Boolean *and* and Non-Boolean *and*: Resolving Vagueness of Plural Predication

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Plural sentences with conjunctive predicates often receive a 'non-boolean' interpretation. E.g. *the men are swimming and crawling* is interpreted as true when only some of the men are swimming, and the rest of them are crawling (Krifka 1990). However, whether this kind of interpretation indicates a general non-boolean *reading* of conjunction remains unclear, since as often as not, the interpretation of such a sentence is strictly 'boolean' (cf. *the men are swimming and smiling*). A challenge for the semantics of plurals is to account for these different interpretations, in which properties are distributed differently over individual men. Winter (2001) proposes to extend the Strongest Meaning Hypothesis of Dalrymple et al. (1998). According to Winter's proposal, a plural sentence with predicate conjunction receives a strong, boolean interpretation unless this contradicts properties of the complex predicate, which results in a weaker interpretation. We challenge this prediction by showing experimentally that for a large set of sentences, there is a continuum of acceptability values for non-boolean interpretations. We account for this continuum with a principle that predicts how language users apply predicates to plural subjects, resolving vagueness systematically. For any given pair of predicates, our principle predicts the divergence from a boolean interpretation based on the *typicality* structure of the complex predicate: the less typical the complex predicate is considered to be in a boolean interpretation, the weaker the interpretation of the sentence becomes. A similar principle has been shown to account for the varying interpretations of plural sentences with reciprocal expressions (Kerem et al. 2009). These results combined imply sensitivity to the conceptual structure of predicates as a basic mechanism of resolving the vagueness of distributive quantification with plural predication.

Background According to the well-known boolean analysis of conjunction, it behaves as set theoretical intersection (Keenan and Faltz 1985; Partee and Rooth 1983). This analysis, combined with a distributivity operator (Link 1983), expects a plural sentence like (1) to be true iff every man is in the intersection of the set of walking individuals and the set of singing individuals. However, sentence (2), despite being structurally similar to (1), receives a non-boolean ('split') interpretation: one predicate applies only to a subset of the men, and the other predicate applies to the remaining men.

    (1) The men are walking and singing   (2) The men are walking and swimming

Many works have described the interpretations of such (and other) plural sentences (e.g. Krifka 1990; Link 1984; Heycock & Zamparelli 2005; Winter 2001). Winter (2001) tries to account for the different interpretations systematically and recognizes a similarity between reciprocity and predicate conjunction. He hypothesizes that weakening effects of the Strongest Meaning Hypothesis (SMH) are not specific to reciprocal constructions, but instead are a general property of plural sentences. He reasons that when the interpretation of a plural predicate leads to universal quantification over singularities, weakening of the initial meaning of such a complex predicate can take place. This weakening takes place only when the complex predicate clashes with a boolean interpretation, i.e. both predicates cannot apply to each singular entity in the plural subject, as is the case for *walking* and *swimming* in (2).

Problem We show that Winter's extended SMH fails to capture the interpretation pattern of plural sentences with predicate conjunction. His reasoning, that non-boolean interpretations are only available when the boolean interpretation is ruled out by known properties of the conjoined predicates, is too strong. In fact, non-boolean interpretations are readily available to many speakers for sentences like (3) and (4), in which the predicates do not strictly exclude a boolean interpretation.

    (3) The men are sitting and cooking   (4) The men are walking and writing

We avoid this problem by first showing experimentally that acceptability of non-boolean readings can be expressed in terms of a continuum, with respect to how strongly a speaker

would tend to resolve the vagueness of plurality by appealing to the 'non-boolean' strategy. This is unexplained by the SMH.

Proposal We claim that the interpretation pattern can be explained using a principle called the Maximal Typicality Hypothesis (MTH), which assumes a systematic relationship between typicality preferences of predicates and interpretation of sentences (Kerem et al. 2009). The MTH was originally formulated to account for the varying interpretations of plural sentences with reciprocals, but we propose to extend it to plural sentences with predicate conjunction. In its extended form, it then takes into account the continuous typicality of boolean predicate conjunction, as triggered by the conceptual structure of the two conjoined predicates. More precisely, we propose the following solution: the interpretation of any plural sentence with predicate conjunction depends on typicality in such a way that the less typical it is for both predicates to apply to each individual in the plural subject, the more a weaker interpretation is available. Thus, we predict a) that there exist different typicality effects given different pairs of predicates and b) that each typicality value predicts the acceptability value of a (non-) boolean reading. Both predictions are borne out experimentally.

Experiments Two experiments were conducted on 33 native speakers of Dutch: a typicality experiment measuring typicality effects for verb pairs in isolation, and an interpretation experiment measuring the interpretation of plural predicate conjunction sentences with those verb pairs. Based on a pretest, we selected 12 verb pairs that were considered compatible (e.g. *sitting and reading*), 12 that were considered incompatible (e.g. *sitting and standing*) and 12 that were rated in between (e.g. *sitting and cooking*) – in order to get a wide range of typicality values.

Experiment 1 checked **typicality effects** for the 36 verb pairs. Subjects were presented with statements about one person involved in two actions, and were asked to rate (on a 6 point scale) how odd it is for the person to be doing those two things simultaneously. We found that mean ratings per verb pair ranged from 1,03 to 5,94. The three groups all differed significantly from each other, with presumed compatible pairs rated lowest (the least odd) and presumed incompatible pairs rated highest (the most odd).

Experiment 2 checked the **interpretation** of plural predicate conjunction sentences containing the same 36 verb pairs in a truth-value judgment task. Each test item consisted of a plural predicate conjunction sentence (e.g. *The men are sitting and standing*) and a drawing depicting four individuals in a non-boolean interpretation of that sentence: one predicate applied only to persons 1 and 2; the other predicate applied only to persons 3 and 4. Filler items (50%) differed in drawing type or sentence type. Subjects were asked to judge whether the sentence is true or false for the given picture. Mean judgments per test item ranged from 24% to 100% true. Again, all three groups differed significantly from each other, with compatible pairs leading to lowest acceptability of the non-boolean interpretation, and incompatible pairs to highest acceptability.

The main test for the MTH is the relationship between the typicality and interpretation measures, for all 36 verb pairs taken together. We found a highly significant **correlation** between typicality rating (exp1) and proportion acceptability of a plural predicate conjunction sentence for the non-boolean interpretation (exp2): the less typical it is to do two things at the same time, the more subjects accept a non-boolean interpretation ($r = .66$, n $= 36$, *p* $< .001$).

Conclusion Results reveal that the availability of non-boolean interpretations of plural sentences with predicate conjunction can be expressed in terms of a continuum, which is unexpected under the SMH. Crucially, we explain this continuum very accurately by extending the MTH, which states that interpretation is systematically affected by typicality – thus neatly specifying the relevant pragmatic considerations. This brings us closer to a general mechanism of vagueness resolution with plural predication.

Selected references Kerem, N. et al. (2009). Typicality Effects and the Logic of Reciprocity. *Proc. of SALT 19*. Krifka, M. (1990). Boolean and non-boolean 'and'. *Papers from the Second Symposium of Logic and Language*. Winter, Y. (2001). Plural Predication and the Strongest Meaning Hypothesis. *Journal of Semantics*.