2012). For example, Papafragou et al. (2008) used eye-tracking to test whether native speakers of English (S-language) and Greek (V-language) allocated the same amount of attention to manner and path while viewing an unfolding event. Results showed that language-specific patterns in motion event lexicalization affected participant's attention allocation during speech production. However, such effects disappeared in a non-verbal condition when the access to language was blocked by task manipulation. Similar results were reported by Von Stutterheim et al. (2012) who investigated how languages with a grammatical aspect system biased speakers' attention towards event trajectory or endpoint. Based on the eye-tracking data from adult participants of seven languages, results illustrated that non-aspect language speakers encoded endpoints more often in verbalization and allocated more attention to endpoints in conceptualization, whereas aspect-language speakers were less prone to mention endpoints in verbalization and paid more attention to the ongoing phase on the same event. The findings are in line with the cognitive grammar that attention is drawn towards the linguistic forms highlighted by grammar.

More recently, several studies have started to use reaction time as a subtle measurement for participant's cognitive behaviors in motion event perception (Flecken, Athanasopoulos, Kuipers, & Thierry, 2015; Ji, 2017; Ji & Hohenstein, 2017, 2018). In a recent study, Ji and Hohenstein (2018) examined how Chinese and English children and adults categorized and responded to caused motion in a non-verbal condition. Results showed that participants demonstrated an overall preference for path-match choices in categorization regardless of age and language group. However, their reaction time to manner and path preferences patterned with the linguistic properties of each language: English monolinguals reacted much quicker in making manner-match choices than path-match choices whereas Chinese monolinguals reacted equally quickly in making manner-and path-match preferences. It was suggested that the form-meaning associations between grammatical status of manner/path and non-linguistic can be detected even if language use was blocked via a verbal shadowing in decision-making.

Beyond studies of monolingual speakers, only few studies have probed into the effects of language on thought with bi- or multilingual speakers. The core issue with bilingual speakers or second language learners lies in whether learning an additional language with contrastive typological features will give rise to the cognitive restructuring and factors that modulate the restructuring process (Bylund & Athanasopoulos, 2014b).

On the one hand, some studies suggest that the already established conceptual categories in the L1 are stable and resistant to change regardless of the increased L2 proficiency (Aveledo & Athanasopoulos, 2016; Cadierno, 2010; Filipovic, 2018). For example, Filipovic (2018) examined the lexicalization patterns and recall memory in causation events (intentional vs non-intentional) with late English-Spanish and Spanish-English bilinguals. Results suggested that bilinguals consistently relied on their habitual L1 thinking patterns as an aid to facilitate memory even though L2 was used in language production.

On the other hand, a few studies have demonstrated that learning an additional language means acquiring a new way of thinking, especially when participant's access to language use is not blocked in cognitive processing (Athanasopoulos, Bylund, et al., 2015; Brown & Gullberg, 2011; Filipović, 2011; Hohenstein et al., 2006; Kersten et al., 2010; Lai et al., 2014). For example, Kersten et al. (2010) examined how late Spanish-English bilinguals classified novel objects by using a supervised learning paradigm. Results showed that bilinguals achieved better performance in manner recognition when tested in an English-instructed context than in a Spanish-instructed context. Similar results were reported by Lai et al. (2014) that in event categorization, late English-Spanish bilinguals in a Spanish-priming condition were more likely to base their judgement on path of motion than those in an English-priming condition and English monolinguals. In addition, Athanasopoulos, Bylund, et al. (2015) further demonstrated that German-English bilinguals switched their preferences between ongoingness and goal orientation in event categorization as function of language in operation.

To sum up, the overall results in L2 acquisition and bilingualism have provided evidence for cognitive restructuring when participants are involved in language use. And the degree of cognitive restructuring is modulated by various predictors such as age of L2 acquisition (Filipović, 2011; Kersten et al., 2010; Lai et al., 2014), L2 proficiency (Athanasopoulos, 2009; Athanasopoulos, Damjanovic, et al., 2015; Ji, 2017; Park & Ziegler, 2014), and the frequency of L2 use (Bylund & Athanasopoulos, 2014a; Bylund et al., 2013).

3. The present study

The current study aims to expand the sphere of event cognition from bilingualism to multilingualism from a lexical perspective and takes a first step in investigating how speakers of three typologically different languages gauge event similarity in caused motion. It aims to examine whether, and to what extent, the acquisition of an L2-English and an L3-Japanese recalibrates the lexicalization (event structures and semantic distributions) and conceptualization patterns (categorical preferences and reaction time) established in the L1-Cantonese when participants are actively involved in speaking the target languages (i.e., L2-English for bilinguals and L3-Japanese for multilinguals). Specific research questions are formulated as follows:

1. How do Cantonese-English-Japanese multilinguals lexicalize caused motion in their L3 compared with Cantonese-English bilinguals and monolinguals of each language?
2. How do Cantonese-English-Japanese multilinguals conceptualize caused motion compared with Cantonese-English bilinguals and monolinguals of each language?

3. To what extent does the amount of language contact with each language affect the restructuring process in the multilingual mind?

