

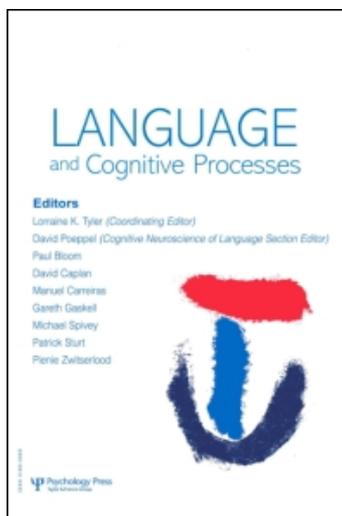
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Event categorisation and language: A cross-linguistic study of motion

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Event categorisation and language: A cross-linguistic study of motion

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It is well known that languages differ in how they encode motion. Languages such as English use verbs that communicate the manner of motion (e.g., *slide*, *skip*), while languages such as Greek regularly encode motion paths in verbs (e.g., *enter*, *ascend*). Here we ask how such cross-linguistic encoding patterns interface with event cognition by comparing labelling and categorisation preferences for motion events by English- and Greek-speaking adults and 5-year-olds. Our studies show that, despite cross-linguistic encoding differences, the categorisation of dynamically unfolding motion events proceeds in identical ways in members of these two linguistic communities. Nevertheless, language-congruent categorisation preferences emerge in tasks that implicitly encourage the use of linguistic stimuli during event apprehension. These data have implications for the relationship between language and event categorisation.

Keywords: Categorisation; Event cognition; Greek; Motion; Space.

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How do humans categorise and talk about events? Unlike object representations, which have been studied extensively in the visual cognition and categorisation literature from infancy to adulthood (see, for instance, Murphy, 2002; Rosch, 1978; Scholl & Pylyshyn, 1999; Spelke, 1990; and for a recent review, Lefebvre & Cohen, 2005), event representations and their basic components remain elusive. Unlike objects, events are fleeting and impermanent: event components have to be extracted from the stream of an observer's dynamic experience of the world and stitched together into cohesive wholes (Avrahami & Kareev, 1994; Newtson & Engquist, 1976; Zacks & Tversky, 2001; Zacks, Tversky, & Iyer, 2001). Furthermore, every event can be construed from multiple perspectives and at various levels of detail – and linguistic representations reflect this freedom of perspective (compare *walking*, *tramping*, and *stomping*; Chomsky, 1959; Gleitman, 1990).

The task of explaining how event concepts map onto language is complicated by the fact that, across languages, there are different ways of segmenting and packaging even the simplest and most 'natural' events. This cross-linguistic variation has led several commentators to pursue the possibility that important aspects of event cognition may not be universal but shaped by the way events are encoded within one's native language (Whorf, 1956; for recent incarnations of Whorfian views, see Boroditsky, 2001; Brown & Levinson, 1993; Imai & Gentner, 1997; Lucy, 1992a, 1992b; Lucy & Gaskins, 2001; Pederson, Danziger, Wilkins, Levinson, Kita, & Senft, 1998; and papers in Bowerman & Levinson, 2001; Gentner & Goldin-Meadow, 2003). On the *salience* hypothesis, since human beings need to share information about the world through the use of language, attention during perceptual and cognitive tasks could end up focusing on those dimensions of experience that can most naturally find their way into one's native language. If true, this possibility entails that speakers of different languages may end up paying attention to different event components as they experience events and that, in learning language, children's attention may be guided towards those event categories/relations that are systematically encoded in their native tongue (Choi & Bowerman, 1991; Gentner & Boroditsky, 2001; McDonough, Choi, & Mandler, 2003).

According to an alternative, *underspecification* hypothesis, the connection between linguistic encoding and cognitive processing is indirect since the linguistic resources mobilised for labelling under-represent the cognitive resources mobilised for cognitive processing of events; in other words, the linguistic and conceptual representations of events are dissociable (see Gleitman & Papafragou, 2005; Papafragou, 2008, for related views). Furthermore, closer inspection of cross-linguistic diversity can reveal underlying similarities in the way languages treat events, which may in turn suggest similarities in the underlying conceptual representation of event structure. For instance, a recent study of verbs of cutting and breaking in 28 languages

revealed that languages draw from a restricted set of semantic dimensions along which cutting and breaking events are distinguished – even though they vary in terms of how many categories these basic elements combine to form and where category boundaries are placed (Majid, Boster, & Bowerman, 2008). Another cross-linguistic study found that verbs of human locomotion in four different languages respect the physical discontinuity between walking and running; furthermore, within each language, the same discontinuity is reflected in both non-linguistic similarity judgements and in typicality ratings for major locomotion verbs – pointing again to convergence across members of different linguistic communities in broad naming and categorisation preferences (Malt, Gennari, Imai, Ameel, Tsuda, & Majid, 2008).

In this paper, we examine the predictions of the salience and the underspecification hypothesis for possible effects (and non-effects) of language on event categorisation, focusing specifically on motion events. There are several reasons for using motion to study how language and event cognition are linked. First, the representation of motion and space is a fundamental human cognitive ability (Carlson & van der Zee, 2005; Emmorey & Reilly, 1995; Hayward & Tarr, 1995; Landau & Jackendoff, 1993; Newcombe & Huttenlocher, 2003; Pick & Acredolo, 1983; Stiles-Davis, Kritchevsky, & Bellugi, 1988; and many others). Second, some of the spatial-mechanical conceptual machinery for motion processing is already available to infants (Baldwin, 1991; Pulverman, Sootsman, Golinkoff, & Hirsh-Pasek, 2003; Pruden, Hirsh-Pasek, Maguire, Meyers, & Golinkoff, 2004; Woodward, 1998; Wynn, 1996). Third, motion and spatial terms are acquired early by language-learning children around the world (Berman & Slobin, 1994; Choi & Bowerman, 1991; McCune-Nicolich, 1981; Smiley & Huttenlocher, 1995). Fourth, despite being rooted in a shared conceptual inventory, the linguistic encoding of motion is characterised by intense typological variability, as we discuss in detail below.

MOTION IN LANGUAGE AND COGNITION

The cross-linguistic packaging of motion events

All languages analyse motion in terms of the displacement of an object (the ‘figure’) with respect to a reference object (the ‘ground’). Beyond these basic components, all languages possess means for further encoding the path and manner of motion (Talmy, 1975, 1985, 1991, 2000; cf. Jackendoff, 1990; Miller & Johnson-Laird, 1976). Path refers to the trajectory of the moving object with respect to the ground, i.e., it specifies the source (*from the forest*), direction/goal (*towards/to the forest*), or intermediate reference point(s) (*through the forest*) of the motion event. Manner covers a great variety of

dimensions such as rhythm, motor pattern, and rate of motion (*rolling/spinning/rotating*) (e.g., Slobin, 2004).

Despite these broad similarities, languages differ systematically in how they map path and manner notions onto lexical and grammatical structures (cf. Slobin, 2004, 2006; Talmy, 1985, 1991, 2000). *Manner* languages (e.g., English, German, Russian, and Mandarin Chinese) typically code manner in the verb (cf. English *skip, run, hop, jog*), and path in a variety of other devices such as particles (*out*), adpositions (*into the room*), verb prefixes (e.g., German *raus-* 'out'; cf. *raus-rennen* 'run out'), etc. *Path* languages (e.g., Modern Greek, Romance, Turkish, Japanese, and Hebrew) typically code path in the verb (cf. Greek *vjeno* 'exit', *beno* 'enter', *ftano* 'arrive/reach', *aneveno* 'ascend', *diashizo* 'cross'), and manner in adverbials (*trehontas* 'running', *me ta podia* 'on foot', *grigora* 'quickly').¹

Drawing the Manner/Path language distinction this way is not meant to imply that the relevant languages lack certain kinds of verb altogether (in fact, there is evidence that all languages possess manner verbs, though not path verbs; Beavers, Levin, & Wei, 2004). For instance, English has path verbs, such as *enter, exit, ascend, and descend*, and Greek has manner verbs, such as *treho* 'run', *kilo* 'roll', *perpato* 'walk', and *peto* 'fly' (e.g., Antonopoulou, 1987 for Greek; Slobin, 2004; Talmy, 2000 for English). But the most characteristic (i.e., colloquial, frequent, and pervasive) way of describing motion in the two languages involves manner and path verbs respectively. In English, most path verbs are borrowings from Romance and belong to a formal register, while manner verbs abound across different genres (e.g., Slobin, 1997, 2003). By contrast, in Greek, path verbs (often followed by additional locative/directional elements) are often the canonical option, as in other Path languages (e.g., Slobin, 1997, 2003, 2004).²

¹ This distinction is inspired by, though not exactly equivalent to, Talmy's distinction between Satellite-framed and Verb-framed languages (e.g., Talmy, 1991). Several commentators have pointed out that more complex constellations of morpho-lexical patterns actually underlie Talmy's typology, such that 'mixed' patterns can be found (e.g., the presence of serial or compounding verbs of the type $V_{\text{MANNER}} + V_{\text{PATH}}$ in Korean; Beavers et al., 2004; see also Kopecka, 2006; Noonan, 2003; Slobin, 2004; Wienold, 1995; Zlatev & Yangklang, 2004).

