Cascades.
Goldman's level-generation, multilevel categorization of action, and multilevel verb semantics

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Abstract. The paper proposes a novel theory of the categorization of acts and applies it to the semantics of action verbs, with fundamental consequences for semantic theory and beyond. The theory is based on Goldman's (1970) multilevel theory of action which is not taken in its original ontological construal, but as a theory of categorization. Goldman's original approach is based on the notion of *level-generation*: acts of a type may under circumstances generate acts of other, more abstract types. For example, the act of flipping a switch may generate the act of turning on the light, this in turn, the act of waking up the baby, and so on. All acts generated are done in one doing, categorized at multiple levels. The acts form a hierarchical structure that Goldman calls an *act-tree*. Level-generation results in a conceptual relation called *c-constitution* here, i.e. constitution under the given circumstances; we also introduce the more general term *cascade* for act-trees. Multilevel cascade-structure categorization is then conflated with a cognitive semantics that assumes that the representation of linguistic meanings has the structure of frames in the sense of Barsalou (1992). Austin's speech-act theory and a multilevel analysis of the concept of writing are discussed in order to illustrate the potential of a cascade approach to verb semantics. The multilevel decomposition account of action verb meanings has far-reaching consequences for the theory of composition. It predicts that the combination of verbs with argument terms and modifiers is sensitive to the distinction of levels within the cascade. It also requires a non-deterministic notion of composition since the level to be selected is often not grammatically and semantically specified. As for the concept of c-constitution, it is shown that it involves not only a relation between the single-level act events themselves, but also homomorphic relations between the roles of the agent and other participants across cascade levels. C-constitution is thus a multi-track relation between the single-level act-types, giving rise to a hyperframe structure. The generalization of c-constitution as to include roles of persons and objects suggests that multilevel categorization in terms of circumstantial constitution may be a very general phenomenon in the psychology of categorization.

KEYWORDS
Level-generation; c-constitution; cascades; multilevel categorization; frames; decomposition; action verbs; criterion predicates; composition; ontology

1 Introduction

The reader be warned: most of the following is novel. We will propose a theory of structured multilevel categorization of action, as such novel to cognitive theory. We will apply this to the semantic analysis of action verbs, in the framework of a recent development in semantics: a theory of linguistic meaning that uses frames for meaning representations of both lexical meanings and meanings generated by composition. Cognitive theory is relevant to this semantic framework since it aims at a cognitively adequate analysis of meaning. In this regard it does not trod the paths you may be used to from formal semantics. Yet, frame semantics of this particular approach aims at the same degree of precision as any accounts in formal semantics.

The point of departure is a philosophical theory from as far back as 1970, the year when the first seminal papers by Richard Montague appeared and triggered the development of formal semantics. Goldman's theory of "level-generation" was the first to come up with the idea (and observation) that we consider ordinary tokens of acts very often as representing more than one type of act. His "Theory of Human Action" received

some discussion in philosophy, but was not taken up in semantics, let alone cognitive psychology. Goldman originally presented his theory as a contribution to philosophical ontology, not to the philosophy of language. In the following, the theory will be re-interpreted as a theory of the *categorization* of acts and therefore as a contribution to cognitive theory and, derivatively, to the philosophy of language, and to semantics as based in cognition. In this respect, the way of dealing with Goldman's theory is novel, too. Thus, this paper is aimed to be more than just a revival of Goldman's theory.

The discussion will start with an introduction of Goldman's notions of level-generation and act-trees, which we will dub "cascades" in order to have a more general term not confined to acts. The philosophical critiques of Goldman's work are briefly reviewed arguing that they did not justice to the main point of his theory. We introduce the central term "c-constitution" – i.e. constitution under the given circumstances – for the relation resulting from level-generation, and provide an informal definition that avoids the criticism brought forward from the philosophical camp.