4. Method

4.1 Participants

A total of 150 university students took part in the study and divided into five language groups (N=30 each group). Native controls of Cantonese ($M_{age=}$22.1, SD=2.7), English ($M_{age=}$23.7, SD=1.9) and Japanese ($M_{age=}$24.6, SD=2.3) were recruited from local universities of China, UK and Japan. Native controls of monolinguals in the study refer to those with limited proficiency and minimal exposure to any foreign language. The dominant language in their daily communication is the native language. Cantonese-English bilinguals ($M_{age=}$20.7, SD=2.1) and Cantonese-English-Japanese multilinguals ($M_{age=}$21.2, SD=1.8) were from Hong Kong where both Cantonese and English are the official languages. According to the language policy in HK, students normally start the L2-English learning from an average age of three as early-bilinguals and pick up a third language as either Major or Minor at university.

For bilingual speakers, their onset of L2 learning was 3.7 (SD=1.5), whereas for multilingual speakers, their L2 onset was 3.4 (SD=1.7), and 19.2 (SD=1.4) for the L3. Due to an early exposure and active use of the L2, speakers have already achieved a high level of proficiency in English. In line with previous studies (Athanasopoulos, Damjanovic, et al., 2015; Montero-Melis et al., 2016; Park & Ziegler, 2014), participant's language proficiency was self-evaluated in a language history questionnaire. Participants needed to evaluate their current proficiency in all languages they know based on a seven-point scale where 7 is the maximum rating. In accordance with the Common European Framework of Reference for language (Council of Europe, 2011), bilingual's proficiency of English (M=6.41; SD=0.51) and multilingual's proficiency of English (M=6.56; SD=0.45) and Japanese (M=6.26; SD=0.67) were above the upper intermediate level (C rating), as measured by their self-rating scores. Thus, bilingualism and multilingualism in the current study is defined as an alternate of two or more languages of high proficiency.

To measure multilinguals' language contact with Cantonese, English and Japanese, daily language use within the last three months was estimated by hours. Participants were asked to self-report the time they spent on doing the daily activities (e.g., watching television, reading for school, and talking with native speakers etc.) with each language. Detailed information about multilingual speakers' language background is presented in Table 1.

[Table 1 is to insert here]

4.2 Materials

4.2.1 Task1: Linguistic Encoding of Caused Motion

Linguistic descriptions of caused motion were elicited by a total of 48 of animated cartoons with 36 test items and 12 control items. Each animation was 6 seconds long. Following the model developed by Hickmann and Hendriks (2010) , this study focuses on a specific type of complex motion where different linguistic elements (i.e. manner of cause, manner of object and agent) can be encoded simultaneously. The test items depicted a boy (the agent) performing a certain action (i.e., push or pull) on the object which directly caused its movement (i.e., roll or slide) along a certain trajectory (i.e., into, out of). Each animation has a clear destination (goal of motion). In addition, the agent moved together with the object throughout the course by walking. The control items shared the same types of actions with the test items but largely minimized the path information. The involvement of the control items had two functions: 1) to distract participants following the same lexicalization patterns and 2) to test whether multilingual speakers have already mastered the related vocabulary to describe various types of manner in the target language. Altogether four specific types of manners of cause (pull, push, drag and kick) and four types of path (into, out of, across and along) were covered in the stimuli.

The stimuli were fully randomized and counterbalanced across participants. A whole list of stimuli is presented in Appendix A.

4.2.2 Task2: Non-linguistic Categorization of Caused Motion

The stimuli consisted of 18 sets of animated videos, including 12 sets of test triads and 6 sets of filler items. The test items had the same content with the stimuli used in the linguistic encoding. This was to make sure that participants had described all scenes prior to event categorization. Each triad contained three animated videos: a target video (e.g., A boy pushes a box into the room), and its two alternates with manner and path as the contrast of interest. For example, for manner-match alternate, manner of cause remained the same while path was changed (e.g., A boy pushes a box out of the room) whereas for path-match alternate, path of motion kept the same whereas manner of cause was different (e.g., A boy pulls a box into the room). In order to keep manner-path as the only contrast of interest, other semantic components in the caused motion (Figure, Ground, and Goal) remained consistent across each test triad. Following Loucks and Pederson (2011), 6 sets of filler items were introduced to mask the contrast of interest and distract participants from strategically using the same pattern throughout the whole course. Thus, half of the filler contrasted manner of cause with Ground while the other half contrasted path with Ground. Altogether four sets of manner of cause contrasts (push-pull; push-drag; push-kick and drag-kick) and four sets of path contrasts were used (into-out of; across-along; out of-along and into-along) in the stimuli. All stimuli were horizontal motions and the direction of agent’s movement (i.e., from left to right or from right to left of the screen) was counterbalanced across each triad.

4.3 Procedure

4.3.1 Training section

Participants were tested individually by the experimenter in a quiet room at their universities. All the stimuli were displayed and run by software Superlab 5.0 on a MacBook laptop. A training session was given at the beginning of each experiment to get participants familiarized with the test procedures.

4.3.2 Test section

Following other well-established studies within the framework of 'thinking-for-speaking' and 'thinking-after-language' (Filipović, 2011, 2018; Gennari et al., 2002; Lai et al., 2014; Montero-Melis, Jaeger & Bylund, 2016; Papafragou & Selimis, 2010), participants verbalized all categorization stimuli in a language production task immediately prior to the subsequent similarity judgements. This operationalization was to maximally boost the engagement of language during the decision-making process.