² The manner/path asymmetry in verb use is made more salient by the following restriction: while in Manner languages manner verbs seem to compose freely with different kinds of path modifiers, in many Path languages manner verbs cannot appear with resultative phrases to denote culminated motion (e.g., there is no Greek equivalent for *The bird is flying out of the cage*; Aske, 1989; Cummins, 1998; Horrocks & Stavrou, 2007; Slobin & Hoiting, 1994; Snyder, 2001; Stringer, 2003). The roots of this constraint lie in the morphosyntax of telicity (Greek disallows non-verbal resultatives, or 'secondary predication', with only few exceptions; see Folli & Ramchand, 2001; Giannakidou & Merchant, 1999; Napoli, 1992; Snyder, 2001; Washio, 1997). In order to convey culminated events, Greek needs to either use a path verb and optionally encode manner in a modifier (e.g., lit. '*The bird is exiting from the cage (flying)*'), or break down the event into two separate clauses, one with a path and the other with a manner verb.

Several psycholinguistic studies have confirmed the typological differences in the description of motion just documented using various types of linguistic data from both adults and children across a variety of languages (Allen, Özyürek, Kita, Brown, Furman, Ishizuka, & Fujii, 2007; Berman & Slobin, 1994; Choi & Bowerman, 1991; Hickmann, 2003; Naigles, Eisenberg, Kako, Hightler, & McGraw, 1998; Özçalışkan & Slobin, 1999, 2003; Papafragou, Massey, & Gleitman, 2002, 2005; Selimis, 2007; Selimis & Katis, 2003; Slobin, 1996a, 1996b, 1997, 2003, 2004; among many others). Such cross-linguistic differences in the encoding of motion appear very early: sensitivity to language-specific patterns appears in elicited narratives by children as young as 3 or 4 (Berman & Slobin, 1994; Selimis, 2007) and in the spontaneous speech of children below the age of 2 (Choi & Bowerman, 1991; Selimis, 2007; Selimis & Katis, 2003).³ Other studies have shown that these lexical and structural tendencies affect the way novel motion verbs are acquired cross-linguistically (Hohenstein, Naigles, & Eisenberg, 2004; Naigles & Terrazas, 1998; Papafragou & Selimis, 2008).

Non-linguistic processing of path and manner of motion

The pervasive cross-linguistic differences we have detailed raise the possibility that the non-linguistic representation of motion might be affected by the different ways linguistic systems dissect and package motion events. According to some commentators, ‘learning a language can affect non-linguistic spatial cognition by selectively maintaining or discouraging sensitivity to spatial distinctions that are, or are not, relevant to that language’ (Bowerman & Choi, 2003, p. 390). Relatedly, some researchers have raised the possibility that manner in both young and older speakers of Manner languages is a salient and differentiated conceptual field compared with speakers of Path languages, with potential implications for how manner of motion is perceived/attended to online and remembered (Slobin, 2004). On this salience hypothesis, manner and path components of motion scenes will be differentially accessible to speakers of Manner and Path languages even in situations that do not involve linguistic communication.⁴

³ These differences are subject to pragmatic effects: manner information in Path languages is likely to be marked when the manner of motion is not inferable from the overall linguistic description or the extra-linguistic knowledge on the part of the addressee (e.g., if a bird is hopping, rather than flying, out of the cage; Papafragou, Massey, & Gleitman, 2005, 2006; cf. Slobin, 1997).

⁴ The salience hypothesis is distinct from the idea that event components that are systematically encoded in a language will enjoy higher conceptual accessibility as speakers of the language prepare their utterances (what Slobin has called ‘thinking for speaking’; see Slobin, 1996b). This last proposal is widely accepted in studies of language production, even though concrete cross-linguistic demonstrations of it have until recently been lacking (but see Papafragou et al., 2008).

Papafragou et al. (2002) set out to test the salience hypothesis. In one experiment, adults and 8-year-old children were shown triads of motion events consisting of a sample event (e.g., a man stumbling into a room) and two variants, a manner variant (a man walking into a room) and a path variant (a man stumbling down the stairs). Participants were asked to choose the variant where the agent was 'doing the same thing' as in the sample. English and Greek speakers did not differ from each other in terms of choosing manner vs. path as the criterion for categorising motion events. The same study showed that English- and Greek-speaking populations were equally good at detecting manner or path changes to static motion vignettes in a recognition memory task. Similar results have been obtained for English vs. Spanish (also a Path language) by Gennari, Sloman, Malt, and Fitch (2002). Taken together, results from these studies argue against the salience hypothesis and in support of the underspecification view in the domain of motion events: both manner and path seem to be available to an equal extent to speakers of different languages for purposes of (non-linguistic) categorisation and memory, regardless of whether these components are prominently and systematically encoded in the language.

Several issues remain about the relationship between event naming and categorisation. To begin with, since event categorisation studies with young children are only beginning to emerge (and the available categorisation data from Papafragou et al., 2002 involved 8-year-olds), it is not known whether younger learners' construals of motion events might be more susceptible to linguistic influences than those of older learners and adults. Recent work suggests that 5-year-old children rely heavily on relational terms such as *top* or *bottom* for solving spatial tasks that involve detecting similarities between two spatial configurations – in fact, children of this age are unable to solve these tasks without the explicit use of lexical labels (Loewenstein & Gentner, 2005). If language plays such an important role in directing children's attention to which spatial arrays count as 'the same', it is possible that young children's representations of spatial events might be swayed by regularities of event encoding in their native language – especially since, as already discussed, events have many dimensions and there is considerable indeterminacy as to which of these dimensions should determine which events are 'similar' and hence belong together (cf. also Gentner & Boroditsky, 2001; Hohenstein, 2005).

Second, event labelling might influence event categorisation even in the absence of permanent effects on cognition. One piece of evidence supporting this possibility comes from Gennari et al. (2002). In their study, when Spanish- or English-speaking adults were asked to perform similarity judgements for motion events immediately after having described the events in their native language, the linguistic labelling affected their choices. But when a separate group of participants performed the similarity task without

previously describing the events, no effect of language was found. These results show that, when language-specific regularities are made salient in an experimental situation, they can mediate categorisation performance – even if, in accordance with the underspecification thesis, the underlying conceptual organisation remains unchanged (cf. also Billman, Swilley, & Krych, 2000; Finkbeiner, Nicol, Greth, & Nakamura, 2002).

At present, little is known about the extent and potency of such linguistic recoding strategies: To what extent do linguistic intrusions surface when language production is not explicitly involved in the task? Are such linguistic recoding effects available to young children? How do linguistic intrusions interact with other (non-linguistic) cues to categorisation? Crucially, linguistic recoding effects (i.e., on-line effects from the implicit use of verbal labels) differ from effects of salience (i.e., deeper shifts in cognitive organisation brought about by habitual language use) – even though within individual tasks, they may be hard to distinguish from each other. To determine whether linguistic effects in a cognitive task are due to salience or to more shallow linguistic recoding of the experimental stimuli, one would need evidence from multiple tasks (as in the Gennari et al. data). The salience hypothesis predicts that categorisation preferences should follow language-congruent patterns across several different testing environments, since language-specific event encoding preferences create stable and deep preferences in judging event identity and similarity. The linguistic intrusion account (which is consistent with the underspecification thesis) expects the effect of language to be limited and reversible by other non-linguistic cues to categorisation, and thus vulnerable across different testing conditions.

In the studies that follow, we address these questions in investigating how linguistic representations and non-linguistic categorisation of motion events come together in the minds of speakers of typologically different languages (English and Greek). Our method differs from our previous work in this area in two major respects: it tests younger (5-year-old) children and it examines categorisation of the same set of motion events under different experimental conditions. First, we compare the way English- and Greek-speaking 5-year-old children and adults describe motion events in a language production task (Experiment 1). Confirming earlier work (Papafragou et al., 2002; Selimis, 2007), we demonstrate that children and adults encode event components such as path and manner of motion differentially. We also compare young children's (and adults') performance in situations where they categorise the very same events under presentation conditions that do not require overtly labelling the events (Experiment 1). Contrary to prior studies, we find language-congruent effects on categorisation, with English speakers being more likely than Greek speakers to adopt manner-based choices. In two further studies (Experiments 2 and 3), we explore the nature of these effects. Crucially, salience accounts predict that language-specific lexical pressures

should consistently affect event conceptualisation across different tasks, with English speakers being more likely to make manner choices than Greek speakers. Alternatively, underspecification accounts predict that such pressures should cease to exert their influence beyond situations that (implicitly or explicitly) involve language use. To anticipate our findings, we show that the observed linguistic effects do not reflect permanent reorganisations of conceptual event structure but temporary, on-line linguistic intrusions subject to task demands. We conclude by discussing implications of these findings for the relationship between event naming and categorisation.

EXPERIMENT 1

This experiment builds on a triad task that has been used in prior studies of motion categorisation (Gennari et al., 2002; Papafragou et al., 2002). Participants were presented with a complex motion event incorporating both a path and a manner component. They next saw two variants of this event: one of the variants preserved the path and the other preserved the manner of the original event. The participants' task was to judge which of the variants represented the same event as the original. The logic of the task is based on the assumption that, when manner and path components of the event are pitted against each other, participants choose the component which they deem most central to the nature of the original event.

