Coreference and disjoint reference in the semantics of narrative dance
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Background: Recent years have seen a resurgence of interest in work that applies the methodology of formal linguistics (including formal semantics) to phenomena outside of natural language. Our research builds on recent approaches to music semantics (Schlenker 2016), dance syntax (Charnavel 2016), and Abusch’s (2013, 2014) studies of picture semantics. In an exploratory production study (using video and motion capture recordings), we investigate how coreference vs. disjoint reference can be encoded in the narrative dance form of bharatanatyam (Puri 1986, 2004; Ramesh 2013). This contributes to developing a foundation for addressing the question of whether dance has meaning that lends itself to an analysis by means of a formal semantics.

Motivation: Narrative dance such as bharatanatyam serves the purpose of explicitly encoding meaning by means of visual (i.e. pictorial) sequences, and can thus be likened to comics without text, as investigated in Abusch’s (2013, 2014) work. Abusch (2013) asks how coreference is established across panels of a ‘silent’ comic, such as Masahi Tanaka’s Gon: e.g., what is the cognitive mechanism by which the bobcat in Fig. 1 is identified across the two panels? The same question can be asked for narrative dance, which shares several properties with silent comics: [i.] it uses a visual medium, [ii.] it can be performed in silence, and [iii.] it serves to tell a story (i.e. it creates a visual narrative). While bharatanatyam has an elaborate inventory of conventionalized gestures (cf. Puri 1986), our aim is to investigate a phenomenon that goes beyond, say, a symbolic gesture for ‘moonlight’, ‘sword’, or ‘strong’.

Design: We carried out a pilot study in collaboration with a professional bharatanatyam dancer, who performed short narratives that we constructed, consisting of six minimal pairs. One sample item is given in (1); the context makes a crowd of people salient, which allows us to introduce new referents as part of the narrative. The coreference condition, (1a), involves a narrative about a single individual, whereas the disjoint reference condition, (1b), introduces a second individual. The dance sequences were recorded both on video and by means of 8 motion capture cameras; the motion capture recordings were post-processed and qualitatively analyzed by means of the Qualisys QTM software.

(1) Context: An artist has designed a statue for a temple. She is at the temple, watching how people interact with the statue; the room is full of people.
   a. The artist sees a strong man sitting on the ground. Then she sees that the same man is holding a spear. [coreference condition]
   b. The artist sees a strong man sitting on the ground. Then she sees that another man is holding a spear. [disjoint reference condition]

Results (Coreference): Figure 2 illustrates the 3D motion-capture rendering of the coreference condition; we observe that the dance sequence involves a fluid transition from the dancer’s [sitting-on-the-ground] position to the [holding-a-spear] position. This is expected, due to low-level processes of indexing in vision (Pylyshyn 2003), as discussed in Abusch (2013:18-19). It serves as a baseline, departing from which we now turn to the mechanisms that a dancer can utilize in order to encode disjoint reference.
Results (Disjoint reference) Figure 3 shows that disjoint reference can be encoded by means of three components. First, the dancer performs a hand-and-arm gesture that symbolizes ‘another’ (roughly: waving the hand from the left to the right; screenshot $P_{23}$); second, she marks a new location (screenshot $P_{24}$), which she then assumes (screenshot $P_{25}$), thereby changing her orientation and direction (see Charnavel 2016); third, she mirrors the original [holding-a-spear] dance position (screenshot $P_{26}$), raising her left instead of her right arm.

Fig. 3: rendering of the disjoint reference condition (1b)

...[sitting on the ground]. Then (she sees) that another man.................. is [holding a spear].

Analysis We build on Abusch (2013:12, 2014:10) in positing satisfaction conditions such as (2a-b) for the different dance positions $P_n$ (note that, since dance is continuous, discrete steps from $P_n$ to $P_{n+1}$ must be stipulated). Dance positions are mapped to propositions $[P_n]$, i.e. dance positions $P_n$ are interpreted by way of situations $\sigma_n$ that satisfy them. In line with Abusch (2013:13), the person in (2a-b) must be existentially quantified, as there is no semantic requirement for, say, $P_{11}$ and $P_{14}$ in Fig. 2 to contain the same person/agent.

(2) a. $\sigma_{21}$ satisfies $P_{21}$ only if in $\sigma_{21}$ a person is sitting.

b. $\sigma_{26}$ satisfies $P_{26}$ only if in $\sigma_{26}$ a person is holding a spear.

By contrast, the group boundary in Fig. 3 blocks the inference towards a larger situation $\sigma$, and thus contributes to the encoding of disjointness between the agents of the two activities. Moreover, the (iconic) location change in $P_{24}$-$P_{25}$ qualifies as a counterpart of linguistic phenomena such as loci and role shift in Sign Languages (e.g. Davidson 2015).

Conclusion We have shown that a formal semantic analysis of narrative dance is warranted in parallel to a formal semantic analysis of pictures as pioneered by Abusch (2013, 2014).