In the first experiment, participants were instructed to watch the categorization stimuli first and describe "what happened" in each clip right after the viewing. Monolinguals narrated in their L1s. As the current study aims to investigate whether learning a new language means acquiring a new way of thinking, bi-and multilingual participants were asked to narrate only in their L2-Engish and L3-Japanese respectively. In order to establish a "monolingual mode" (Grosjean, 2001), all instructions were given in the language participants used in speech production.

After the linguistic encoding, participants moved on to a subsequent similarity judgement. Following Ji and Hohenstein (2018), participants were instructed that the categorization stimuli were presented in a synchronized order where the target video played first at the bottom of the screen. Then the target disappeared right after its completion, followed by its two simultaneous alternates playing side by side at the top of the screen. A half-second black screen was placed between the target video and its two alternates within each triad and a one-second black screen was placed between triads. The presentation order of each triad was counterbalanced across participants in each group. The location of manner- and path-match alternate on the screen (right-or left-side) was counterbalanced across stimuli in a fixed order. Participants needed to decide which alternate video was more similar to the target by pressing one of the two keys: A and L respectively on the keyboard. They were required to make their decisions as soon as possible as their reaction time in the decision-making process was automatically recorded. After the experimental session, participants were instructed to complete a language background questionnaire.

4.4 Data coding

4.4.1 Linguistic data

The linguistic data was transcribed by three L1 speakers of each language and segmented in to clauses. Only test items were coded for the analysis. Following Berman and Slobin (1994) a clause is defined as either syntactically simplex sentences or complex sentences containing a unified predicate. Then the semantic encoding of each clause was conducted following the guidelines developed for English and Japanese (Brown & Gullberg, 2010; Hickmann, Taranne, & Bonnet, 2009). Cantonese data was transcribed based on the adapted guidelines for Chinese data (Ji & Hohenstein, 2014). Descriptions without a specific focus on motion were excluded from the analysis (e.g., The river was frozen). Most of the target responses (98%) consisted of one clause. Within each clause, descriptions were coded from two perspectives: 1) whether participants mentioned path and manner of cause and 2) where the target elements were encoded (i.e., in the main verb or other peripheral devices). To establish data coding reliability, 20% of the entire data was re-coded by a second rater. The inter-coder reliability measured by the Kappa Index (Cohen's kappa = .97) showed that a high agreement was reached between coders on the frequency and semantic distribution of each element. For the control items, one point was given when participants used the target manner verbs in their oral descriptions.

4.4.2 Non-linguistic data

Non-linguistic data in the similarity judgement task was coded as a binary dependent variable where "0" represented participants' choice for path-match alternate, and "1" for cause-manner-match alternate. Participants' reaction time in each triad was measured as a continuous variable and calculated from the onset of playing of the alternative video until participants made their decisions. Theoretically, the longest RT to each triad is 6 seconds (the same length as the video clip). Outliers of extremely long and short values were trimmed with plus and minus two standard deviations (SD) from the mean. Altogether 85 outliers out of 1,800 items were replaced by two SDs from the mean. After the data trimming, more than 95% of the data was included in the data set.

5. Results

5.1 Linguistic encoding of caused motion event

5.1.1. Frequency of Manner and Path encoding across five groups

Altogether 5324 target descriptions were included for the final analysis. Monolingual descriptions were in Cantonese, English and Japanese. Bilingual descriptions were in L2-English whereas multilingual descriptions were in L3-Japanese. Participants' selection of manner of cause and path across each utterance was transformed into percentage scores and compared as a function of participant group. As shown in Figure 1, participants of each group were very likely to express Path with a high-to-ceiling frequency (English: M=97.22%, SD=4.95%; Bilinguals: M=95.83%, SD=5.35%; Cantonese: M=95.65%, SD=5.24%; Multilinguals: M=96.95%, SD=3.45%; Japanese: M=97.03%, SD=3.17%). However, regarding the encoding of Manner of Cause, there was a hierarchical decrease across participant group (English: M=98.15%, SD=3.59%; Bilinguals: M=97.31%, SD=4.40%; Cantonese: M=90.65%, SD=11.49%; Multilinguals: M=79.91%, SD=17.79%; Japanese: M=76.85%, SD=13.56%), that is, English monolinguals, bilinguals in L2-English and Cantonese monolinguals predominantly encoded manner of cause in their oral descriptions, as shown in (5), (6) and (7), while Japanese monolinguals and multilinguals in L3-Japanese presented the lowest level of C-manner encoding, as shown in (8) and (9).

(5) English monolinguals:

A boy is pulling [C-manner] a metal chair into [Path] his bedroom (ENG12cau).

(6) Bilinguals: A boy is pushing [C-manner] a suitcase across [Path] the street (BIL21cau).