Method

Participants. Participants were native speakers of either English or Modern Greek grouped into two general age groups. The Child group consisted of 10 English-speaking children between 4;5 and 5;7 years (mean age 4;9) and 10 Greek-speaking children between 4;5 and 5;10 years (mean age 5;3). Children were recruited from daycare centres at Newark, Delaware (USA) and Northern Evia (Greece) respectively. The Adult group consisted of 10 English-speaking adults and 12 Greek-speaking adults, mostly drawn from the undergraduate populations of the University of Delaware and the University of Athens respectively.

Materials. Unlike prior work that used static depictions of motion (series of digital photographs or line drawings; Papafragou et al., 2002), our stimuli included dynamically evolving events. Specifically, stimuli consisted of 48 short silent animated motion clips in PowerPoint 2003 format. The motion events were created so as to represent familiar everyday actions but also involved complex scenes with simultaneous and salient path and manner components. Paths involved a variety of spatial relations (cf. past, into,

across, out of, away from). Manner properties involved the rate, speed, or internal (non-translocational) features of motion, or the instrument/vehicle used to propel the agent forward (cf. jumping, spinning, skating). For practical reasons, the posture of the agent did not change while the event was unfolding (e.g., there was no arm, leg or head movement for human agents).

The events were organised in 16 triads. Each triad consisted of a sample event and two variants (see the three panels in Figure 1 for an example). Sample events depicted entities (persons, animals, or objects) spontaneously moving along a path in a certain manner (e.g., a turtle swimming out of a cave). Importantly, all sample motion scenes involved change-of-state (resultative or telic) events. Each of the variants presented a specific change to the original event. In the Same-Path variant, the manner of movement was changed whereas path was kept the same (the turtle jumped out of the cave). In the Same-Manner variant, the path was changed whereas manner remained the same (the turtle swam past the cave). A full list of the triads is given in Table 1. Half of the triads involved animate and the other half inanimate agents.

Procedure. The motion stimuli were presented on two identical laptop computers placed next to each other. Each sample played twice, once on the screen on the left and once on the screen on the right. Then participants watched the two variants, one on the left and the other on the right screen, and had to match the sample to one of the variants. In detail, the presentation sequence for each triad was as follows:

- a. Sample event shown on the left screen (the right screen is black).
- b. Sample event replayed on the right screen (the left screen is black).
- c. Both screens are black.
- d. First alternate shown on the left screen (the right screen is black). The last frame of the event freezes on screen.
- e. Second alternate shown on the right screen. At the end, the last frame freezes on screen.

While participants were shown the sample event, they heard a sentence which contained a non-specific verb (e.g., English: *Look! The turtle is doing something!*; Greek: *Kita! I helona kati kani!*). Then they were shown the two variants and were asked to pick the one that best matched the sample: *Do you see the turtle doing the same thing now?* (English)/*Tora vlepis oti I helona kani to idio pragma?* (Greek). At the end of the session, participants were asked to view all scenes again (samples and variants) and describe them to the experimenter. Unlike the main phase of the experiment, sample events were viewed only once. Responses were tape recorded.

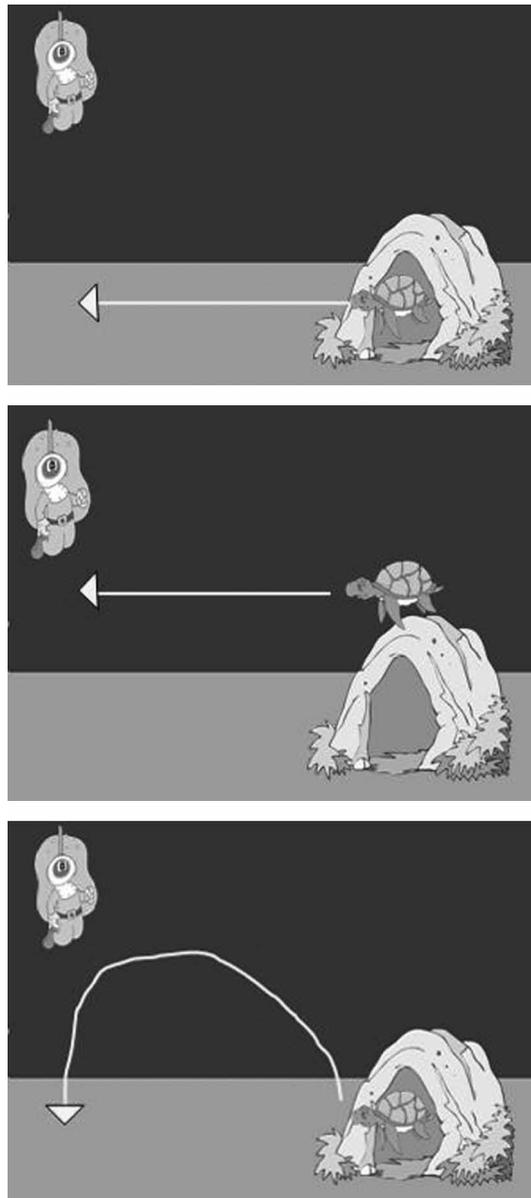


Figure 1. Sample stimuli (shown as still snapshots) for Exp. 1. From top to bottom: Sample event (a turtle is swimming out of a cave), Path variant (a turtle is swimming past a cave), and Manner variant (a turtle is jumping out of a cave).

TABLE 1
Experimental stimuli (Exp. 1)

<i>Sample</i>	<i>Same-Manner</i>	<i>Same-Path</i>
1. A ball is bouncing to a box.	...bouncing past a box.	...rolling to a box.
2. An eagle is flying over and to the other side of a cage.	...flying by a cage.	...zooming over and to the other side of a cage.
3. Two balloons are floating up to the sun.	...floating down to a tent.	...spinning up to the sun.
4. A dog is walking and ends up behind a tree.	...walking to his house.	... jumping and ends up behind a tree.
5. A water lily is floating across a river.	...floating along a river.	...swirling across a river.
6. A bottle is floating down to the bottom of the sea.	...floating up to the surface of the sea.	...spinning down to the bottom of the sea.
7. A duck is ice-skating across a ring.	...ice-skating around a ring.	...roller-blading across a ring.
8. A leaf is spinning away from a tree.	...spinning down from a tree.	...blown away from a tree.
9. A bee is flying to a flower.	...flying up to a beehive.	...walking to a flower.
10. A horse is running and ends up behind a fence.	...running past a fence.	...galloping and ends up behind a fence.
11. A frog is jumping and ends up in front of a rock.	...jumping and ends up on a rock.	...hopping and ends up in front of a rock.
12. A turtle is swimming out of a cave.	...swimming over and to the other side of a cave.	... jumping out of cave.
13. A bottle is floating to a boat.	...floating to a cave.	...bobbing to a boat.
14. A guy with a parachute is going off a plane.	...is going up to a plane.	...zigzagging down off a plane.
15. A snowball is rolling down a hill and onto a bush.	...rolling down a hill and into a bush.	...bouncing down a hill and onto a bush.
16. A flower is swirling around a house.	...swirling past the house.	...blown around the house.

We included a practice triad in the beginning of each session which did not involve pure motion/displacement events but showed a man manipulating a box. Three Greek-speaking and two English-speaking children who did not pass the practice triad were replaced.

Participants were tested individually in a single session (with the exception of four Greek-speaking children who were tested in two sessions on two consecutive days because the procedure could not be completed within the school day). English-speaking participants were tested by a research assistant who is a native speaker of English and Greek-speaking participants were tested by the second author who is a native speaker of Greek. Screen allocation (left-right) for Same-Path and Same-Manner variants was counterbalanced for each participant, with the constraint that consecutive

variants playing on the same screen were never of the same type (i.e., Same-Path or Same-Manner). Order of presentation of the triads was counter-balanced within each condition.

Coding. Linguistic descriptions were coded for type of main verb (manner, path, or other – i.e., non-motion – verb). Path verbs encoded the trajectory of the moving agent and/or the relationship between the agent and a reference point (e.g. English *circle, cross, go, leave*, and Greek *beno* ‘enter’, *vjeno* ‘exit’, *perno* ‘pass’, *plisiazio* ‘approach’). Manner verbs encoded details such as the speed, gait, rate, or means of motion (e.g., English *fly, jump, spin, swim*, and their Greek equivalents *peto, pido, strifojirno* and *kolibo* respectively). Manner and path verbal periphrases were treated as manner and path verbs respectively (manner examples include the English *do jumping*, and the Greek *kano ena pidima* ‘do a jump’; path instances include the English *do circles*, and the Greek *kano kiklus* ‘do circles’).

We also coded whether speakers included manner or path information in their linguistic descriptions regardless of whether this information was encoded in the main verb or elsewhere in the sentence. Beyond the main verb, manner can be expressed in modifiers such as adverbials (English *fast*, Greek *grigora*), prepositional phrases (English *with a parachute*, Greek *me to alexiptoto*), or gerunds (English *spinning*, Greek *strifogirizontas*). Path can be expressed through prepositional phrases (English *to the box*, Greek *sto kuti*), particles and adverbials (English *away*, Greek *makria*), and source/goal/extend/route nominals (English *He crossed the river*, Greek *Plisiazio to luludi* ‘She’s approaching the flower’).

