Conceptual Signatures of Atomicity Across Languages

Logico-semantic theories suggest that *atomicity* underlies the representation of both telicity in the semantics of verbal predicates and the mass/count distinction in the semantics of nominals ([1]-[3]; cf. [4]-[7]). It is plausible that atomicity has a counterpart in non-linguistic cognition: atomicity for temporal entities would underlie the distinction between bounded events whose representation includes inherent endpoints and unbounded events whose representation lacks such boundaries [8]. Similarly, atomicity for spatial entities would underlie the distinction between objects that possess inherent spatial boundaries and substances that lack such boundaries [9]. Here we aim to **(a)** uncover the non-linguistic features that could provide the basis for conceptual atomicity (bounded events and objects) across the domains of temporal and spatial entities and **(b)** test whether these conceptual features precede the linguistic encoding of boundedness and objecthood.

We propose that a well-defined internal structure is a distinguishing feature of atomicity (see also [7], [9]). Two predictions follow from this hypothesis: (1) No Restructuring: viewers should be more sensitive to structural changes to atomic entities (bounded events and objects) than to non-atomic entities (unbounded events and substances); (2) Distinct Parts: subparts of atomic entities should be more likely to be perceived as distinct from one another than subparts of non-atomic entities. We test these predictions in Experiments 1 (1a: events, 1b: objects) and 2 (2a: events, 2b: objects) respectively, across English- and Mandarin-speaking adult participants.

We also test how conceptual representations of atomicity arise in the mind. We hypothesize that conceptual atomicity precedes and structures the linguistic encoding of atomicity. Alternatively, the conceptual signature of atomicity might arise because of familiarity with the way atomicity is encoded in the viewer's language. Only the first hypothesis predicts that non-linguistic atomicity would be conceptualized in similar ways cross-linguistically.

We compare speakers of Mandarin Chinese and English because the two languages differ in the linguistic encoding of boundedness and objecthood. While English speakers can use different predicates (e.g. *fix/drive a car*) to denote boundedness contrasts, in Mandarin, mono-morphemic verbs (e.g. *kai* "drive") are generally inherently unbounded ([10], [11], [12]). In the nominal domain, while English speakers can specify objecthood in language via count/mass syntax (*a vase/clay*). Mandarin lacks count-mass syntax, thus all nouns can appear in their bare form ([13]).

No Restructuring *Experiment 1a (Events)*: We created 16 videos of bounded events (e.g. cutting the paper in half) and 16 videos of closely related unbounded events (e.g. cutting pieces from the paper). We confirmed that naïve viewers construe the videos along these lines in a prior norming study in which people were asked if the event "had a beginning, midpoint and endpoint" (M=90% vs. 17.5% for bounded vs. unbounded events). Each video was edited so that the temporal order of the second and third quarters of the video was flipped. Participants (English N=24; Mandarin N=24) watched the original video followed by the restructured video, and were asked to decide whether the two videos were identical. English-speaking participants were more likely to accurately judge the original video and the structurally disrupted video as different for Bounded Events (M=77.7%) than for Unbounded Events (M=60.9 %) (*glmer*, $p<0.001$), as were Mandarin-speaking participants (Bounded M=74.8%, Unbounded M=68.6%, $p<0.05$). As expected, both groups of participants were better at detecting structural disruptions to bounded events than to unbounded events.

Experiment 1b (Objects): We used 16 pairs of object (e.g. vase) and substance (e.g. clay) images, which were confirmed to be construed along these lines (1-7 scale; 1=object, 7=substance;

M=2.91 vs. 4.81 for objects and substances, respectively). We created structurally disrupted versions of each entity by flipping the order of the second and third vertical quadrants of the image (Table 1). Participants (English N=24; Mandarin N=24) were briefly (100ms) shown the original entity, followed by the structurally disrupted entity (100ms). They were asked to identify whether the two entities were identical. English speakers were more likely to accurately judge the original entity and the structurally disrupted entity as different for Objects (M=87.8%) than for Substances (M=58.6%) ($p<0.001$), as were Mandarin-speaking participants (Objects M=87%, Substances M=67.6%, $p<0.001$). Taken together, Experiments 1a and 1b show that regardless of one's native language, the cognitive system is better at detecting structural disruptions to atomic entities than to non-atomic entities.

Distinct Parts *Experiment 2a (Events)*: We segmented each original video from Experiment 1a into nine temporal segments, and used the fifth and the eighth segments (roughly, a middle and close-to-the-boundary segment). Participants (English N=24; Mandarin N=24) watched each segment and were asked to decide whether the two videos were identical or not. As expected, English-speaking participants were more likely to accurately identify the two segments as distinct for Bounded (M=71.4%) than for Unbounded events (M=66.5%) ($p<0.05$), as were Mandarin-speaking participants (Bounded M=57.5%, Unbounded M=53.1%, $p<0.05$).

Experiment 2b (Objects): Using the 16 original images used in Experiment 1b, we took two different segments from each image. One segment was cropped at the center, and another segment was cropped at the top right corner (again, a middle and close-to-the-boundary segment). Participants (English N=24; Mandarin N=24) saw each subpart and were asked to identify whether the two segments they saw were identical. As expected, English-speaking participants were more likely to accurately identify the two subparts as distinct for Objects (M=73.6%) than for Substances (M=54.4%) ($p<0.001$)), as were Mandarin-speaking participants (Objects M=78.6%, Substances M=57.1%, $p<0.001$). Again, Experiments 2a and 2b show that regardless of one's native language, the cognitive system is more likely to perceive two subparts of atomic entities as distinct from one another than subparts of non-atomic entities.

Discussion Together, these results throw light onto the nature of entity categories in the human mind: both English-speaking and Mandarin-speaking viewers process atomic and non-atomic entities differently, with only the former having a well-defined (temporal/spatial) structure with integrally-ordered, distinct parts. We propose that these key conceptual characteristics organize atomicity and can be used to individuate entities. These features of non-linguistic atomicity are potentially universal and are conceptualized in similar ways cross-linguistically. Furthermore, these conceptual features can be used to map entity concepts onto foundational semantics in natural language.

Table 1. Sample entity images (Exp.1b)

condition	original	structurally disrupted
object		
substance		

References [1] Bach 1986. *Ling&Phil.* [2] Jackendoff 1991. *Cognition.* [3] Taylor 1977*. Ling&Phil.* [4] Champollion 2015. *Theoretical Linguistics*. [5] Champollion 2017. OUP. [6] Filip 2012. OUP. [7] Wellwood et al. 2018. In *Oxford studies in experimental philosophy.* [8] Ji & Papafragou 2020. *Cognition*. [9] Prasada et al. 2002. *Cognition.* [10] Lin, 2004. *MIT.* [11] Sybesma, 1997. *Journal of East Asian Linguistics*. [12] Tai, 1984. *CLS.* [13] Chierchia, 1998. *Events and Grammar.*