(7) Cantonese monolinguals:

Keoi5	zoeng1	jat1 gaa3ce1	laai1jap6 [C-manner + path]	jat1go3saan1dung6	
He	DM	a toy car	drag-enter	a	cave

'He dragged a toy car into a cave.' (CAN6cau)

(8) Japanese monolinguals:

Kara-wa	sūtsukēsu-o	dōkutsu-ni	ireta [C-path in the main verb].
He-TOP	suitcase-ACC	cave-GOAL	make enter-PST

'He moved a suitcase into the cave.' (JAP20cau)

(9) Multilinguals:

Kara-wa	hoīru -o	tento -ni	ireta [C-path in the main verb].
He-TOP	wheel-ACC	tent-GOAL	make enter-PST

'He moved a wheel into the tent.' (MUL21cau)

To access whether speakers from each group differed in the likelihood to encode Manner of Cause and Path, two separate logistic mixed-effect models [1] [2] were fitted using the *glmer* function from the lme4 package (Bates et al., 2014) in R (R development team, 2018). Within each model, the binary dependent variable was the selection of the target semantic element (yes or no) and the fixed effect was participant group. For path encoding, results showed that the inclusion of participant group did not significantly improve the model fit compared with the null model (χ^2 (4) =7.29, p=0.12), indicating that group is not a main effect. In other words, participants across different groups were equally likely to encode path in their linguistic description. For manner encoding, the fixed effect was participant group and the random effects are crossed random intercepts for participant and item. The inclusion of participant group significantly increased the model fit compared with the null model (χ^2 (4) =479.44, p<.001), indicating that participant group is a main effect. Forward coding was used to compare the log-likelihood of manner of cause encoding with the next group. Results showed that bilinguals encoded more manner of cause than Cantonese monolinguals ($\beta_{\text{Bilinguals-Cantonese}} = 1.59$, SE = 0.23, Wald z =6.70, $p < .001$) but patterned with English monolinguals ($\beta_{\text{Bilinguals-English}} = -0.39$, SE = 0.29, Wald z =-1.32, p = 0.18). Multilinguals encoded less manner of cause than Cantonese monolinguals ($\beta_{\text{Multilingual-Cantonese}} = -1.00$, SE = 0.13, Wald z =-7.43, $p <.001$) but patterned with Japanese monolinguals ($\beta_{\text{Multilinguals-Japanese}} = 0.21$, SE = 0.11, Wald z =-1.88, p=0.06).

[Figure 1 is to insert here]

5.1.2 Semantic distribution of Manner of Cause and Path across five groups

The semantic distribution of C-manner and path is in line with the typological status of each language (Table 2). Being an S-language, English encodes manner of cause in the main verb (M=97.8%, SD=3.5) whereas path in the satellite (M=97.6%, SD=2.6). As encoding path in verb whereas manner in subordination is the default choice for V-language speakers in a boundary-crossing event, Japanese encodes path in the main verb (M=95.0%, SD=5.8) whereas manner in subordination (M=96.3%, SD=8.5). Cantonese, an equipollent-framed language standing midway on the continuum of S-and V-languages, encodes manner (M=93.9%, SD=9.8) and path (M=96.1%, SD=6.4) in verbs with equal grammatical status. Language-specific examples are given in (10), (11), and (12) below.

(10) English: C-manner in the main verb, path in the satellite

A boy is pushing [C-manner in the main verb] a box across [path in satellite] the road (ENG11cau).

(11) Japanese: C-manner in subordination, path in the main verb

Kara-wa	sūtsukēsu-o	**oshite** [C-manner in OTH]	michi-o	watalimashita [Path in the main verb].
He-TOP	suitcase-ACC	**pushing-GER**	street-ACC	cross PST.

'He crossed the street pushing a box.' (JAP12cau)

(12) Cantonese: C-manner and path in main verbs

Go3 naam4 zai2	zoeng1	go3toi2	teui1fann1 [C-manner + path in the verb]	seoi6 fong2 (CAN5cau).
A boy	DM	a table	push-enter	the bedroom

‘A boy pushed a table into the bedroom.’

[Table 2 is to insert here]

To further address whether participants across each group have the same likelihood to use a manner verb or a path verb, two separate logistic mixed effect models [3] [4] were fitted with the usage of Manner verb or Path verb as the respective dependent variable. The fixed effect was language group. The random effects were crossed random intercept for participant and item. For the use of manner verbs, forward coding was used to compare the log-likelihood of manner encoding with the next group. Results showed that English monolinguals and bilinguals were equally likely to encode manner in the verb form, but more frequently than Cantonese monolinguals ($\beta_{Bilingual\text{-}Cantonese}$ = 0.87, SE = 0.24, Wald z =3.60, $p < .001$). However, multilinguals used significantly less manner verbs compared with Cantonese monolinguals ($\beta_{Cantonese\text{-}Multilingual}$ = 4.83, SE = 0.19, Wald z =24.67, $p < .001$), although not exactly resembled the patterns of Japanese monolinguals ($\beta_{Multilingual\text{-}Japanese}$ = -2.52, SE = 0.21, Wald z = -12.24, $p<.001$). For the use of Path verbs, bilinguals patterned with English monolinguals in not encoding path in the main verb. Multilinguals used more path verbs than bilingual speakers ($\beta_{Multilingual\text{-}Bilingual}$ = 9.52, SE = 0.36, Wald z =26.1, $p<0.01$) but fewer path verbs than Japanese monolinguals ($\beta_{Multilingual\text{-}Japanese}$ = -2.35, SE =0.19, Wald z = -12.11, $p<0.01$).