Judgements in the triad task were coded as manner or path choices depending on which component of the sample event was retained in the variant chosen.

Results

Linguistic production results (main verbs). We begin with the results of the linguistic production task. A summary of the linguistic production data is given in Table 2. As is clear from the Table, there is an asymmetry in the expected direction between English and Greek: English speakers used many more manner verbs than Greek speakers, and the opposite pattern holds for path verbs. We entered the proportion of responses containing exclusively manner verbs into both a subject and an item ANOVA with Language (English, Greek) and Age (Adults, Children) as factors. The analyses returned a main effect of Language, $F_1(1, 38) = 92.39$, $MSE = 0.03$, $p < .0001$; $F_2(1, 15) = 337.03$, $MSE = 0.013$, $p < .0001$; $M_{Eng} = 0.77$ vs. $M_{Gr} = 0.25$; a main effect of Age, $F_1(1, 38) = 4.17$, $MSE = 0.04$, $p = .04$; $F_2(1, 15) = 8.67$, $MSE = 0.022$, $p = .01$; $M_{ad} = 0.56$ vs. $M_{ch} = 0.45$; and an interaction

TABLE 2
Linguistic production results (Exp. 1)

Per cent of verb types	English		Greek	
	Children	Adults	Children	Adults
Path V	24.59	6.88	63.34	52.08
Manner V	66.46	87.92	25.42	25.87
Path V+Manner V (2 clauses)	2.29	0.00	8.13	18.40
Other V	6.67	5.21	3.13	3.65
Total	100	100	100	100

between Language and Age $F_1(1, 38) = 3.83$, $MSE = 0.04$, $p = .05$; $F_2(1, 15) = 24.90$, $MSE = 0.007$, $p < .0001$. The interaction was due to the fact that, in Greek, children and adults were equally likely to produce a manner verb ($M = 0.25$ in both groups), while in English, children were less likely to do so than adults ($M_{ad} = 0.88$ vs. $M_{ch} = 0.66$, $p < .05$).

Similar analyses using the proportion of responses containing path verbs only returned a main effect of Language, $F_1(1, 38) = 91.46$, $MSE = 0.03$, $p < .0001$; $F_2(1, 15) = 219.94$, $MSE = 0.01$, $p < .0001$; $M_{Eng} = 0.15$ vs. $M_{Gr} = 0.58$; a main effect of Age, $F_1(1, 38) = 10.43$, $MSE = 0.03$, $p = .002$; $F_2(1, 15) = 14.67$, $MSE = 0.022$, $p = .002$; $M_{ad} = 0.30$ vs. $M_{ch} = 0.43$; and no Language by Age interaction, $F_1(1, 38) = 0.56$, $MSE = 0.03$; $F_2(1, 15) = 1.85$, $MSE = 0.009$; for English, $M_{ad} = 0.07$ vs. $M_{ch} = 0.24$, and for Greek, $M_{ad} = 0.52$ vs. $M_{ch} = 0.63$.

Finally, ANOVAs using the proportion of Mixed responses (i.e., responses containing both a manner and a path verb) as the dependent variable returned a main effect of Language, $F_1(1, 38) = 22.48$, $MSE = 0.006$, $p < .0001$; $F_2(1, 15) = 68.82$, $MSE = 0.003$, $p < .0001$; a main effect of Age significant only by items, $F_1(1, 38) = 2.43$; $MSE = 0.006$; $F_2(1, 15) = 9.60$, $MSE = 0.003$, $p = .007$; and a Language by Age interaction, $F_1(1, 38) = 6.03$, $MSE = 0.006$, $p = .01$; $F_2(1, 15) = 32.03$, $MSE = 0.002$, $p < .0001$. The interaction can be explained by the fact that Age appears to affect Mixed responses more dramatically in the case of the Greek-speaking population (with children producing them 8% and adults 18% of the time) than the English-speaking population where Mixed responses are vanishingly rare (they occur in 2% and 0% of children's and adults' productions respectively).

A list of path and manner verbs together with their distribution (tokens) in the speech of adults and children in the two language groups is given in Appendix A and B respectively. The Appendices reveal the lexicalisation biases of the two languages in all their glory. Both adults and children in the English group used several manner verbs frequently, including *bounce*, *fall*, *float*, *fly*, *hop*, *jump*, *roll*, *run*, *skate*, *swim*, and *walk*, alongside some path

verbs such as deictic *come* and especially *go*. In Greek, frequent manner verbs include *girizo* ('spin'), *kilo* ('roll'), *perpato* ('walk'), *peto* ('fly'), *pefto* ('fall'), *pido* ('jump'), *strovilizome* ('whirl around'), *treho* ('run'), and *horopido* ('jump up and down'). However, manner verbs as a group are much less frequent than path verbs: especially for children, verbs such as *aneveno* ('ascend'), *kateveno* ('descend'), *fevgo* ('leave'), and especially *pao* ('go') account for the majority of responses. Overall, in the English group, children use 8 different types of path verbs and adults only 2 (*come* and *go*), while in the Greek group, children use 14 different path verbs and adults 34. In the manner domain, English-speaking children employ a total of 34 different verb types and adults 23; Greek-speaking children employ 19 manner verbs and adults 35 (note that this count excludes the high number of path and especially manner verbal periphrases in Greek, which are not individually listed in Table 3). In sum, then, the source of the English–Greek asymmetry is not located so much in the lack of diversity in the Greek manner vocabulary (at least for adults) but in the lack of diversity in the English path verb repertory and the difference in frequency of use for manner and path verbs in the two languages (cf. Selimis, 2007).

Linguistic production results (clause structure). In a separate analysis, we asked whether speakers included manner or path information anywhere in the sentence, including the main verb, but also a variety of modifiers (a summary of participants' responses is given in Table 3). We entered the proportion of responses that included manner elements (regardless of their lexical-grammatical expression) as a dependent variable into both a subject and an item ANOVA with Language and Age as factors. We found a main effect of Language, $F_1(1, 38) = 35.89$, $MSE = 0.02$, $p = .02$; $F_2(1, 15) = 142.24$, $MSE = 0.01$, $p < .0001$; $M_{Eng} = 0.80$ vs. $M_{Gr} = 0.51$; a main effect of Age, $F_1(1, 38) = 22.45$, $MSE = 0.02$, $p < .0001$; $F_2(1, 15) = 52.10$, $MSE = 0.017$, $p < .0001$; $M_{ch} = 0.54$ vs. $M_{ad} = 0.77$; and an interaction between Language and Age that was only significant by items, $F_1(1, 38) = 0.95$, $MSE = 0.02$; $F_2(1, 15) = 5.13$, $MSE = 0.007$, $p = .039$; for English, $M_{ch} = 0.71$ vs. $M_{ad} = 0.90$, and for Greek, $M_{ch} = 0.37$ vs. $M_{ad} = 0.65$.

We conducted the same analyses using as the dependent variable the proportion of responses containing path information regardless of whether this information was encoded in the main verb or distributed in the sentence. These analyses too returned a main effect of Language, $F_1(1, 38) = 17.99$, $MSE = 0.02$, $p = .0001$; $F_2(1, 15) = 108.73$, $MSE = 0.007$, $p < .0001$; $M_{Eng} = 0.65$ vs. $M_{Gr} = 0.87$; a main effect of Age, $F_1(1, 38) = 17.31$, $MSE = 0.02$, $p = .0002$; $F_2(1, 15) = 48.55$, $MSE = 0.015$, $p < .0001$; $M_{ch} = 0.65$ vs. $M_{ad} = 0.87$; and an interaction between Language and Age, $F_1(1, 38) = 4.37$, $MSE = 0.02$, $p = .04$; $F_2(1, 15) = 28.34$, $MSE = 0.006$, $p < .0001$. The interaction arises because, even though Greek speakers are more likely to offer path

TABLE 3
Overall distribution (%) of participants' linguistic responses (Exp. 1)

<i>Sentence structure</i>	<i>English</i>		<i>Greek</i>	
	<i>Children</i>	<i>Adults</i>	<i>Children</i>	<i>Adults</i>
<i>Path only</i>				
Path V	0.63	0.00	6.3	1.56
Path V+Path modifier	21.88	6.04	52.50	31.42
Other V+Path modifier	1.88	3.96	3.96	1.56
<i>Manner only</i>				
Manner V	43.54	13.13	15.83	3.99
Manner V+Manner modifier	2.29	4.17	1.67	3.30
Other V+Manner modifier	0.42	0.83	0.00	0.17
<i>Mixed</i>				
Path V+Manner modifier	0.63	0.42	1.46	1.22
Path V+Path modifier+Manner modifier	1.46	0.42	2.29	18.40
Manner V+Path modifier	20.63	68.96	7.08	14.06
Manner V+Manner modifier+Path modifier	0.21	1.46	0.63	4.69
Manner V+Path V	0.21	0.00	0.63	0.35
Manner V+Path V+Path modifier	1.46	0.00	6.04	12.15
Manner V+Path V+Manner modifier	0.21	0.00	0.21	0.00
Manner V+Path V+Manner modifier+Path modifier	0.42	0.00	1.25	6.25
Other V+Manner modifier+Path modifier	0.00	0.42	0.00	0.87
<i>Other Vs</i>	4.17	0.00	0.21	0.00
Total	100	100	100	100

Note: Verbs or modifiers of the same type (path/manner) were only coded once for each response. Hence a structure such as 'Manner V+Path modifier' can refer to sentences with more than one Path modifier, or more than one Manner V (even though such 'stacked' responses are infrequent).

information than English speakers, the difference seems to be wider in children's ($M_{\text{Eng}} = 0.49$ vs. $M_{\text{Gr}} = 0.82$) than in adults' responses ($M_{\text{Eng}} = 0.81$ vs. $M_{\text{Gr}} = 0.92$).

