Alternate Categorization: a Formal-Conceptual Semantics of Reciprocal Alternations *

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1 Introduction

The reciprocal alternation is a cross-linguistically common pattern of variation between verbal forms and their meanings [5]. It involves collective predicates (1a) and/or 'with' forms (1b) that alternate with binary predicates: transitive verbs (1c) and verbs with prepositional complements (1d).

(1) a. Sue and Dan fought/talked.
b. Sue fought/talked with Dan.
c. Sue fought Dan.
d. Sue talked to Dan.

While the semantics of alternations as in (1) has been extensively discussed in the literature, there is currently no general account of the intricate semantic relations between these forms. The goal of this paper is twofold: to present a formal model of these semantic relations, and to examine enough data that allow us to evaluate it. In an earlier work (Kruitwagen et al. [4]), we presented a prototype model of collective sentences like (1a). Here we extend this model into a general semantic threshold-based model. In this model, a verbal root has a *conceptual core* specifying the attributes that underly meanings of different verbal forms, although the weights of those attributes vary between alternations. The model is tested against old data, and new data from five different verbs showing the 'with' alternation (1b) and other binary forms (1c-d). The results show strong support for our proposed model, which unlike previous alternatives, accounts for (the lack of) entailments between alternates as in (1) without compromising the formal semantic coherence of the theory. The result is a semantic theory that is flexible enough, although restricted within boundaries of the root's conceptual core.

2 The theoretical proposal

In many previous works (see [1, 8], among others) it is proposed that eventive reciprocal sentences (1a) are logically related to their 'with' alternates (1b). Both kinds of sentences are assumed to involve full symmetry between the participants of the event. When there are only two participants, this approach entails that collective sentences (1a) are equivalent to their 'with' alternates (1b), as well as to a conjunction of binary predications like *Sue fought Dan and Dan fought Sue* describing one symmetric event. Rákosi [6] challenges the first equivalence, arguing that 'with' sentences like *A fought with B* require a lesser extent of agency from B

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than from A. On the basis of Hungarian data about such sentences, Rákosi postulates a new thematic label ('partner') for 'with' arguments. However, the semantic properties of this role and its differences from classic 'agent' and 'patient' remain unanalyzed.

Our proposal relies on the common assumption that the abstract morphology and semantics of a verbal root feed the verb's different forms [7]. Semantically, we propose that each root r denotes a complex *conceptual core* (CC). The CC is an aggregate of primitive features that make up the root's general meaning. Of these features we focus on *activity* (A_r) and *intentionality* (I_r) of the root's meaning. For instance, for the root *fight* (f) we have A_f='physically oppose' and I_f='be hostile to'. These features are treated as functions from events and pairs of entities to the real interval $[0, 1]$. The A_f and I_f levels that an entity x reaches towards an entity y in an event e determine the typicality of that event as an instance where x fights y. That typicality makes the sentence true if it exceeds a pragmatic *threshold* [3]. Formally, a binary form (e.g. transitive *fight, talk to*) of a root r denotes the 3-place predicate, which is defined in terms of the CC features and the threshold as follows:

$$\mathbf{B}_r(x, y, e) \;\Leftrightarrow\; [A_r(x, y, e) + I_r(x, y, e)]/2 > thr$$

In words: a speaker categorizes an event e as an instance of a binary form with arguments x and y if the average level of activity and intentionality from x towards y in e exceeds the threshold *thr*. Our critical assumption is about the way binary ($\mathbf{B}_r$) predicates (1c/d), collective ($\mathbf{C}_r$) predicates (1a), and 'with' ($\mathbf{W}_r$) predicates (1b) differ while manifesting the CC of one and the same root. We propose:

$$\mathbf{C}_r(x + y, e) \;\Leftrightarrow\; [A_r(x, y, e) + I_r(x, y, e) + A_r(y, x, e) + I_r(y, x, e)]/4 > thr$$