5.2 Similarity judgement of caused motion event

5.2.1 Categorical preferences of cause-manner-/path-match alternates across five groups

Figure 2 shows participants’ manner/path-match preferences in the subsequent categorization task. A logistic mixed effect model [5] was built with participants’ categorical choice as a binary dependent variable and participant group as the fixed effect. Random effects included crossed-random intercepts for items and participants. The intercept represents the log-likelihood to choose a Manner-match alternate and the negative value illustrated that participants across language group had an overall preference for path-match alternate (β_0 =-0.57, SE = 0.20, Wald z =-2.79, p =0.005). Involving participant group as the fixed-effect didn't significantly optimize the model (χ^2 (4) =8.86, p=0.07) compared with the null model, indicating that group was not a main effect and participants across each group were equally likely to choose a Path-match alternate in motion event categorization (English: M=65.56%, SD=30.93%; Bilinguals: M=61.67%, SD=30.13%; Cantonese: M=62.50%, SD=28.85%; Multilinguals: M=62.78%, SD=33.52%; Japanese: M=70.56%, SD=25.40%).

[Figure 2 is to insert here]

5.2.2 Reaction time to Manner-/Path-match alternates across five groups

Participants' RT to manner-and path-match preference was measured as a continuous variable and used to indicate participants' efficiency in cognitive processing. The mean RT to manner- and path-alternate across each participant group was presented in Table3.

[Table 3 is to insert here]

A mixed effect model [6] was built using the *lmer* function from the lme4 package (Bates et al., 2014) with log-transformed RT as the continuous dependent variable. Fixed effects included participant group, preference type (i.e., manner- or path-match preference) and their interaction. Random effects included the crossed random intercepts for participant and item. The dependent variable was log-transformed to meet the assumption of the normality of residuals. The details of fixed-effect parameter estimates were given in Table 4. Results suggested that both participant group and the interaction with preference type were main effects.

[Table 4 is to insert here]

To further address the interaction between participant group and preference types, five separate mixed effect models were built with log-transformed RT as the dependent variable and preference type as the fixed effect to address the within group difference. Random effects included crossed random intercepts for participant and item. The intercept for each model set path-match alternate as the benchmark for comparison. Results confirmed that the RT for manner- and path-match alternate in Cantonese monolinguals were equally the same. For English monolinguals ($\beta_0 = -0.14$, SE = 0.04, t =-3.55, $p < .001$) and bilinguals ($\beta_0 = -0.12$, SE = 0.04, t =-3.26, p=0.001), their mean RT to manner-match alternate was faster than path-match alternate. However, for Japanese monolinguals ($\beta_0 = 0.14$, SE = 0.04, t =4.05, $p < .001$) and multilinguals ($\beta_0 = 0.10$, SE = 0.03, t =3.34, $p < .001$), their mean RT to path-match alternate was faster than manner-match alternate, as visualized in Figure 3.

In addition, another two mixed effect models were built with log-transformed RT as the dependent variable, and participant group as the fixed effect to address the between-group difference. Random effects included crossed random intercepts for participant and item. Results suggested that English monolinguals had the fastest RT in making manner-match choices than bilinguals ($\beta_0 = -0.11$, SE = 0.04, t =-2.89, p = .03), multilinguals ($\beta_0 = -0.19$, SE = 0.04, t =-4.79, $p < .001$) and Japanese speakers ($\beta_0 = -0.11$, SE = 0.04, t =-2.61, p = .04), while Japanese monolinguals had the fastest RT in making path-match decisions than all the other four groups (vs. English, $\beta_0 = -0.18$, SE = 0.03, t =-6.46, $p < .001$; vs. Bilingual, $\beta_0 = -0.26$, SE = 0.03, t =-8.98, $p < .001$; vs. Cantonese: $\beta_0 = -0.11$, SE = 0.03, t =-4.01, $p < .001$; vs. Multilingual: $\beta_0 = -0.22$, SE = 0.03, t =-7.96, $p < .001$).

[Figure 3 is to insert here]

5.3. Factors predictive of cognitive restructuring in the multilingual mind

We further investigated for multilingual speakers, whether the amount of contact with each language affects their degree of cognitive restructuring in both linguistic and non-linguistic tasks. Following Athanasopoulos (2009), language contact is defined as the amount of language use multilinguals have with each language and measured by totaling participant's amount of use of the L1, L2 and L3. On average, multilinguals used Cantonese 24.63% (SD=9.22) of the time, English 26.20% (SD=12.99) of the time and Japanese 49.16% (SD=13.89) of the time. Thus, Japanese was the dominant language used in daily activities.

A logistic mixed effect model [7] was set up with the absence or presence of manner verbs as binary dependent variable, the respective amount of L1, L2 and L3 use as fixed effects, and intercepts for items and participants as the random effects. For the use of manner verbs, it was positively associated with the amount of English use, whereas negatively correlated with the amount of Japanese use. However, the use of Cantonese was not a main predictor here, as illustrated in Table 5.