Categorisation results. Results from the categorisation task are given in Figure 2. The proportion of manner categorisation choices was entered into both a subject and an item ANOVA with Language (English, Greek) and Age (Children, Adults) as factors (see Figure 2). The ANOVAs yielded a main effect of Language, $F_1(1, 38) = 8.4$, $MSE = 0.04$, $p = .0062$; $F_2(1, 15) = 25$, $MSE = 0.063$, $p < .0001$, with English speakers offering manner matches 42% of the time and Greek speakers 24% of the time. The analyses further revealed a main effect of Age, $F_1(1, 38) = 5.31$, $MSE = 0.04$, $p = .002$; $F_2(1, 15) = 10$, $MSE = 0.10$, $p = .006$, with children overall being more likely to offer manner choices than adults ($M_{\text{ch}} = 0.40$ and $M_{\text{ad}} = 0.26$). Finally, the

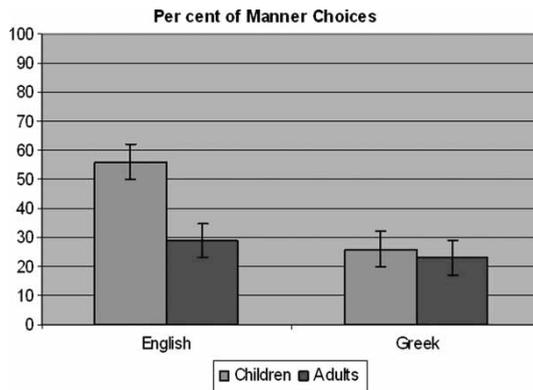


Figure 2. Categorisation results (Exp. 1).

ANOVAs yielded no interaction between Language and Age, $F_1(1, 38) = 3.83$, $MSE = 0.04$; $F_2(1, 15) = 10$, $MSE = 0.10$.

Separate analyses showed that the Animacy of the agent did not have an effect on categorisation choices, nor did it interact with Language and Age.

Relationship between labelling and categorisation. Since our stimuli involved familiar events, it is possible that people tacitly labelled the events in their native language as they encountered them. Any categorisation preferences may thus simply be the result of prior (implicit) linguistic labelling of the sample and variants. To determine whether labelling preferences predict categorisation preferences, we coded those trials where the sample and either the Same-Manner or the Same-Path variant were named with the same verb by a participant as Manner Verb Matches (MVM) and Path Verb Matches (PVM) respectively. All other trials were coded as No Matches (NM). For a triad to be coded as a Path/Manner Verb Match, the following conditions should be met: (a) the very same verb should appear in the sample and only one of the variants; (b) if the sample contained more than one verb, only one of these verbs should reappear in one of the variants; (c) the match should be in the direction anticipated by our design (e.g., cases where the same path verb was used for the sample and the Same-Manner variant were coded as NM).

We found that, in English-speaking adults, MVM were quite frequent ($M = 0.61$) and much more numerous than NM ($M = 0.36$); as expected, PVM were extremely rare (only 3 tokens, or 1.88% of the answers). In English-speaking children, MVM were about as frequent as NM ($M = 0.43$ vs. 0.47 respectively), with PVM dispreferred ($M = 0.09$). In the speech of Greek adults, NM were the canonical case ($M = 0.54$), with frequent PVM ($M = 0.35$) and few MVM ($M = 0.09$). Greek children similarly gave mostly

NM responses ($M = 0.59$), alongside several PVM ($M = 0.30$) and few MVM ($M = 0.10$). In sum, manner lexicalisation biases in English seem to produce strong tendencies for uniform and consistent labelling of the sample and the Same-Manner variant for both adults and children. In Greek, path lexicalisation biases exist but lead to somewhat fewer simple verb matches across samples and Same-Path variants.

We next asked whether a verb match for a specific participant on a specific item predicted previous categorisation preferences. We conducted two different sets of Fisher's exact tests (we did not use chi-squares because of low values in some cells). In the first set of tests, we asked whether including a Manner Verb Match (MVM, No MVM) in participants' utterances predicted categorisation choice (manner, path). For purposes of these analyses, PVM and NM were collapsed into the 'No MVM' category. In the second set of tests, we asked whether including a Path Verb Match (PVM, No PVM) predicted categorisation preference (manner, path). For purposes of these tests, MVM and NM were collapsed into the 'No PVM' category. Each of our 16 items was submitted to both types of Fisher's exact test. For each item, we included data from all participants (i.e., from both languages and age groups).

Beginning with the analyses examining the role of the presence or absence of a Manner Verb Match on categorisation, significant results were found for only 2 of the 16 items. In these 2 items, the presence of a MVM in a participant's utterance predicted whether that same participant would choose the same-manner variant in the categorisation task (item 2, $p = .0012$; item 12, $p = .01$; Fisher's exact, two-tailed). Two additional items produced marginally significant results in the predicted direction (item 9, $p = .09$; and item 16, $p = .07$; Fisher's exact, two-tailed). For each of these four items, we went on to conduct two separate analyses for English vs. Greek speakers. The new analyses showed that, in one case (item 9), the relationship between MVM and categorisation held marginally in the data from native English speakers ($p = .07$) but not in those from native Greek speakers ($p > .1$; Fisher's exact, two-tailed). In two items (2 and 16), the relationship held only in the data from Greek speakers ($p = .09$ and $.02$ respectively; Fisher's exact, two-tailed). In the last item (no. 12), the two separate analyses did not yield significant results.

Turning to the analyses that looked at the role of the presence or absence of a Path Verb Match on categorisation, a (marginally) significant result was found only for item 5 ($p = .06$, Fisher's exact, two-tailed).

Taken together, these data point to the conclusion that participants' categorisation preferences were generally not affected by the linguistic overlap (or lack thereof) between samples and variants in the very same participants' verbal descriptions. In the rare cases where there was a relationship between verbal labelling and categorisation, this relationship

seemed to be independent from cross-linguistic typological differences (such as the English–Greek difference in the encoding of manner and path information in the verb). We conclude that, in the present study, verbal matches within the event triads were not spontaneously and systematically recruited for purposes of categorisation.

Discussion

Our results point to two main conclusions. First, our production data confirm the expected asymmetry in the type of motion verbs offered by speakers of English and Greek: (a) English speakers offered a high proportion of manner verbs, while Greek speakers offered a high proportion of path verbs; (b) the verb asymmetry held across age groups (i.e., it was already evident in the 5-year-old population). Beyond these lexicalisation biases for the main verb, we found that the manner/path asymmetry extended to the overall kind of motion information offered by the two language groups (including adverbial and other modifiers of the main verb). Second, our categorisation results show that categorisation preferences from speakers of different languages split along typological lines, with English speakers being more likely to offer manner choices than Greek speakers.

These results can be interpreted as evidence supporting the salience hypothesis. Recall that, according to this hypothesis, speakers of languages that consistently and frequently encode manner information are more likely to attend to manner in various cognitive tasks (such as categorisation or memory) compared with speakers of languages where manner is not encoded with the same precision and frequency. The English–Greek asymmetry in categorisation is in the direction predicted by the typological asymmetry in manner encoding that characterises the two languages.

An alternative interpretation for these findings is that the linguistic instructions in the triad task may have induced language-based responses. As we saw in the previous section, it is unlikely that participants relied on linguistic (verb) labels for the sample and variant events to solve the categorisation task, since there is generally no relation between what a participant said and what that same participant chose in the categorisation task. Nevertheless, it is still an open possibility that participants implicitly used verbal labels *for the sample events only* and that these initial labels affected subsequent classification preferences. Support for this hypothesis comes from the fact that the verbal prompt accompanying the sample (*Look! The X is doing something!*) could have implicitly encouraged participants to label the event ('The X is Ving') in their native language. Even if no further implicit labelling took place, and participants did not use labelling strategically to solve the categorisation task, this initial label could have guided them towards manner or path dimensions of the event and biased subsequent choices.

As discussed in the Introduction, it is not possible to determine on the basis of a single task whether language-congruent behaviour is due to deep, language-driven shifts in the salience of conceptual categories or to more transient effects of co-opting verbal labels to solve a cognitive task. To adjudicate between these two alternative possibilities, we replicated the triad task but changed the biasing linguistic prompt (Experiment 2) and, in a further modification, the presentation of the stimulus events (Experiment 3). If salience of manner and path components produced the differences in categorisation performance between the English and Greek speakers, these differences should persist in the new tasks. But if on-line verbal intrusions were responsible for the observed cross-linguistic differences in categorisation, these new manipulations – to the extent that they make participants less likely to use language as a way of encoding the sample stimulus – should make categorisation differences between the two language groups diminish or disappear.