Here the typicality of e as an instance of the collective form $\mathbf{C}_r$ is the average level of activity and intentionality in e from x towards y and from y towards x. Thus, the collective form differs from the binary form since both directions of A and I (from x to y and from y to x) are equally weighed. It also contrasts with our proposed typicality of the 'with' form $\mathbf{W}_r$, where the subject's activity and intentionality weigh more heavily than the 'with'-complement. However, unlike other objects, the 'with'-complement's activity and intentionality are assumed to have a non-zero weight c. Formally:

$$\mathbf{W}_r(x, y, e) \;\Leftrightarrow$$
$$(1-c) \cdot [A_r(x, y, e) + I_r(x, y, e)]/2 + c \cdot [A_r(y, x, e) + I_r(y, x, e)]/2 > thr,$$
$$\text{where } 0 < c < 0.5$$

Note that substituting $c = 0$ in this definition of the 'with' predicate gives the definition of the binary meaning $\mathbf{B}_r(x, y, e)$ above, whereas $c = 0.5$ yields the definition of the collective meaning $\mathbf{C}_r(x + y, e)$. Thus, these two meanings are viewed as limiting cases of the 'with' predicate meaning.

In the three different verbal forms we consider, our proposal lets the activity (A) and intentionality (I) features have different weights in relation to the entities x and y. However, we assume that the same conceptual root r defines the A and I attributes, and that the same threshold *thr* is relevant for categorizing events using the three forms. This predicts some standardly assumed entailments between sentences like (1a-d), but also some non-entailments, as stated and illustrated below:

E1. If the binary form symmetrically holds between x and y in some event e, that entails the 'with' form in both its directions. For example:

A fights B and B fights A (in e)

$\Rightarrow$ *A fights with B and B fights with A* (in e)

E2. If the 'with' form symmetrically holds between x and y in some event e, that entails the collective form in both its directions:

A fights with B and B fights with A (in e)

$\Rightarrow$ *A and B fight, and B and A fight* (in e)

NE1. For neither the collective form nor the 'with' form is it necessary that the binary form symmetrically holds between x and y:

A and B fight or A fights with B $\not\Rightarrow$ *A fights B and B fights A*

More generally, from our proposal it can be concluded that neither the collective nor the 'with' form entails that the binary form holds in any of its two directions:

(i) *A and B fight* $\not\Rightarrow$ *A fights B* (ii) *A and B fight* $\not\Rightarrow$ *B fights A*

(iii) *A fights with B* $\not\Rightarrow$ *A fights B* (iv) *A fights with B* $\not\Rightarrow$ *B fights A*

NE2. The collective form does not entail the 'with' form:

A and B fight $\not\Rightarrow$ *A fights with B*

NE3. The 'with' form does not entail the collective form:

A fights with B $\not\Rightarrow$ *A and B fight*

NE4. The 'with' form is not symmetric:

A fights with B $\not\Rightarrow$ *B fights with A*

NE5. The binary form does not entail the 'with' form:

A fights B $\not\Rightarrow$ *A fights with B*

The proofs of these (non-)entailments follow from our definitions of the $\mathbf{B}_r$, $\mathbf{C}_r$ and $\mathbf{W}_r$ predicates by simple numeric considerations.

Entailments *E1* and *E2* are consensual but express regularities that cannot be accounted for by merely giving an unanalysed theta role to the 'with' complement as in Rákosi's proposal [6]. The non-entailments *NE1-NE5* go against most previous proposals about lexical reciprocity. To examine these predictions, we collect more data on collective, binary and 'with' predicates using the same methods of [4].

3 The experimental work

3.1 Materials and procedure

Five Dutch verbs were examined: *vechten* 'fight', *knuffelen* 'hug', *praten* 'talk', *botsen* 'collide', and *appen* 'send WhatsApp'. All verbs have a *met* ('with') alternation and another binary alternation: transitive (e.g. *knuffelen*) or prepositional (e.g. *botsen tegen* 'collide against'). Kruitwagen et al. [4] report initial experiments with these verbs and video materials describing different asymmetric events. To evaluate the current, more general proposal, our experiments use the same video materials with a wider range of constructions, including the 'with' forms and more ordering variations between the arguments. Two videos clips were used per verb, featuring two human actors: 'Violet' and 'Mark'. In both clips Mark is passive while Violet is active and shows the expected intention. For example, in the video clips corresponding to