In our construal of Goldman's theory, we will take level-generation as a fundamental cognitive process. The resulting relation of c-constitution will be integrated in the frame theory of cognitive representation in Barsalou (1992) and later work based on this approach (e.g. Löbner 2014). In this framework, c-constitution will be modeled as a relation between first-order action frames that results from the process of level-generation. This will allow us to adopt the cascade perspective to verb semantics. We assume that linguistic meanings are concepts represented in our cognitive system. We further assume that linguistic meanings, in particular lexical meanings, have the structure of Barsalou frames. Thus frame theory provides a general model for decomposition. The observation that we categorize human action using a cascade of multiple categorization, leads to the conclusion that lexical verb meanings may have cascade structure, too.

A first look at the data shows that most action verbs do not denote basic, single-level types of action. As classes of non-basic action verbs, we will briefly review "criterion predicates" for which Kearns (2003) and Sæbø (2008, 2016) proposed two-level analyses. In addition, various verb-semantic phenomena will be presented that display explicit or implicit level-generation. Two related examples will be introduced in detail: Austin's classical multilevel account of speech acts and the cascade of action involved with writing. The writing cascade is used as a case study for developing the semantic consequences of a multilevel approach for decomposition and for the theory of composition and reference. As a major point, it is observed that the composition of a non-basic action verb with its argument specifications or verb modifiers necessarily involves the selection of a cascade level to which these operations apply; this predicts the availability of multiple readings without lexical or syntactic ambiguity, a consequence which is theoretically welcome. Thus, the cascade approach to verb meaning opens novel perspectives for the theory of semantic composition.

We will see that the relation of c-constitution is not restricted to acts as such, but is paralleled for the agents and other act participants across levels, such as the agent and the product of writing. This finding suggests that level-generation and c-constitution may be fundamental conceptual phenomena of general application in cognition. A brief outlook in this direction is given in the concluding section.

2 Goldman's level-generation: doing multiple things in one

2.1 Examples

A few example will illustrate the phenomenon. You will see that it is perfectly familiar. Each one of the cases in (1a–d) displays a "cascade" of things that one may happen to do in a single doing – under circumstances. The upward arrows ↟ indicate that the higher action is brought about by the lower action.

(1)

ruin one's night			
↥			
wake up the baby	make y smile		
↥	↥		
lighten the room	do y a favor	purchase z	disappoint y
↥	↥	↥	↥
turn on the light	let y pass	pay for z	decline y's request
↥	↥	↥	↥
flip the light switch	keep the door open	hand money to y	say "No" to y
a.	b.	c.	d.

If you flip the light switch, under normal circumstances, you will thereby turn on the light, thereby lighten the room, maybe wake up the baby sleeping there, and thereby ruin your night. All this is done in one – by pressing your finger on the light switch. It may not all be intended, but probably the first three levels will be. Depending on the context, you might answer the question "What did you do?" by expressing each of these levels, saying "I flipped the light switch.", "I turned on the light.", etc. Each of the descriptions given in (1a) would truthfully apply to what is done in the situation assumed. The analogue applies to the other three examples. The general upward relation is in terms of "by": the higher-level type of act is done *by* performing the lower-level type of act. The examples given each conjure up a whole scene that may involve other protagonists, like the baby in (1a), the passing person in (1b), the person who takes the payment in (1c), and the addressee in (1d). Yet – crucially – all the acts related to, are acts by the same agent: it's not, for example, 'y smiles' but '[the agent] makes y smile'. This is crucial for realizing that these things also happen strictly at the same time. Even if the light goes on a moment later than when you flip the switch, and if the baby wakes up even later, and it turns out that you ruined your night only a long time later – you caused all this in the very moment you flipped the light switch: this was the moment when you ruined your night (according to the construal of the example). A higher level action may consist in causing some event, and there may be a temporal delay between the act of causing and the event caused.[1]

2.2 Act-tokens, act-types, and act-TTs

The upward relation symbolized by the arrow ↥ in the examples represents what Goldman called level-generation. The first question concerning ↥ is: what kind of thing does it relate. Goldman (1970) distinguishes act-tokens and act-types. *Act-types* are common enough: it is types such as 'open the door', 'turn on the light', 'wake up the baby', or 'decline a request'.[2] They can be defined more or less specifically, for example as 'open', 'open a door', 'open (a particular) door' etc. In philosophy, types of act (or action) are often subsumed under the notion of "property", in semantics, under "types of events". Act-types are exemplified / enacted / performed / implemented if someone does something of that type. The agent then produces an *act-token* of this type. If Sue does something that can be described as "open the door", she produces a token of the act-type 'open the door'. An act-token has a determinate agent and occurs at a determinate time.