[Table 5 is to insert here]

Following Ji and Hohenstein (2018), a multiple linear regression [8] was built with mean differences of RT in manner-match preference minus path-match preference as the dependent variable, and the respective amount of L1, L2 and L3 use as explanatory variables. Positive values of RT indicated longer reaction time in making manner-match choices whereas negative values represented longer time in path-match choices. Results showed that the more frequently English was used in daily communication, the faster participants reacted to manner-match choices; whereas the more frequently Japanese was used, the faster participants reacted to path-match choices [9]. However, Cantonese use was not a main predictor, as shown in Table 6.

[Table 6 is to insert here]

6. General discussion

The current study goes beyond the bipartite classification of motion events with multilingual speakers of three typologically different languages and aims to investigate whether and to what extent acquiring an additional language gives rise to cognitive restructuring when the target language is actively involved in the decision-making process. It also addresses how the amount of language contact with each language modulates this process.

The first research question examined how multilingual speakers lexicalized caused motion in comparison with bilingual and monolingual controls of each language. Participants' responses in event lexicalization were analyzed in terms of the frequency of manner and path selection and their semantic distribution (i.e., encoded by motion verb or satellite). Results of the monolingual data confirmed the typological constraints of each language. For manner encoding, English (S-language) expressed manner of cause more frequently than Cantonese (E-language). Meanwhile, Japanese (V-language) presented the lowest frequency of manner encoding. The differences in information selection can be attributed to the language-specific conflation patterns and availability of manner expressions in caused motion (Talmy, 2000). In Japanese, as cause of motion is frequently conflated with path in the main verb, there is no obligatory syntactic slot for the encoding of manner of cause. As a result, manner of cause can be easily added or dropped in the description. In addition, Japanese has a limited set of lexical devices for manner expressions (Matsumoto, 2017), such that speakers opted to use a more general expression to encode pure causation (i.e., put, take, carry). Being an equipollently-framed language, Cantonese most prototypically encodes manner and path in a verb-compound. Although Cantonese allows the conflation of cause with path in the main verb while not expressing manner at all, this construction is not used as frequently as that in Japanese.

For path encoding, all three monolingual groups reached a ceiling level, indicating that path is a central element in motion events (Talmy, 1985, 2000). The results are in line with the manner salience hypothesis that cross-linguistic differences in event lexicalization are only found in the likelihood of manner selection (Slobin, 1996a, 2004). With regard to the semantic distribution of manner and path, English monolinguals predominantly encoded manner in the main verb like other S-languages (Slobin, 2004), whereas Japanese monolinguals encoded path in the main verb like other V-languages (Brown & Chen, 2013; Spring & Horie, 2013). Meanwhile, Cantonese monolinguals encoded manner and path in a verb-compound with equal grammatical salience (Francis & Matthews, 2006; Matthews, 2006).

Turing to bilingual speakers, results suggested that bilinguals in L2 English largely patterned with English monolinguals in both manner selection (i.e., with high frequency) and semantic distribution (i.e., manner verb + path satellite). This suggests that bilingual speakers have fully acquired the L2-based lexicalization patterns due to early exposure and active use of the L2 in daily communication (Aveledo & Athanasopoulos, 2016; Bylund & Athanasopoulos, 2014a; Bylund et al., 2013). For multilingual speakers in L3 Japanese, results indicate an ongoing cognitive restructuring towards the L3-based patterns as multilinguals with a high proficiency in Japanese presented a tendency of encoding manner less frequently, a typical characteristic of V-language speakers. We have ruled out the possibility that the lower frequency of manner encoding in L3 learners might be due to the incomplete acquisition of the target vocabulary or the use of avoidance as a communication strategy, because they have already mastered all target manner expressions in their descriptions of the control items.

In addition, multilingual learners presented a clear divergence from the L1-and L2-based patterns towards target L3-based patterns in using the "path verbs +manner subordinate" construction when describing a boundary-crossing event, a construction that has triggered difficulties for learners with contrastive linguistic features (Daller et al., 2011). There are two reasons to account for this. Firstly, as mentioned in the typology section, Cantonese is an E-language with properties of both S- and V-languages (Yiu, 2013). Although the most conventional way in Cantonese is the serial-verb construction, encoding manner in a subordinate form whereas path in the main verb is also used in oral description. Therefore, the partial overlap between the L1 and L3 facilitates learner's acquisition of the target forms (Ji et al., 2011; Ji & Hohenstein, 2014). In addition, as multilinguals have already achieved an advanced level in the L3 and used Japanese as the predominant language in their daily communication (cf. Table 1), the active use of language facilitates the restructuring process towards the target linguistic forms (Bylund & Athanasopoulos, 2014a; Park & Ziegler, 2014), which will be discussed with more details in the third research question.