sentences with the verb *vechten* 'fight', Violet hits Mark angrily. In one of the two clips, which we refer to as 'Intentional Mark' (*M+I*), Mark shows the expected intention (e.g. anger). In the other clip, *M-I*, Mark looks indifferent. To the collective and binary sentences that were examined in [4] we added the other direction of the binary sentence and the two directions of the 'with' sentence (1b). This results in a total of three data points per verb and clip on top of the two examined by [4]. Thus, for each verb root we collected data in a 2×5 between-subject design with independent variables Intention of the passive figure 'Mark' (*M+I* or *M-I*), and Sentence Type of five different values:

V&M	collective form, active first	*Violet en Mark knuffelen* ('hug')
VbM	binary form, active subject	*Violet knuffelt* ('hugs') *Mark*
MbV	binary form, passive subject	*Mark knuffelt* ('hugs') *Violet*
VwM	'with' form, active subject	*Violet knuffelt met* ('hugs with') *Mark*
MwV	'with' form, passive subject	*Mark knuffelt met* ('hugs with') *Violet*

Each of 477 participants (286 female, age M=26) received a LimeSurvey questionnaire with four target items and six filler items, and made a truth-value judgement on those ten items based on the video clips.

		V&M		VbM		MbV		VwM		MwV	
		%	of	%	of	%	of	%	of	%	of
vechten	**M+I**	40%	53	77%	35	32%	57	62%	42	36%	39
('fight')	**M-I**	19%	58	55%	33	4%	49	39%	41	5%	40
knuffelen	**M+I**	84%	57	97%	32	40%	53	84%	45	61%	44
('hug')	**M-I**	51%	49	100%	33	9%	58	67%	43	37%	41
praten	**M+I**	35%	34	100%	32	0%	35	42%	43	16%	45
('talk')	**M-I**	16%	38	94%	33	0%	33	36%	44	0%	41
botsen	**M+I**	69%	59	100%	35	4%	53	94%	32	34%	32
('collide')	**M-I**	70%	53	91%	34	4%	53	82%	33	33%	33
appen	**M+I**	57%	35	100%	34	3%	33	74%	39	27%	41
('WhatsApp')	**M-I**	30%	33	100%	32	9%	34	24%	42	10%	40
TOTAL		**47%**	**469**	**91%**	**333**	**11%**	**458**	**60%**	**404**	**26%**	**396**

Figure 1: **Results** – *positive answers per clip and sentence form are reported as percentages ('%') of the total numbers of participants who responded to each truth-value judgement ('of').*

3.2 Results and Analysis

For each clip and sentence type per verb, Figure 1 reports the percentages of total number of participants who judged the sentence as true. Unsurprisingly, these results are consistent with the intuitive entailments *E1* and *E2*. More importantly, as can be seen in Figure 2, with 9 of the 10 scenarios (5 of 5 verbs), significantly more participants ($p < 0.05$, Fisher exact test 2-tailed) answered positively on the collective *V&M* sentences than on the binary *MbV* sentences (column (i)). Similar results appeared for the 'with' *MwV* sentences against the binary *MbV* sentences (6/10 scenarios, 4/5 verbs, column (ii)), and against the binary *VbM* sentences (10/10 scenarios, 5/5 verbs, column (iii)). This supports *NE1*. In a similar fashion, the results show support for *NE2* (6/10 scenarios, 4/5 verbs, column (iv)), *NE3* (4/10 scenarios, 3/5 verbs, column (v)), *NE4* (9/10 scenarios, 5/5 verbs, column (vi)), and *NE5* (5/10 scenarios,

