

The morphosemantics of *-ed*

Background: It is often assumed that *-ed* morphology applies to verbal predicates to yield adjectives denoting what Kratzer (2000) called result and target states, i.e. states that hold of an individual as a result of the culmination of a preceding event. For instance, in (1), the relevant portion of the road undergoes a change of state over time as a result of the work of the highway crew.

(1) After the work of the highway crew, highway 101 had a **widened** portion at exit 24.

However, it has been known at least since Nedjalkov (1988) that *-ed* adjectives may be used even in contexts where no preceding causing event is implied. For example, (2) does not entail that the relevant portion of the freeway has ever changed in width.

(2) The 101 freeway was constructed with a **widened** portion between San Jose and San Francisco. Based on such facts, Koontz-Garboden (2010) argues that the semantics of *-ed* forms calls for a generalization of the notion of change in an individual beyond the standard temporal one, to include change over a spatial interval (Gawron 2009). In (2), the freeway can be understood as having changed in width at the region named by the *between*-phrase.

Problem: Koontz-Garboden’s generalized change analysis still does not capture the full range of data involving *-ed* forms and the verbs they are derived from. First, as (3) shows, change of state verbs need not entail change in any individual over either space or time. (All examples are attested.)

- (3) a. The strobiformis cones in Mexico gradually **lengthen** as you go south along the Sierra Madre Occidental through Sonora, Chihuahua and Durango, the longest cones being in Durango.
 b. [In children with fetal alcohol syndrome] the divot or groove between the nose and upper lip **flattens** with increased prenatal alcohol exposure.

(3-a) describes a situation in which the average length of cones gradually increases as a function of geographic location ordered from North to South. (3-b) describes a situation in which the shortness of the thumb of an individual x depends on the severity of the condition found in x . Correspondingly, (4) shows that adjectives derived in *-ed* also need not imply change in any individual over either temporal or spatial intervals. (4), for instance, conveys the existence of a *difference* in the degree of shortness of the described thumb and the “normal” or standard thumb.

(4) Fetal alcohol syndrome causes facial abnormalities, including **flattened** cheekbones ... and a **flattened** groove between the upper lip and nose.

The challenge is to derive the full range of interpretations available to *-ed* forms from a single underlying meaning, derived compositionally from the meaning of the input to the *-ed* morphemes – change of state (COS) verbs – and the meaning of the *-ed* morpheme. We provide an analysis of both.

Analysis

COS verbs: We propose that the relevant notion of change involved in the meaning of COS verbs should be modeled as a relation between what we call a *generalized individual concept* (GIC) and an ordered domain. GICs are functions of type (τ, e) , where τ is any simple type. A verb like *shorten* (intransitive) denotes a relation between a GIC and an ordered domain as defined in (5), where f is a variable over GIC, O a poset, **short** a measure function mapping entities to their degree of shortness, and \leq is the ordering relation on O . Intuitively, a function and a poset are in the denotation of *shorten* if it is possible to find a point in the order such that the value of the GIC at that point is shorter than its value at a point lower in the order.

$$(5) \quad \llbracket \text{shorten} \rrbracket = \lambda f_{(\tau,e)} \lambda O_{(\tau,t)}. \exists o \in O [\exists o' \leq o : \mathbf{short}(f(o)) > \mathbf{short}(f(o'))]$$

Standard change of state cases are ones where the subject of the verb is individual denoting and the ordered domain O , a temporal interval. Since the first argument of *shorten* is a GIC, any e -type expression it combines with is shifted into a GIC meaning. An example of this is (6). Here, Pinocchio’s nose is shifted to the GIC in (6-a), a function from indices to stages of Pinocchio’s nose. Resolving the value of O to a temporal interval I , the resulting proposition is (6-b), which says that Pinocchio’s nose at some moment of I is shorter than it was at a preceding moment of I (a shortening event has occurred).

(6) Pinocchio’s nose shortened.

