Similarity Demonstratives

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In Cognitive Science, similarity is regarded as a basic concept of human cognition explaining cognitive skills like perception, classification and learning (e.g. Tversky 1977). In view of its importance in cognition, it is no surprise that there are multiple ways to express similarity in natural languages, for example by adjectives and verbs, as in English *similar/resemble* and German *ähnlich/gleichen*, and by comparison constructions like equatives and similes. In this paper we will consider demonstratives expressing similarity, like German *so*, Polish *tak* and English *such*, which will be called *similarity demonstratives* in this paper. The focus will be on German *so*, which can occur in various positions modifying, e.g., adjectives and nouns. In (1a), for example, Anna's height is characterized as being similar to the height of the person the speaker points to, and in (1b) Anna's car is characterized as similar in certain respects to the car the speaker points to.

(1) a. (speaker pointing to a person): So groß ist Anna.
'Anna is this tall.'

b. (speaker pointing to a car in the street): So ein Auto hat Anna.
'Anna has a car like this.'

When comparing the demonstrative *so* to standard demonstratives like *dieser/this*, the question arises of what it refers to in (1a,b). Consider (1b): Does the demonstrative refer to a property of cars, or does it refer to the car the speaker points to? On the former view, the ontology is required to include degrees and properties, or kinds, that the speaker can point to. Carlson's interpretation of English *such*, for example, rests on the assumption that one can point to kinds (Carlson 1980). On the latter view, the question arises of how it is possible that the individual the speaker points to can serve as a modifier.

In this paper a sparse ontology including only individuals will be presupposed. Other entities, like degrees, will only occur as auxiliary units. We will start from Nunberg's (1993) adaptation of the Kaplanian analysis, interpreting demonstratives as directly referential expressions but at the same time dismissing the idea that the referent of the pointing gesture is necessarily identical to the interpretation of the demonstrative. This allows for a straightforward interpretation of the German demonstrative *so* such that the referent of the demonstration is the person the speaker points to, and it's relation to the referent of the *so*-phrase is similarity instead of identity. In (1b), for example, it will be assumed that the referent of the demonstration is the car the speaker points to, and its relation to the referent of the NP *so ein Auto* is similarity instead of identity.

The semantics of ad-nominal *so* is given in (2), where SIM is a three place relation combining the referent of the NP *x*, the target of the pointing gesture x_{target}, and a set of contextually relevant features of comparison *F*. Note that the demonstrative *so* is spelt out as a modifier of determiners thereby accounting for its pre-determiner position. Assuming movement, the demonstrative can also be analyzed as a nominal modifier – $\lambda P.\ \lambda x.\ sim(x, x_{target}, F)\ \&\ P(x)$ – yielding the same quantifier as in (2c) (due to associativity of intersection). This is good reason to consider the occurrence of the demonstrative in (1b) as ad-nominal, in spite of its pre-determiner position.

(2) a. [[so]] $= \lambda D.\ \lambda P.\ D(\lambda x.\ \textsc{sim}(x, x_{target}, F)\ \&\ P(x))$

b. [[so ein]] $= \lambda P.\ \lambda Q.\ \exists x.\ \textsc{sim}\ (x, x_{target}, F)\ \&\ P(x)\ \&\ Q(x)$

c. [[so ein Auto]] $= \lambda Q.\ \exists x.\ \textsc{sim}\ (x, x_{target}, F)\ \&\ car(x)\ \&\ Q(x)$

For this idea to gain substance a notion of similarity is required which is not a semantic primitive. It will be proposed to take advantage of the findings on similarity in Artificial Intelligence, implementing similarity by the help of multi-dimensional attribute spaces. These spaces are close to Gärdenfors' (2000) conceptual spaces but they provide a qualitative similarity measure instead of a geometrical one. Spelling out the notion of similarity by means of multi-dimensional spaces raises (i) the question of what the features of comparison are in the nominal case, and (ii) the question of how to integrate multi-dimensional spaces in standard semantics.

Ad (i), in the adjectival case there is a single feature of comparison, which is determined by the meaning of the adjective – in (1a) Anna is compared to the object the speaker points to with respect to height. In the nominal case the features of comparison must be inferred from the context. There are, however, constraints on which properties qualify as features of comparison imposed by the meaning of the noun. You can compare cars with respect to essential properties like *drive type*, *horsepower*, *number of doors* etc. But you can hardly compare cars with respect to accidental properties like having a toll sticker from Slovenia on its windshield.[1] Features of comparison in the nominal case appear to be restricted to essential properties (or k-properties in terms of Prasada & Dillingham 2006) of the concept corresponding to the noun meaning.

Ad (ii), combination of multi-dimensional spaces with standard semantics will be done by means of *generalized measure functions* adapting the idea of adjectival measure functions (cf. Kennedy 1999) to the nominal case. While adjectives are one-dimensional, nouns are multi-dimensional.[2] Moreover, while adjectival dimensions relate to ratio scales (at least those of dimensional adjectives like *tall* and *heavy*), nominal dimensions relate to scales of various types – ratio, ordinal, or even nominal. Thus, while adjectival measure functions map individuals to degrees on a single dimension, cf. (3a), generalized measure functions map individuals to points or regions in multi-dimensional spaces, cf. (3b).

(3) a. μ_{height}: $U \rightarrow \Re$
b. μ_{car}: $U \rightarrow \langle \text{drive-type}, hp, \ldots \rangle$, where drive-type$\in\{\text{diesel}, \text{gas}, \ldots\}$, hp$\in\Re^{+}$, …

Combining standard semantics with multi-dimensional spaces will allow for a non-primitive notion of similarity to be defined on these spaces, or rather, a number of similarity notions of different type. The type of similarity expressed by, e.g., German *so* and English *such* will be shown to be close to identity – we will use the *indiscernability* notion of similarity from rough set theory (Pawlak 1998). Other expressions of similarity, e.g. English *resemble* / German *ähnlich* are less strict and may be accounted for by the notion of similarity specified by Tversky's contrast model.

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[1] Prasada and Dillingham (2006) present an experimental study showing that humans represent principled connections between concepts that correspond to nouns and some, but not all, of its properties.

[2] Sassoon (2011) argues that adjectives may have more than one dimension, too, which are, however, are integrated by logical operations, e.g., conjunction, while nominal dimensions are integrated through similarity. Integration by conjunction yields a list of successive comparison operations instead of one single comparison. From this point of view, her distinction between adjectives and nouns is close to the one proposed here.