The second research question probed into how multilingual speakers conceptualized caused motion in comparison with bilingual and monolinguals controls of each language. Two types of measurement were used: a categorical preference and reaction time. Results suggested that on the one hand, participants preferred a path-match alternate irrespective of the language background in event categorization. However, the RT to manner- and path-match alternate was closely associated with language-specific lexicalization patterns, demonstrating a 'thinking-for-speaking' effect. One possible explanation for the lack of language-specific properties in the overt selection might be that path is the core element in motion events (Tamly, 1985, 2000). Previous studies reported that children demonstrated a cognitive salience towards path in non-verbal behaviors before fully acquiring the language-specific patterns for motion event descriptions (Allen et al., 2007; Ji & Hohenstein, 2018). The second possible reason might be that the inter-typological distinctions across languages are cline rather than categorical, such that the cross-linguistic differences in lexicalization might not be clear-cut enough for absolute distinctions in non-linguistic categorization (Ji & Hohenstein, 2017; Loucks & Pederson, 2011). In contrast, the RT of manner-and path-match selection presented clear language-specific patterns: English monolinguals reacted much quicker in making manner-match choices than path-match choices, had the fastest RT in making manner decisions than bilinguals, multilinguals and Japanese monolinguals. However, Japanese monolinguals reacted much quicker in making path-match choices than manner-match choices, and had the fastest RT in making path decisions than the other language groups. Meanwhile, Cantonese monolinguals had equal efficiency in making either manner-or path-match choices. In line with the 'thinking for speaking' and 'thinking after language' accounts (Slobin, 1996; Wolff & Holmes, 2011), when given a categorization task, speakers tend to draw on all resources of representation available, including the linguistic ones, to facilitate decision-making. Thus, the language-specific regularities made available in the linguistic encoding task tend to mediate participants' performances in a subsequent non-linguistic task in language-specific ways [10] (Gennari et al., 2002; Montero-Melis & Bylund, 2017; Wolff & Holmes, 2011). Previous studies have demonstrated that language effects are most likely to appear when the stimuli are complex or when the task has a time limitation (Filipovic, 2018; Trueswell & Papafragou, 2010). Thus, the different processing efficiency participants had in similarity judgements can be interpreted as a consequence of language mediation. In English, as manner is expressed in the main verb and used with high frequency, the high manner codabiltiy may contribute to a higher cognitive salience in mental representations which increases its accessibility in cognitive processing (Slobin, 2004). Based on the concept of cognitive grammar (Langacker, 2008), attention is drawn towards form-meaning associations that was highlighted by grammar. Speakers are more likely to access the highlighted linguistic elements when perceiving and retrieving relevant information from memory. Thus, as manner of motion is prominently marked in English, monolinguals of English may have attended to manner of motion at the first instance due to its higher salience. Although participants finally opted for path-match alternate, their reaction time to manner was much quicker. In contrast, as Japanese typically encodes path in the main verb whereas manner in subornation with relatively low codability, the easy access to path directed speakers' attention to path at the first instance. This may facilitate the information retrieval of path and processing efficiency in making path-match choices. As for Cantonese, given that manner and path are typically expressed in a verb compound with equal salience, it is plausible to assume manner and path were retrieved "in a parallel fashion" with equal amount of attention being paid to both elements simultaneously (Ji & Hohenstein, 2017, 2018).

For bilingual speakers, results suggested that bilinguals patterned with English monolinguals in reacting much quicker to manner-match alternate than path-match alternate, indicating that early exposure to an L2 not only gave rise to the internalization of novel linguistic frames, but also the L2-specific way of 'thinking for speaking' in event perception. Turning to multilingual speakers, results showed that proficient multilinguals demonstrated a tendency towards Japanese monolinguals in reacting much quicker to path-match alternate than manner-match alternate when Japanese was at operation, indicating an ongoing process of cognitive restructuring in the multilingual mind. It is suggested that bi-and multilingual learners are able to reconstruct their conceptualization patterns towards the target language when speaking an L2 or L3. The results indicate that learning a new language means acquiring a new way of thinking and the L1'thinking-for-speaking' patterns are subject to reconstructing in online thinking (Slobin, 1996; Wolff & Holmes, 2011). The findings are in line with previous studies that on the one hand, non-linguistic representations tend to be modulated by language-specific properties when the access to the target language is not blocked during or prior to event categorization (Montero-Melis & Bylund, 2017; Trueswell & Papafragou, 2010); on the other, bi-and multilingual's conceptualization patterns are dynamic and susceptible to change with the language at operation (Athanasopoulos, Bylund, et al., 2015; Kersten et al., 2010; Lai et al., 2014).

The third research question examined whether multilingual speakers' linguistic and non-linguistic behaviors were modulated by the amount of contact with each language. Results suggested that the degree of conceptual restructuring in both verbal and non-verbal task was associated with the amount of language contact with L3-Japanese and L2-English. In other words, the more frequently participants used an L3, the more L3-based linguistic and non-linguistic patterns they are able to produce. The results can be explained in terms of entrenchment and routinisation (Langacker, 2008) that the frequent use of the target forms may lead to an entrenchment of corresponding conceptual categories. And the associations between language and conceptual representations can be strengthened by a large amount of exposure and frequent usage of the target language. The results were in line with previous studies that the more frequently a target language was used, the more likely participants would exhibit associated conceptualization patterns (Athanasopoulos, Damjanovic, et al., 2015; Bylund & Athanasopoulos, 2014a; Bylund et al., 2013). Following this reasoning, due to the contrastive typological differences between L2-English and L3-Japanese, the frequent use of English may hinder the restructuring process towards the L3-based patterns in event lexicalization and conceptualization. However, the amount of L1 use did not serve as a core predictor in the current study. There were two possible reasons. Firstly, as Cantonese is an E-language with properties of both S-and V-languages, the less contrastive typological differences may eliminate the influence that language placed on cognition. Secondly, as indicated by participants' self-reported amount of language contact, the use of Cantonese only accounted for a quite small proportion compared with the predominant use of English and Japanese. Thus, the effect of L1 might be diminished due to the inactive involvement in daily communication.