EXPERIMENT 2

Method

Participants. Participants were native speakers of either English or Modern Greek that fell into two general age groups. The Child group consisted of 10 English-speaking children between 4;10 and 5;10 years (mean age 4;11) and 10 Greek-speaking children between 4;7 and 5;10 (mean age 5;5). The Adult group consisted of 10 English-speaking adults and 10 Greek-speaking adults. Children and adults were recruited from the same populations as in Experiment 1 but none of them had taken part in the earlier Experiment.

Materials. The same clips were used as in Experiment 1.

Procedure. The procedure was the same as in Experiment 1 with the following changes. Participants heard a simple prompt (*Look! Greek Kita!*) upon presentation of the samples. Their similarity judgements were now elicited by using the prompt *Do you see the same now?* (Greek *Tora vlepis to idio?*). Unlike Experiment 1, participants were not asked to describe the clips at the end of the session.

Coding. Judgements were coded again as manner or path choices.

Results

Results from the Experiment are presented in Figure 3a. The proportion of manner choices was entered into both a subject and an item ANOVA with Language (English, Greek) and Age (Children, Adults) as factors. The

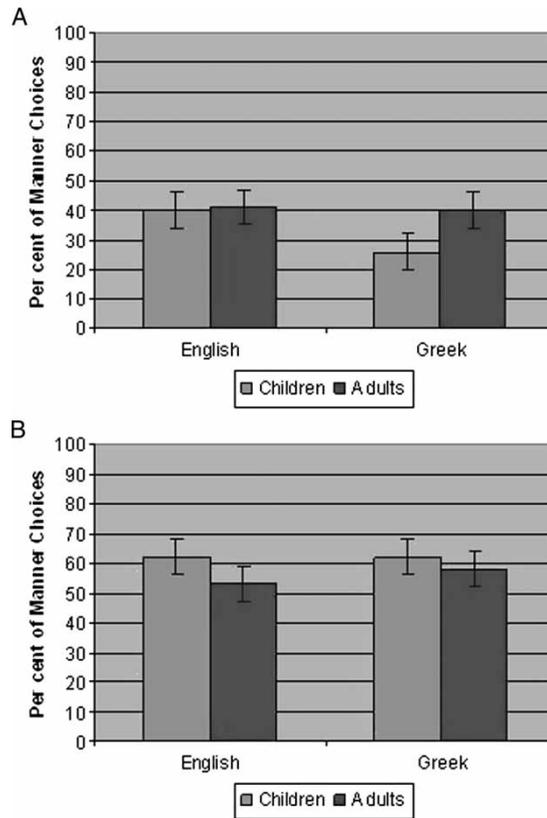


Figure 3. Categorisation results (Exp. 2 and 3).

analyses revealed no main effect of Language, $F_1(1, 36) = 1.6$, $MSE = 0.03$; $F_2(1, 15) = 1.20$, $MSE = 0.32$: English speakers offered manner matches 41% and Greek speakers 33% of the time. There was also no main effect of Age, $F_1(1, 36) = 1.4$, $MSE = 0.03$; $F_2(1, 15) = 3.15$, $MSE = 0.12$: children offered manner matches 33% and adults 40% of the time. Finally, there was no interaction between Language and Age, $F_1(1, 38) = 1$, $MSE = 0.03$; $F_2(1, 15) = 0.513$, $MSE = 0.27$. In both the English and the Greek data, participants' responses were significantly different from chance, $t(19) = -2.4$, $p = .02$ and $t(19) = -3.2$, $p = .004$ respectively, i.e., there was a significant preference for path choices (see Figure 3a).

Discussion

The present study modified the non-linguistic categorisation task of Experiment 1 so as not to encourage linguistic labelling of the sample

events. Under these conditions, adults and children in both language populations we tested behaved identically. These results argue against the salience hypothesis; they also support the conclusion that the language-congruent categorisation preferences in Experiment 1 were due to transient rather than permanent effects of verbal encoding.

To further test the hypothesis that absence of a biasing linguistic prompt should lead to similar categorisation patterns cross-linguistically, in Experiment 3 we replicated Experiment 2 replacing the sequential presentation of the sample events and variants with a simultaneous presentation. We reasoned that, since the simultaneous presentation alleviates the pressure for linguistically or otherwise encoding and retaining the sample scene in memory, it should also lead to uniform responses across languages (perhaps driven mostly by perceptual similarities between sample and variants).

EXPERIMENT 3

Method

Participants. Participants were native speakers of either English or Modern Greek grouped into two age groups. The Child group included 10 English-speaking children between 4;5 and 5;9 years (mean age 5;4) and 10 Greek-speaking children between 4;6 and 5;7 (mean age 5;4). The Adult group consisted of 10 English-speaking adults and 10 Greek-speaking adults. Children and adults were recruited from the same populations as in Experiments 1 and 2. None of them had taken part in the earlier experiments.

Materials. The same clips were used as in Experiments 1 and 2.

Procedure. The same procedure as in Experiment 2 was followed with two major modifications. First, participants now saw a continuous display of both the sample and the two variants. Stimuli were presented on three laptop computers placed side by side. The middle laptop displayed the sample event and was placed further away from the participant. The other two screens were placed to its left and right side and slightly closer to the participant. Second, participants were told that they would watch three similar events on the three screens and they would have to pick the screen (right/left) which showed the most similar event to that shown in the middle screen. They were also told that the events would go on playing until they made their choice.

At the beginning of each triad, participants were given the opportunity to inspect the first (frozen) frames of each event to familiarise themselves with the event participants. Then the sample started playing and participants' attention was drawn to the middle screen. About 3 s later, the two variants

started playing simultaneously. This step-wise presentation of the stimuli was done to facilitate processing (and comparison) of three ongoing parallel events. The three events continued to play in a loop until participants responded.

Because of the complexity of the task of inspecting three dynamically unfolding events, we added one more pretest triad for participants in this experiment. In the new pretest sample event, a genie gave a man a pizza. In one of the variants, the genie gave the man a slice of pizza, while in the other the genie performed an unrelated action (he gave the man a toy car). Children who failed the first pretest had to pass this second pretest trial to be included in the study. Two children in the Greek group and one child in the English group failed to pass both pretests and were replaced.

Coding. Judgements were coded again as manner or path choices.

Results

Results from this experiment are given in Figure 3b. An ANOVA with Language and Age as factors returned no main effect of Language, $F_1(1, 36) = 0.63$, $MSE = 0.02$; $F_2 < 1$, $MSE = 0.16$; $M_{\text{Eng}} = 0.57$ and $M_{\text{Gr}} = 0.60$, or Age, $F_1(1, 36) = 0.21$, $MSE = 0.02$; $F_2 < 1$, $MSE = 0.22$; $M_{\text{ad}} = 0.55$ and $M_{\text{ch}} = 0.62$, and no interaction between Language and Age, $F_1(1, 36) = 0.19$, $MSE = 0.02$; $F_2 < 1$, $MSE = 0.16$. In other words, when presented with motion events unfolding concurrently, both language groups performed identically. In both the English and the Greek data, participants made manner choices at rates significantly different from chance, $t(19) = 2.75$, $p = .01$ and $t(19) = 2.01$, $p = .05$ respectively.

To explore categorisation preferences more closely, we took a more detailed look at individual items. Four items (2, 7, 8, and 16; see Table 1) rarely elicited manner matches from any of the four Age \times Language groups ($M = 0.13$, range: .7–0.27); furthermore, the path bias for these items held across all four groups. Of these items, two included manner changes that might have been more subtle than in other triads (a duck was ice-skating vs. roller-blading across a ring; an eagle was flying vs. zooming over a cage). The other two included motions of inanimate agents in physical events in which the manner is incidental and non-intentional (a leaf and a flower were being moved around by the wind). The remaining 14 items elicited predominantly manner categorisation choices ($M = 0.73$, range: 0.55–0.92).

Comparison of Experiments 2 and 3. Inspection of the two panels in Figure 3 leads to the conclusion that participants were more likely to offer manner guesses in Experiment 3 than in Experiment 2 (59% vs. 37% of responses). This difference between Experiments 2 and 3 was confirmed in

an ANOVA with Experiment, Language, and Age as factors. The analysis returned a main effect of Experiment, significant by subjects only, $F_1(1, 72) = 28.10$, $MSE = 0.03$, $p < .0001$; $F_2(1, 15) = 1$, $MSE = 0.19$, but no main effects of Language, $F_1(1, 72) = 0.44$, $MSE = 0.03$; $F_2(1, 15) = 0.85$, $MSE = 0.22$, or Age, $F_1(1, 72) = 0.007$, $MSE = 0.03$; $F_2(1, 15) = 0.34$, $MSE = 0.2$, and no interactions.