According to Goldman (1970), the upward relation in cases like those illustrated in (1) obtains between act-tokens; there is a token of 'flip the light switch' that level-generates a token (by the same agent and at the same time) of 'turn on the light', and so on. In his account, two act-tokens are different if they are tokens of different types (1970:11). This means that the relation of level-generation does not obtain between act-

[1] At least, this is the point of view we will take. For an extensive discussion of this point see Ginet (1990). Not much, it appears, depends on the assumption that the "generating" lower-level acts strictly take in the same time as the generated higher-level acts.

[2] Descriptions of types will be marked by single quotes.

tokens as such (whatever this may be), but between acts-as-tokens-of-a-type. For example, (1d) is to be construed as: a token of the act-type 'say "No" to y" level-generates a token of the act-type 'decline y's request', and this in turn a token of the act-type 'disappoint y'.

Tokens-of-a-type are a very natural kind of thing. Whenever we talk about acts or events, we do while describing them as of one type or other. For example, if we use a VP for event reference, the VP provides a description of the event referred to and thereby gives its type. Language cannot refer to acts other than by type description and semantic and pragmatic means that fix the reference to particular tokens of that type. This does not only hold for acts and events, but in general for all things we verbally refer to: we always refer qua type, that is, using expressions that provide a type description. It may even be argued that this applies beyond language to thinking in general: we can't think of things, or even perceive things, without categorizing them in one way or other.

We will refer to a token-of-a-type as a "TT" for short, and introduce the following notation:

(2) **Definition**: For a type T and an entity t, **t/T** is the "token t of the type T".

2.3 Goldman's theory of act-levels

2.3.1 The multilayered view on human action

In his theory of human action (Goldman 1970), Goldman's point of departure is the observation that agents, when they act, may do several distinct things in one; they produce a whole set of act-tokens. Goldman emphasizes that these act-tokens are distinct "because", he argues, "the *properties* picked out […] are distinct properties" [3] (Goldman 1970: his italics) – flipping the light switch does not exemplify the same property as turning on the light etc. One crucial difference of the properties distinguished concerns the respective causal relationships of the types of action: flipping the light switch may cause the light to go on, but turning the light on does not cause the light switch to be flipped. Thus, acts by the same agent at the same time which relate to each other like those in the example cannot be identical as they have different properties. Goldman presents this argument against the proponents of what he calls the "identity thesis" put forward by Anscombe (1963) and Davidson (1963), among others he mentions [p. 2]. According to Goldman, there is one doing by the agent that constitutes a combination of distinct act-tokens of distinct act-types. Goldman's criterion of identity for act-tokens is this: "Two act-tokens are identical if and only if they involve the same agent, the same property, and the same time" [p. 10]. "Each act-token is a token of one and only one type (property)." he says [p. 11]. This is the reason why we construe Goldman's theory as a theory of act-TTs, rather than in his diction of "act-tokens". When Goldman talks of act-tokens, he really refers to an act-TT of an implicit type, to act-tokens *as they are categorized*.[4] If we confine the discussion strictly to act-TTs and act types, the question as to whether the act-tokens are identical or not is not relevant.[5]

[3] In Goldman's terminology, the sentences in (1) each express a "property" of the agent. What he calls properties, we refer to as "types", a term also used by Goldman.

[4] We may observe at this point, that the controversy as to whether in such cases there is one or are more than one act-token involved dissolves if one replaces reference to act-tokens by reference to act-TTs. No-one will deny that to act-TTs a/A and a'/A' are different if A and A' are different act-types.