7. Conclusion

The current study extends the scope of motion research by examining how Cantonese-English-Japanese multilinguals lexicalize and conceptualize caused motion in a boundary-crossing situation. Specifically, it explores how language-specific patterns in lexicalization affect different levels of cognitive processing by using two types of measurements: a categorical measurement of similarity judgements and a continuous measurement of reaction time. Findings showed that in event lexicalization, multilingual speakers demonstrated a clear trend towards the target language in encoding path in the main verbs whereas manner in subordination when describing a boundary-crossing event. Although no cross-linguistic differences were found in the categorical preferences of event categorization, reaction time illustrated that multilingual speakers presented an ongoing process of cognitive restructuring towards the L3 in reacting much quicker to path-match alternate than manner-match alternate. In both tasks, the amount of language contact with L2 and L3 served as main predictors for the degree of cognitive restructuring for multilingual speakers.

The current findings demonstrate that learning an additional language may continue shaping or influencing bi-and multilingual's cognitive processing when the target language is actively involved in the decision-making process. In other words, learners are able to acquire relevant structures of the target language and corresponding thinking patterns when provided with sufficient language-specific instances (Athanasopoulos, Damjanovic, et al., 2015; Bylund & Athanasopoulos, 2014a; Cadierno, 2010; Park, 2019). On the whole, the current findings show that that learning a new language means acquiring an alternative way of thinking, and speakers can switch between distinct sets of thinking patterns depending on which language they are using. This new finding makes a timely contribution to the hypothesis of thinking-for-speaking, and sheds light on the complexity and diversity of how language shapes thought in the multilingual mind. This helps understanding how people learn multiple languages.

Future research may combine the measurement of reaction time with the use of the eye-tracking technique to explore participants' attention allocation patterns during event perception. Also, other extra-linguistic factors such as language proficiency, length of immersion need to be taken into further consideration when examining the dynamic relationship between the progress of language learning and change of cognitive state in the bi-or multilingual mind.

Notes:

1. model1<-glmer (FrequencyPath~ Group + (1|Subject) + (1|Item), family=binomial, data=Task1, REML=FALSE)
2. model2<-glmer (FrequencyManner~ Group + (1|Subject) + (1|Item), family=binomial, data=Task1, REML=FALSE)
3. model3<-glmer (MannerVerb~ Group + (1|Subject) + (1|Item), family=binomial, data=Task1, REML=FALSE)
4. model4<-glmer (PathVerb~ Group + (1|Subject) + (1|Item), family=binomial, data=Task1, REML=FALSE)
5. model5<-glmer (Choice~ Group + (1|Subject) + (1|Item), family=binomial, data=Task2, REML=FALSE)

6. model6<-lmer (log(RT) ~factor(Choice)*Group+(1|Subject) + (1|Item), data=Task2, REML=FALSE).
7. model7<-glmer (MannerVerb~L1use + L2use + L3use+ (1|Subject) + (1|Item), family=binomial, data=Task2, REML=FALSE)
8. model8<-lm (RT differences~ L1 use+ L2 use+ L3 use, data=Task2)
9. We conducted extra statistical analyses regarding the relationship between different types of language contact multilinguals had with each of their languages (i.e., Watching TV, Surfing the Internet, Reading and Writing) and the degree of cognitive restructuring. Results showed that only exposure to audiovisual media (watching TV) indicated the degree of how multilinguals restructured their cognitive patterns towards the target language. Please refer to the Supplementary Materials for detail.
10. We thank one of the anonymous reviewers for pointing out that an alternative way to interpret the RT results is to adopt a mild version of linguistic relativity hypothesis, that is, language effects may still be held aside from explicit verbal contexts.

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Figure captions

Figure 1. Mean Frequency of Manner and Path encoding across language groups

Figure 2. Mean percentage of manner/path preferences across groups

Figure 3. Mean RT to manner-match and path-match alternate as a function of group

Appendix A

Item	Target	Manner-match alternate	Path-match alternate
1	Pull chair out of room	Pull chair into a room	Push chair out of a room
2	Drag toy car into cave	Drag toy car out of cave	Kick toy car into cave
3	Push wheel into camp	Push wheel out of camp	Kick wheel into camp
4	Drag boat across river	Drag boat along the river	Push boat across river
5	Drag wheel across ice	Drag wheel along ice	Kick wheel across ice
6	Push suitcase across street	Push suitcase along street	Pull suitcase across street
7	Drag trolley into supermarket	Drag trolley along supermarket	Push trolley into supermarket
8	Pull woods into tent	Pull woods along tent	Push woods into tent
9	Push barrel into house	Push barrel along house	Kick barrel into house
10	Push suitcase out of pyramid	Push suitcase along pyramid	Drag suitcase out of pyramid
11	Push box out of cave	Push box along cave	Pull box out of cave
12	Push wheel out of tunnel	Push wheel along tunnel	Kick wheel out of tunnel

Appendix B

A demonstration of the video stimuli used in the similarity judgement task (Item 1).

Target

Manner-match alternate

Path-match alternate