Investigating the Planning of Manner, Path and Deixis in Mandarin Directional Serial Verb Constructions using EEG-MVPA

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How speakers transform an event into a structured utterance remains a central question in language production. Mandarin directional serial verb constructions (DSVCs) offer a useful test case because a single predicate for a motion action can encode several event components, typically including manner of motion, path, and deictic orientation. A motion event can be described with a three-morpheme sequence such as 跑_run+上_up+来_come or 走_walk+进_in+去_go, where the first element specifies manner, the second path, and the third direction of movement relative to the speaker's perspective. Analyses have argued that such constructions are internally structured rather than unanalyzable lexical compounds [1, 2], but it remains unclear whether these components are planned as separate units and, if so, whether their encoding follows the order in which they are spoken or the structure of the event being described.

The present study tested this using EEG-based time-resolved multivariate pattern analysis (MVPA) during Mandarin DSVC production. Participants (N=23) described visual motion-event prompts with a three-morpheme DSVC in a fixed manner-path-deixis order (Figure 1). The stimulus set factorially manipulated 4 manners (run, walk, jump and skate), 4 paths (in, out, up and down), and 2 deictic orientations (come vs. go), with 4 visual versions per condition (e.g. mirroring the images). We decoded manner, path, and deixis separately from picture onset using correctly produced trials, each against its chance level (0.25 for manner and path, 0.50 for deixis). Our main analysis was cross-version temporal decoding: classifiers were trained on three of the four visual versions and tested on the held-out version, so above-chance classification could not reflect the visual properties of any single image. Cross version temporal generalization analyses tested whether component patterns were transient or sustained, with significance assessed by cluster-based permutation.

Group results (N=23) show significant cross-version decoding for all three components, but with different temporal profiles. Deixis becomes decodable early (~150-200ms) and is sustained across the epoch, with temporal-generalization clusters spanning roughly 200–300ms off the diagonal, indicating a stable code for deictic orientation. Path shows an early, transient effect in the cross-version decoding (significant ~200-480ms, peak 391ms). In the cross-version temporal generalization matrix, however, the only significant cluster is a late, roughly square block near speech onset (train/test ≈ 1250–2000ms), with no significant early diagonal. Manner, the first-articulated component, rises above chance only later (from ~600ms, peaking at 1127ms near speech onset), with a broad late generalization cluster. Because training and testing used different visual versions, these effects cannot be attributed to the appearance of individual scenes.

Together, these results suggest a graded planning profile that does not follow the order of articulation. Manner, the first-articulated component, becomes decodable last, near speech onset, consistent with late, articulation-related encoding. Deixis, though articulated last, is decodable early and sustained until articulation. Path is decodable early but transiently, re-emerging as a sustained pattern only near speech onset. Both are available before their articulatory position, a profile consistent with structurally rather than linearly incremental planning. This interpretation remains tentative, but by applying EEG-MVPA to a controlled multi-component predicate rather than to single-word naming, this study extends production-decoding work [3, 4] to the formulation of complex Mandarin motion descriptions.

References

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Figures

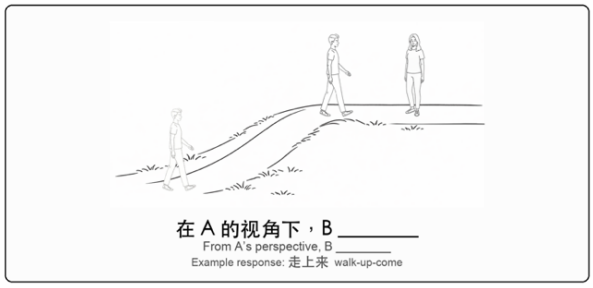

Figure 1 Picture-prompt display. Participants saw a visual motion event and completed the sentence context 在_from A 的_'s 视角下_perspective， B___ with a Mandarin DSVC response; the example response 走_walk+上_up+来_come.

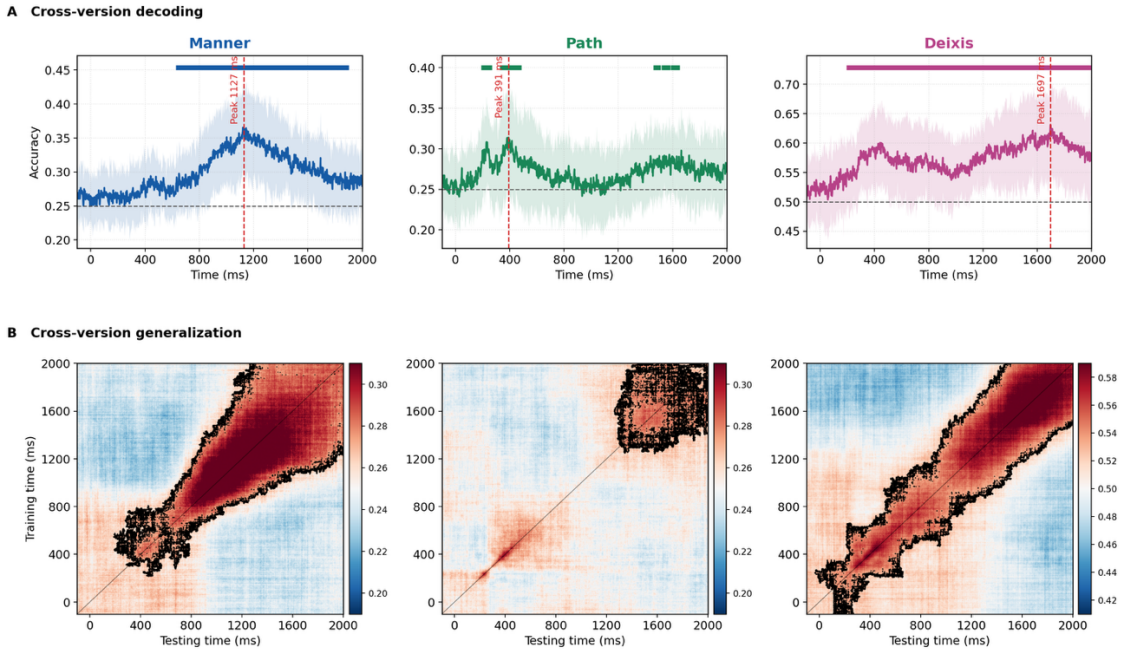

Figure 2 Group cross-version decoding and temporal generalization (N = 23). Columns show manner, path, and deixis. Panel A shows group cross-version decoding accuracy (classifiers trained on three of the four visual versions and tested on the held-out version); the dashed horizontal line marks chance (0.25 for manner and path, 0.50 for deixis), the thickened line segments mark significant above-chance clusters (cluster-based permutation), and the dashed vertical line marks the peak latency. Panel B shows the corresponding train-time × test-time cross-version generalization matrix, black contours indicate cluster-corrected significant regions.