Discussion

This experiment introduced a novel method for probing event categorisation by presenting the sample event and both event variants simultaneously and continuously to participants making similarity judgements. This task artificially removes one of the major characteristics of dynamically developing events, namely their fleeting nature and, in that sense, differs from actual event categorisation circumstances where event identification often needs to happen on the basis of a single exposure to a dynamic stimulus. However, this set-up has the advantage of allowing us to examine event categorisation in the absence of event memory. In that sense, this event categorisation task is closer to classic match-to-sample object categorisation tasks (e.g., Lucy & Gaskins, 2001) compared to its previous incarnations in Experiments 1 and 2. Results from this experiment confirm the conclusion that, when English and Greek speakers view unfolding motion, they are drawn to the same event components in deciding what counts as 'the same' event. This finding offers another piece of evidence against the salience hypothesis, according to which habitual linguistic encoding of certain semantic distinctions makes such distinctions more prominent during non-linguistic cognitive tasks.

A striking feature of the current presentation conditions is that the event components that determine event identity are more likely to rely on the way the agent is moving compared to the previous experiment. This heightened reliance on manner is presumably dictated by perceptual features of the dynamic event. This aspect of the present findings raises two further questions. First, could it be that, in making their judgments, participants simply paid attention to low-level features of the ongoing events, rather than to higher-level constructs such as manner or path? Low-level features of the scene such as gait, speed, displacement of the moving agent with respect to the agent's own centre of gravity, etc., almost always correspond to features of manner of motion (e.g., Slobin, 2004). We do not think this possibility is very likely for the following reason: if such features determined speakers' choices, participants should always make manner choices. However, as we saw in the detailed analysis of results, on certain items participants from all language and age groups consistently switched to path choices. These items included two events with inanimate agents (a leaf and a flower moved around

by the wind), where manner of motion remained salient but was presumably irrelevant. Participants thus seemed to recognise that, in the words of one Greek adult, they could base their answers on either the ‘similarity’ (i.e., manner aspects) or the ‘logic’ (i.e., the relational/path component) of the events.

Second, is manner of motion inherently ‘attention-grabbing’ compared with path, at least when motion events are inspected on-line? Such an in-built asymmetry would explain the increase of manner-based choices between Experiments 2 and 3. However, it is doubtful whether a general salience ranking of manner and path can be established, or whether such a ranking would be meaningful, once established. One reason to doubt the viability of a ranking comes from a recent eye-tracking study which measured English and Greek speakers’ attention to manner and path in ongoing motion events (Papafragou et al., 2008): path (defined as the endpoint of the agent’s trajectory) was found to attract more looks than the manner of motion (defined as the vehicle used for locomotion) from both populations. Relatedly, studies in the artificial category learning literature show that English-speaking adults have strong path biases in categorising novel event exemplars (Kersten, Goldstone, & Schaffert, 1998). Even within the word learning literature, studies comparing the potency of manner and path categories have produced inconsistent results: some studies have found that children prefer manner over result when interpreting novel action verbs, at least at the early stages of verb learning (Gentner, 1978), while other studies report that children overwhelmingly prefer to label the outcome rather than the manner of motion (Behrend, 1990; Forbes & Farrar, 1993; Gropen, Pinker, Hollander, & Goldberg, 1991; see also Behrend, Harris, & Cartwright, 1995). We conclude that, depending on the task particulars and the items used, either path or manner may attract attention, or be weighed more heavily in determining event identity.⁵

GENERAL DISCUSSION

This paper compared two hypotheses about the relationship between linguistic and conceptual representations. According to the salience hypothesis, linguistic dimensions prominent in lexicalisation patterns can shape the non-linguistic processes of segmenting and mentally ‘packaging’ events. For instance, according to some commentators, ‘verbs... – including those

⁵ It is an interesting question whether path and manner can be broken down into more fine-grained perceptual or force/mechanical features which attract attention when motion is visually parsed (see Cavanagh, Labianca, & Thornton, 2001; Marr & Vaina, 1982; cf. Bingham, Schmidt, & Rosenblum, 1995; Johansson, 1973; Thornton, Rensink & Shiffrar, 1999; Wallach, 1965).

concerned with spatial relations – provide framing structures for the encoding of events and experience; hence a linguistic effect on these categories could reasonably be expected to have cognitive consequences’ (Gentner & Boroditsky, 2001, p. 247). Alternatively, on the underspecification hypothesis, linguistic representations are not isomorphic to non-linguistic (conceptual) representations: in other words, the representation of space and events is not shaped by categories and distinctions provided by one’s native language.

We tested the explanatory potential of these two hypotheses by comparing the non-linguistic categorisation of motion events by speakers of English and Greek. These two languages exhibit an asymmetry in terms of expressing path and manner of motion (see Talmy, 1975, 1985). Our linguistic production data document this asymmetry in English and Greek: (a) when asked to describe short motion events, English speakers offer a high proportion of manner verbs, while Greek speakers offer a high proportion of path verbs (see Table 2); (b) beyond these verb lexicalisation biases, the manner/path asymmetry generalises to the overall kind of motion information offered by the two language groups, including adverbial and other modifiers of the main verb (see Table 3); (c) these cross-linguistic differences are already apparent by age 5. These data support and extend a growing body of work on cross-linguistic differences in motion verb typology and add to evidence suggesting that children quickly grasp and follow language-specific patterns for the expression of spatial relations and events (Allen et al., 2007; Bowerman & Choi, 2003; Choi & Bowerman, 1991; Papafragou et al., 2002; Selimis, 2007; Slobin, 1996a, 1996b, 1997, 2003; among many others).

Crucially, when presented with a moving agent and told that the agent ‘was doing something’, English and Greek speakers diverged in terms of what they took the agent to be engaged in: English speakers were more likely than Greek speakers to consider the way the agent was moving as the basis for judging motion event identity (Exp. 1; see Figure 2). These data are consistent with the classic version of the salience hypothesis, according to which cognition is more likely to be reorganised along language-based lines as a result of exposure to (and familiarity with) one’s native language (e.g., Lucy & Gaskins, 2001). They are also consistent with a weaker hypothesis, according to which participants fell back on linguistic labels for the sample event in Experiment 1, especially since the instructions included a non-specific verb in the target language (‘doing something’).

Further experimentation supports the second explanation: If the biasing linguistic prompt is removed (Exp. 2) or the events are presented simultaneously (Exp. 3), both children and adults in the two language groups behave identically when asked to decide which of the triad events are ‘the same’ (see Figure 3a and 3b). Moreover, inspection of classification preferences for

individual events reveals commonalities in the way individual events are categorised by speakers of the two languages. These last findings mesh well with data from Papafragou et al. (2002), who asked English- and Greek-speaking adults and older children to categorise motion events in a triad task similar to the present one. In that work, each of the motion events was presented as a series of digital photographs, and (just like Exp. 3) all of the events within a triad were laid out in such a way that they could be inspected in parallel by participants. In that study, both 8-year-old children and adults in the two languages behaved identically.

These results argue against the salience hypothesis and in support of the underspecification position in the domain of motion events. Contrary to theories that posit that ‘language invades our thinking because languages are good to think with’ (Levinson, 2001, p. 584), our data suggest that conceptual organisation is independent of language-specific encoding preferences. In that respect, our data are consistent with prior studies that have pointed out that naming and non-linguistic categorisation diverge. For instance, Munnich, Landau, and Doshier (2001) studied the *on/above* spatial contrast, which is encoded by different prepositions in English but is not grammaticalised in Korean: they found that, despite this difference, English and Korean speakers had equally good memory for the relevant spatial locations. Similar effects have been observed in the area of object categorisation: Malt, Sloman, Gennari, Shi, and Wang (1999) found that, despite differences in the vocabulary used by English, Spanish, and Chinese subjects for everyday containers such as bottles, jars, jugs, and boxes, similarity judgements for differently labelled containers by speakers of the three languages did not differ much (if at all).

Additionally, the present data show that, to the extent that suitable linguistic labels are available during categorisation, such linguistic labels can be co-opted as a way of solving the categorisation task. In that sense (implicit) linguistic labels may function as an invitation to extract commonalities across scenes and events – and adopt a perspective on event structure. This possibility is consistent with the underspecification hypothesis to the extent that such linguistic intrusions reflect on-line, transient effects of language – in other words, a strategy that participants can adopt (consciously or not) to solve non-linguistic tasks and not a permanent reorganisation of the underlying cognitive representation of motion.

How widespread are on-line linguistic intrusions into otherwise non-linguistic categorisation tasks? We know that tasks where participants are asked to make a judgement about which events or relations are ‘the same’ are vastly underspecified (Bloom, 1994), especially in the absence of objective standards of similarity (Goodman, 1955). Recall that other studies have shown that, for such tasks, linguistic labels can affect adults’ criteria for similarity if introduced prior to the experiment: Gennari et al. (2002) found

that Spanish and English speakers were more likely to judge that motion events expressed with the same verb in their language were similar if they had described the events immediately prior to making a similarity judgement than if they had simply performed the similarity task without a preceding labelling phase. Other research suggests that linguistic-encoding preferences can affect categorisation choices (at least for adults) even if no overt linguistic labels are used by participants. For instance, in open-ended tasks where participants are asked to decide which two spatial arrays are 'the same', people's choices tend to align with the preferred way of encoding space in their linguistic community (e.g., *X is to the left of Y* vs. *X is to the north of Y*; Levinson, 2003). Moreover, implicit spatial labels can be implicated in rapid on-line processing of spatial arrays (Dessalegn & Landau, 2008).