[5] Ginet (1990) devotes a chapter to this question and comes to the conclusion that "the issue over the individuation of action, though sufficiently interesting in its own right, is not one on which much else depends. As far as I can see, there is no other significant question in the philosophy of action that depends on it." [p. 70]

2.3.2 Act levels and level-generation

In Goldman's theory of action, the act-tokens enacted with a single doing are ordered in levels. Act-tokens at lower levels "level-generate" higher-level act-tokens of the same agent at the same time. If an act-token a by agent s level-generates an act-token a', then s does a' "by" or sometimes "in" doing a [p. 20f].

There are different types of level-generation. Also, level-generation can be a many-to-one, one-to-one, or one-to-many relationship. I will use original examples from Goldman (1970) in order to introduce and illustrate Goldman's types of level-generation. As above, we use the symbol ↥ for level-generation:

(3) Four types of level-generation[6]

1. **Causal generation**
   "Act-token a of agent s causally generates act-token a' of agent s only if
   (a) a causes e, and
   (b) a' consists in s 's causing e." [p. 23]

   Examples [p.23]:
   's flips the switch' ↥ 's turns on the light'
   's shoots the gun' ↥ 's kills George'
   's closes the door' ↥ 's prevents a fly from entering the house'

2. **Conventional generation**
   "Act-token a of agent s conventionally generates act-token a' of agent s only if the performance of A in circumstances C (possibly null), together with a rule R saying that a done in C counts as a', guarantees the performance of a'." [p. 26]

   Examples [p.25]:
   's moves his queen to king-knight-seven' ↥ 's checkmates his opponent'
   's breaks his promise' ↥ 's does what he ought not to do'
   's extends his arm out the car window' ↥ 's signals for a turn'

3. **Simple generation**
   "In simple generation the existence of certain circumstances, conjoined with the performance of a , ensures that the agent has performed a'." [p. 26]

   Examples [p.27]
   's jumps 6 feet 3 inches' ↥ 's outjumps George'
   's comes home after 12:00' ↥ 's breaks his promise'
   's asserts that p' ↥ 's lies'

4. **Augmentation generation**
   "The generated act is formed by "augmenting" the generating act with some relevant fact or circumstance." [p. 28]

   Special case: Compound generation
   "The augmenting circumstance is a co-temporal[7] act of the agent." [p. 28]

The discussion of augmentation generation will be postponed to 3.1.

[6] In the quotes, upper-case letters for variables denoting tokens and persons are replace by lower-case letters, as we want to reserve in this paper the use of upper-case letters for type variables.

[7] Goldman uses the term "co-temporal" in the sense that two acts are co-temporal if one is done while *also*, that is, in parallel, doing the other. Act-tokens that coincide due to level-generation have the same temporal extension, but they are not, in Goldman's sense, "co-temporal".