		(i) V&M vs MbV	(ii) MwV vs MbV	(iii) MwV vs VbM	(iv) V&M vs MwV	(v) V&M vs VwM	(vi) VwM vs MwV	(vii) VwM vs VbM
vechten	**M+I**	p=0.428	p=0.666	**p<0.001**	p=0.829	**p=0.040**	**p=0.026**	p=0.217
('fight')	**M-I**	**p=0.034**	p=1	**p<0.001**	p=0.068	**p=0.039**	**p<0.001**	p=0.242
knuffelen	**M+I**	**p<0.001**	**p=0.042**	**p<0.001**	**p=0.012**	p=1	**p=0.018**	p=0.129
('hug')	**M-I**	**p<0.001**	**p<0.001**	**p<0.001**	p=0.204	p=0.139	**p=0.008**	**p<0.001**
praten	**M+I**	**p<0.001**	**p=0.016**	**p<0.001**	p=0.062	p=0.641	**p=0.009**	**p<0.001**
('talk')	**M-I**	**p=0.027**	p=1	**p<0.001**	**p=0.009**	**p=0.047**	**p<0.001**	**p<0.001**
botsen	**M+I**	**p<0.001**	**p<0.001**	**p<0.001**	**p=0.0018**	**p=0.008**	**p<0.001**	p=0.224
('collide')	**M-I**	**p<0.001**	**p<0.001**	**p<0.001**	**p=0.0016**	p=0.310	**p<0.001**	p=0.305
appen	**M+I**	**p<0.001**	**p=0.009**	**p<0.001**	**p=0.010**	p=0.144	**p<0.001**	**p=0.0012**
('WhatsApp')	**M-I**	**p=0.033**	p=1	**p<0.001**	**p=0.038**	p=0.603	p=0.142	**p<0.001**
TOTAL		**p < 0.00000001**	**p < 0.00001**	**p < 0.00001**	**p < 0.00001**	**p = 0.0001**	**p < 0.00001**	**p < 0.00001**

NE1 NE2 NE3 NE4 NE5

Figure 2: **Fisher exact tests (two-tailed)** – *the comparisons between responses on the five sentence forms evaluate the evidence for non-entailments* NE1-NE5.

3/5 verbs, column (vii)). The totals in Figure 2 show the same kind of support, and the trends in the tests of *NE1-NE5* are in the same direction for all verbs and scenarios.

3.3 Discussion

All the effects discovered support *NE1-NE5* and are consistent with *E1-E2*. We propose that this results from differences in argument structure as constrained by our model. Binary entries (e.g. transitive *knuffelen* 'hug') require higher levels of activity and intentionality of the singular agent compared to 'with' forms, which in turn require more agent activity and intentionality than what is required from each of the two agents in a conjunctive *A and B* subject of a collective intransitive form.

3.4 Followup

The non-entailments *NE1*(i-ii) involve a conjunctive subject (e.g. *Violet and Mark* VERB) with a collective verbal form, as well as a 'with' form with the opposite order (*Mark* VERB *with Violet*). This change in ordering might in principle provide an alternative account of *NE1*(i-ii): linear word order might have a general effect on agency requirements, both for two conjoined NPs and for two NPs with different grammatical functions. To examine this possible account we ran a similar procedure on Prolific comparing truth-value judgements on sentences of the forms *Violet and Mark*/*Mark and Violet vechten* ('fight'). With 32-40 (M=35) participants per condition, we did not discover any significant effect according to the Fisher Exact test, with maximal odd-ratio effect sizes for *vechten* 'fight' *M-I* (p=0.094, *o.r.*=2.92) and *knuffelen* 'hug' *M+I* (p=0.613, *o.r.*=3.1). Thus, we found no evidence that linear order alone explains the results regarding *NE1*(i-ii), though it might play a small role.

4 Conclusions

Our threshold model of reciprocal alternations provides a more nuanced analysis of theta-roles than what mere labels like 'agent', 'patient' or 'partner' describe. In this sense our proposal substantiates Dowty's [2] proto-role assumptions. Unlike previous proposals, our analysis is

supported by extensive experimental evidence. Future work may be able to extend this picture further by testing the separation between Activity and Intentionality and their linear contribution, e.g. by comparing our model to (possibly non-linear) typicality equations with other conceptual parameters.

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