As our present data show, such linguistic intrusions are neither consistent nor necessary. Specifically, when the experimental instructions do not encourage linguistic recoding (as in Exp. 1), participants do not spontaneously fall back onto linguistic labels to solve the categorisation task (see Exp. 2 and 3). Other data confirm that linguistic intrusions into otherwise non-linguistic tasks may be limited and easily overridden by other biases. For instance, people's judgements of the sameness of spatial arrays are not tied to linguistic-encoding patterns but can flexibly adapt to external spatial cues (Li, Abarbanell, & Papafragou, 2005; Li & Gleitman, 2002). And, as reviewed already, there are several cases in which the linguistic representation of objects and relations did not percolate into non-linguistic tasks (Gennari et al., 2002; Malt et al., 1999; Munnich et al., 2001). Thus the preferred way of linguistically encoding space within a community, even though usable and useful in otherwise open-ended spatial tasks, does not reflect a permanent change in spatial representation.

Even though the behaviour of linguistic intrusions is currently not well understood, it seems reasonable to assume that their role depends on several factors including the ease of labelling of the target events, and the perceived difficulty or open-endedness of the task. Furthermore, their scope seems to extend beyond categorisation to other cognitive processes. For instance, in the literature on working memory, there is evidence that adults (but not young children) spontaneously and implicitly recruit linguistic labelling as a strategy to solve memory problems (Hitch, Halliday, Schaafstal, & Hefferman, 1991; Palmer, 2000). Most relevant for present purposes is a recent study by Papafragou, Hulbert, and Trueswell (2008) which recorded eye movements from Greek- and English-speaking adults as they watched short animated motion clips and tried to remember them for a later memory task. Eye movements during inspection of motion events were nearly identical for both language groups, supporting the underspecification view; nevertheless, towards the end of the clips, participants tended to look at regions that their

language tended not to encode in the verb (English speakers were more likely to look at path and Greek speakers at manner). Further experimentation revealed that this pattern was due to a linguistic ‘compensation’/recoding strategy for details of the event that participants thought they might forget (as opposed to a true salience effect). Specifically, this strategy (as measured by the corresponding difference in eye movements) was more likely to occur in memory tasks with high cognitive load; furthermore, this strategy was eliminated in tasks that required verbal interference (e.g., counting) but was preserved in tasks that involved non-verbal interference (e.g., tapping; Trueswell & Papafragou, 2008). These data point to two conclusions that cohere strongly with the present work. First, in non-linguistic tasks, event apprehension is dissociable from language-specific encoding preferences and seems to proceed in a similar fashion across members of different linguistic communities. Second, language can play a role in event processing, since linguistic labels can be flexibly used to support memory (especially for difficult tasks); as a result, linguistic intrusions can lead to shifts in attention to event components that correspond to language-specific event encoding preferences. Nevertheless, these effects are transient and task-dependent, and do not reflect an underlying shift in the representation of dynamic events across speakers of different languages.

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APPENDIX A
Path Verb counts in adults and children (Exp. 1)

	<i>English</i>		<i>Greek</i>			
	<i>Children N = 10</i>	<i>Adults N = 10</i>		<i>Gloss</i>	<i>Children N = 10</i>	<i>Adults N = 12</i>
Circle	1	–	akolutho	<i>follow</i>	–	4
come	21	–	akubo	<i>touch/reach</i>	–	1
cross	1	–	aneveno	<i>ascend</i>	16	29
go	122	25	apomakrinome	<i>move-away</i>	–	1
hide	3	–	beno	<i>enter</i>	10	1
land	1	–	diashizo	<i>cross</i>	–	3
leave	1	–	epistrefo	<i>return</i>	–	2
rise	–	8	erhome	<i>come</i>	–	2
start	2	–	fevgo	<i>leave</i>	11	82
periphrases	1	–	ftano	<i>arrive/reach</i>	3	56
			jirno ^a	<i>circle</i>	4	1
			jirno/jirizo ^a	<i>return</i>	4	1
			kataligo	<i>reach/land-up</i>	–	29
			katefthinome	<i>head-for</i>	–	20
			kateveno	<i>descend</i>	25	25
			kolo	<i>reach</i>	–	1
			krivome	<i>hide</i>	8	12
			ksekino	<i>start-off</i>	–	8
			ksekolo	<i>move-away</i>	–	2
			ksekrivome ^b	<i>exit (lit. un-hide)</i>	–	1
			kseperno	<i>surpass/overtake</i>	–	3
			metakinume	<i>move/change-place</i>	–	27
			pao	<i>go</i>	257	181

(Continued)

APPENDIX A (Continued)

English		Greek			
Children N = 10	Adults N = 10	Gloss	Children N = 10	Adults N = 12	
		periferome	roam-around	–	1
		peristrefome	move-around	–	1
		perno ^c	take	6	7
		perno ^c	pass	3	17
		plisiazo	approach	–	3
		prosjionome	land	–	1
		prosperno	pass-by	–	2
		prohoro	advance	7	7
		sikono	lift-up	–	1
		sikonome	get-up	3	–
		vjeno	exit	6	7
		vrisko	reach	–	3
		periphrases		11	23
Total number	153	33	Total number	374	565

^a *jirno* has two path entries depending on its meaning. The same verb also appears as a manner verb in Appendix B with the interpretation ‘roam around/spin’ (cf. also *periferome* and *peristrefome* which were also entered as both manner and path verbs depending on whether their interpretation involved translocation or motion in place).

^b *kse-krivome* was coined ad hoc (prefix *kse-* denoting reversal + *krivome* ‘hide’), i.e., it is not an existing Greek verb.

^c *perno* (‘take’) has stress on the first syllable, while *perno* (‘pass’) on the second.

APPENDIX B
Manner Verb counts in adults and children (Exp. 1)

	<i>English</i>		<i>Greek</i>			
	<i>Children</i> <i>N = 10</i>	<i>Adults</i> <i>N = 10</i>		<i>Gloss</i>	<i>Children</i> <i>N = 10</i>	<i>Adults</i> <i>N = 12</i>
blow	–	10	eorume	<i>swing/sway</i>	–	9
bob	–	2	anadiome	<i>emerge (lit. dive-up)</i>	–	3
bounce	25	23	anapido	<i>jump-up</i>	–	3
bump	3	–	anevokateveno	<i>bob-up-and-down</i>	–	2
crash	1	–	anemostrovilizome	<i>whirl-around</i>	–	1
crawl	2	2	vatheno	<i>sink (lit. deepen)</i>	–	1
dance	1	–	vuliazio	<i>sink</i>	1	2
drift	–	6	vuto	<i>dive</i>	–	1
drop	1	–	vithizome	<i>sink</i>	1	7
drown	1	–	jirno/jirizo	<i>spin</i>	13	1
fall	23	52	epipleo	<i>float</i>	–	1
flip	1	–	kalpazo	<i>gallop</i>	–	3
float	32	70	katrakilo	<i>come-tumbling-down</i>	1	7
fly	57	62	klotso	<i>kick</i>	–	1
frog jump ^a	1	–	kilo	<i>roll</i>	2	14
gallop	–	2	kolibo	<i>swim</i>	4	3
hop	31	13	kunieme	<i>swing</i>	–	1
ice skate	4	–	paraserno	<i>sweep-away</i>	–	2
jump	19	32	parasirome/parasernome	<i>get-swept-away</i>	–	8
leap	–	2	periferome	<i>roam-around</i>	–	1
parachute	–	1	peristrefome	<i>rotate</i>	–	1
pop	1	–	perpato	<i>walk</i>	11	1
push oneself	1	–	peto ^I	<i>fly</i>	20	37
ride	2	–	peto ^T	<i>throw</i>	4	–

(Continued)

APPENDIX B (Continued)

	English		Greek			
	Children N = 10	Adults N = 10		Gloss	Children N = 10	Adults N = 12
roll	19	29	pefto	<i>fall</i>	18	55
roller skate	1	–	pido	<i>jump</i>	12	8
run	16	16	pleo	<i>sail</i>	–	1
sink	2	12	rufo	<i>suck in</i>	1	–
skate	22	27	sprohno	<i>push</i>	2	–
skip	1	–	strifojirizo ^T	<i>cause-to-twist-and-turn</i>	–	3
skydive	–	2	strifojirizo/strifojirno ^I	<i>twist-and-turn</i>	4	8
slip	2	–	strovilizome	<i>whirl-around</i>	–	18
spin	12	7	treho	<i>run</i>	10	9
swim	23	19	tsulo	<i>slide</i>	1	1
swirl	2	–	fiso	<i>blow</i>	1	1
tumble	3	2	honome	<i>squeeze-in</i>	–	1
turn	4	–	horopido	<i>jump-up-and-down</i>	27	9
twirl	2	3	htipo	<i>hit</i>	1	1
twist	3	–	periphrases		30	66
walk	16	27				
zigzag	1	–				
Periphrases	3	1				
Total number	338	422	Total number		164	291

^a *frog jump* was coined ad hoc.^{I/T}: These mark phonologically identical non-causative/intransitive (I) – causative/transitive (T) doublets in Greek (e.g., *peto* ‘fly’/‘throw’).