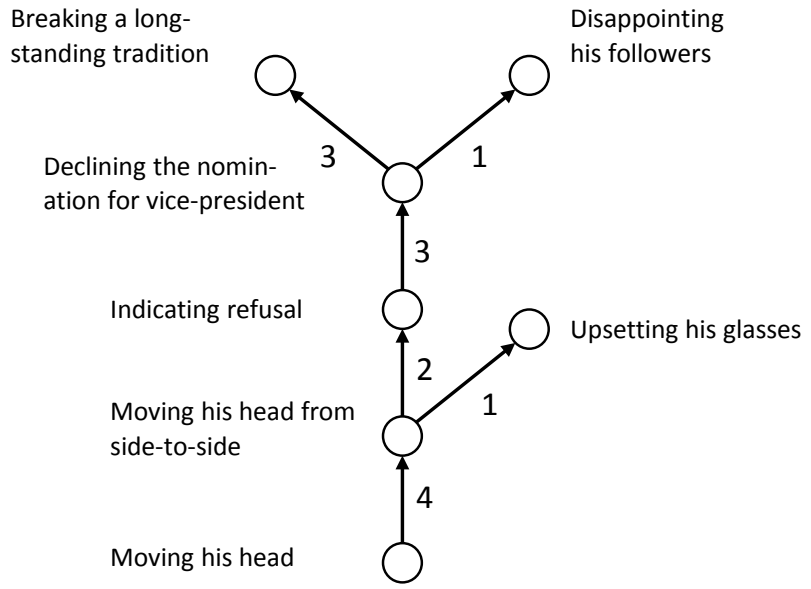

Fig. 1 Goldman's act-tree for declining the nomination for vice-president

The distinction of types of level-generation reflects that level-generation may draw on different types of connection between actions: on causal connections, on convention, or just on the constellation of facts (simple generation). Augmentation will be illustrated and discussed in more detail in 3.1. We will argue there that augmentation should be distinguished from level-generation proper. It is important to observe that causal generation is not a relation between an act and an event caused by that act. Rather causal generation obtains between one act[-TT] and another one, that consists in the *causation* of the event caused.

Goldman uses "act-tree" diagrams for complex level-generational act structures; the trees are to be read bottom-up. The act-tree in Fig. 1 contains instances of all four types of level-generation.[8] The diagram displays seven nodes that stand for act-tokens of different types as labeled. They are connected by arrows that lead from the generating act to a generated act. The numbers that annotate the arrows indicate the four subtypes of level-generation as numbered in (3). The tree contains two act-nodes with upward branching generation. Moving the agent's head not only conventionally generates indicating a refusal, but also causally generates upsetting the agent's glasses. The agent's declining the nomination causally generates his disappointing his followers; it also generates in simple generation breaking a long-standing tradition. The latter constitutes simple generation because it comes about by the mere circumstances of such a tradition having obtained for a long time up to the moment where the agent does what he does. If an act-token generates two or more others which do not generate each other, then the generated acts are at a higher level, but the levels are independent of each other; in particular, they are not the same level. According to Goldman [p. 31], two acts are "at the same level" if and only if they are distinct but generated by the same act and generating the same acts. His examples include 'hitting the tallest man in the room' and 'hitting the wealthiest man in the room' where in the given circumstances the tallest man in the room is at the same time the wealthiest one.

Goldman gives the following general definition of level-generation[9].

(4) "Act-token a level-generates act-token a' if and only if
(i) a and a' are distinct act-tokens of the same agent that are not on the same level;

[8] The diagram is adapted from Goldman (1970, p. 34), with dots replaced by circles and lines by upwards arrows.
[9] P. 43, italics omitted; Arabic numbering replaced by Roman, upper-case variables by lower case.

(ii) neither a nor a' is subsequent to the other; neither a nor a' is a temporal part of the other; and a and a' are not co-temporal;
(iii) there is a set of conditions c* such that
  (a) the conjunction of a and c* entails a', but neither a nor c* alone entails a';
  (b) if the agent had not done a, then he would not have done a';
  (c) if c* had not obtained, then even though s did a, he would not have done a'."

2.3.3 Basic vs. non-basic act-types

The notion of level-generation immediately raises the question whether there is a basic level of action. Goldman (1970) answers the question to the positive. His examples of basic act-types include the following:

(5) extending one's arm
moving one's finger
bending one's knee
shrugging one's shoulder
opening one's eyes
turning one's head
puckering one's lips
wrinkling one's nose [p. 18]

Informally, a type of action is basic if it does not require a generating act of a different type in order to come about. A convenient test for non-basic act-types is to check if there are different types of act for implementing it. For example, an electric light may be turned on by doing various more basic things, like flipping a light switch, triggering a motion detector, using a smart phone touch display, or giving a voice command to an electronic device that controls the light. Even these act-types are not basic, though; none of the lowest-level act-types in the act-trees in (1) is basic.

According to Goldman, all action is caused by a current *want* to act correspondently. Essentially, he defines basic act-types as things an agent would do if they had the want to do so and were in standard condition with respect to this type of act, *and* if the act can be brought about without level-generation.[10] Basicness is primarily defined for act-types, and derivatively for act-TTs. Due to Goldman's definition, basic acts are necessarily intentional – although they may level-generate acts that are not intended.