- a. $\lambda i. \text{Pinocchio's-nose}(i)$
 b. $\exists o \in O [\exists o' \leq o : \mathbf{short}(\text{Pinocchio's-nose}(o)) > \mathbf{short}(\text{Pinocchio's-nose}(o'))]$

In cases of spatial change such as (2), the subject NP more transparently denotes a GIC, in (2) the function from spatial intervals to parts of the road. Cases like (3-a) fall out immediately on this analysis, and differ from the standard case only in that the GIC denotes a **kind-individual**, yielding distinct instances of the kind at each spatial location, rather than different spatial parts of a single individual. This is shown in (7). (7-a) gives the type-shifted meaning of the NP *The strobiformis cones in Mexico*, a function assigning to every location the cones in that location, essentially its meaning as a kind-individual. The O parameter, specified by the modifier, is determined to be some subset of the set of locations defined by the Sierra Madre Occidental, ordered from north to south. Let O_{smo} stand for this set. The proposition expressed by (3-a) is in (7-b) (assuming measure functions for kind-individuals, which are defined in the paper).

- (7) a. $\llbracket \text{The strobiformis cones in Mexico} \rrbracket = \lambda l. \iota x : \text{cone}(x)(l)$
 b. $\exists o \in O_{smo} [\exists o' \leq o : \mathbf{long}(\iota x : \text{cone}(x)(o)) > \mathbf{long}(\iota x : \text{cone}(x)(o'))]$

In (3-b), the subject NP is shifted to the GIC in (8). The O parameter is taken to be some subset of the set of babies partially ordered by the severity of the fetal alcohol syndrome condition exhibited by them. Let O_{fas} stand for this set. The proposition expressed by (3-b) is in (8-b).

- (8) a. $\lambda x. x$'s divot
 b. $\exists o \in O_{fas} [\exists o' \leq o : \mathbf{flat}(o$'s divot) > $\mathbf{flat}(o'$'s divot)]

Derived –ed forms: Our analysis of –ed forms starts with the observation that –ed derives adjectives not only out of verbs, but also out of nouns, as shown in (9). In the denominal derivations like (9), –ed contributes an underspecified relation associated with possession.

- (9) a. A **bearded** man (a man who *has* a beard)
 b. A **flowered** dress (a dress that *has* flowers printed on it)

This morphological syncretism is not an idiosyncratic fact about English, but reflects a cross-linguistic pattern; the full paper shows that morphological equivalents of –ed in Hebrew and Salish (Burton and Davis 1996) also derive adjectives from both nouns and verbs, with the same semantic effects. We propose that –ed has a highly underspecified semantic contribution, relating the denotation of its input to an individual through a binary relation R . Let V be a variable over expressions of any type that matches the family of types we assigned to COS verbs. The meanings of verbal and nominal –ed are then in (10).

- (10) a. Nominal –ed: $\lambda P_{(et)} \lambda x. R(x, P)$
 b. Verbal –ed: $\lambda V_{((\tau,e)((\tau,t)t))} \lambda x. R(x, V)$

The conditions under which an individual bears R to the denotation of a nominal are given in (11) as meaning postulates in the metalanguage.

- (11) Nominal –ed: If $P \in D_{(et)}$ and $a \in D_e$, $R(a, P) = 1$ iff $\exists y [P(y) \ \& \ R(a, y)]$

We assume that the resolution of R is similar to the resolution of possessive relations, and that the latter is partly conventionalized and partly contextual. In the nominal cases, the relation can vary significantly. E.g., a *flowered garden* is a garden containing flowering plants, while a *flowered dress* is a dress with images of flowers reproduced on it.

In the more abstract verbal case, individuals are related to pairs consisting of a GIC and an ordered domain, such that the values determined by the GIC show a directed change in values (determined by the input verb) over the domain. As defined in (12), an individual can be naturally said to bear R to such a pair when that individual verifies the change, i.e. when the individual (or a temporal stage/spatial part thereof) is the value of the GIC at a point o in the order that shows a change from its preceding points.

- (12) a. If $V \in D_{((\tau,e)((\tau,t)t))}$ for some τ , and $a \in D_e$, $R(a, V) = 1$ iff there is a pair $\langle f_{\tau,e}, O_{\tau,t} \rangle$ such that a verifies $V(f)(O)$
 b. a verifies $V(f)(O)$ iff $\exists o \in O : f(o) = a$ and $\exists o' \leq o : \delta(a) > \delta(f(o'))$, where δ is the measure function specified by V .

Since verifying a change requires identifying an element that shows a difference in value relative to a lower-ranked element, one indispensable part of a change is this higher-ranked element showing the difference. In this way, the argument of a deverbal –ed adjective can be said to stand in a part-whole relation to the change described by the source verb. The use of R to instantiate the part/whole relation is found in other uncontroversial cases of possession, e.g., nominal possession, as expected if the lexical semantic core of –ed is the possessive relation, as we claim.