2.4 Critics of Goldman's theory

Goldman's theory was criticized in Castañeda (1979), Bennett (1988), and McCann (1982), among other philosophers. A central point of criticism is Goldman's formal definition of level-generation quoted in (4). The critics show by counterexamples that it would apply to cases of act pairs that are obviously not intended to be included.

Goldman's definition in (4) is essentially in terms of logical conditions on statements to the extent that *s does a* and *s does a'* where s's doing a level-generates s's doing a'. Logical conditions, properties, and relations are in terms of truth-values (entailment) or in terms of extensions of concepts. For example, if a sentence B is always and necessarily true if sentence A is, then A and B are related by logical entailment: A

[10] Goldman's elaborate definition is this: "*Property* A *is a basic act-type for* S *at* t *if and only if:* (a) *If* S *were in standard condition with respect to* A *at* t*, then if* S *wanted to exemplify* A *at* t*,* S*'s exemplifying* A *at* t *would result from his want; and* (b) *the fact expressed by* (a) *does not depend on* S*'s level-generational knowledge nor on* S*'s cause-and-effect knowledge, except possibly the knowledge that his exemplifying* A *would be caused by his want.*" [p. 67] Goldman discusses, and rejects, a definition of basic action given in Danto (1963). "In Arthur Danto's article "What We Can Do" […] there is a confusion between causation and causal generation that results in an inadequate definition of the notion of a basic action" [p. 24].

entails B. If a type, or concept, or predicate P is such that it applies to all cases that another type (or concept or predicate) Q implies, then P is in the logical relationship of superordination to Q. By contrast, conceptual relations concern the conceptual content. For example, the two sentences *Today is Tuesday* and *Tomorrow is Wednesday* logically entail each other. At the same time, there are conceptual meaning relations between them that *explain* why they are logically equivalent (both refer to a day, the second sentence to a day following the one referred to in the first; Wednesdays are related to Tuesdays in the same way). Stating a certain logical relation does not amount to saying anything about the conceptual level, although we may hypothesize that the logical relation be due to a conceptual relation.[11]

Taking a look at the conditions in (4), we realize that (4i) is just a restricting precondition for the definition, and that the conditions in (4iii) are in terms of logical entailment (or can be paraphrased as such).[12] The only (probably) non-logical condition is the restriction in clause (ii) that a and a' be not co-temporal; but this weak constraint is far from capturing the basically non-logical notion of level-generation. Level-generation, as introduced by Goldman, is a genuinely conceptual, or as we see it, cognitive relation. In his reply to Castañeda (1979), Goldman explicitly locates level-generation in the realm of psychology:

> "[…] insofar as philosophical theorizing is an attempt to lay bare the fundamental features of our conceptual scheme [i.e. level-generation, the author], it should not rest content with a "string" of explicit definitions. Our conceptual scheme is a *psychological structure, or a manifestation of a psychological structure*, and it is not the analysis of concepts alone that will facilitate our understanding of this structure."
> [Goldman 1979: 269, my italics]

Being a conceptual relation, level-generation has logical consequences; the logical supervenes the conceptual; however, supervenience is but a weak correspondence relation.[13] Given that, Goldman's own formal definition fails to capture the real nature of the notion of level-generation – in fact no definition in terms of logical relations can. A definition like the one intended in (4) can only provide necessary logical conditions to be met by level-generation. The critics mentioned are right in pointing out that Goldman's attempt at a [logical] analysis of the relation does not provide a sufficient condition; but that does not invalidate the underlying intuitive notion of level-generation that Goldman's attempt at an analysis was aimed at.

> "[…T]he idea of level-generation, I think, is an intuitive or pre-analytic idea, implicit within our common-sense framework. […T]he idea of level-generation is implicit in our use of the phrase, "s did … *by* doing ---," and in our use of the phrase, "s did … *in* doing ---." That it is an intuitive notion is reflected in the fact that once a few examples of it are given, any ordinary speaker can readily identify numerous other cases that fall under the same concept. […] Since there is a prior notion to be analyzed, we do not want to provide merely a *stipulative* definition. We want to provide a definition that captures our antecedent notion (while also capturing the amplifications of the notion – e.g., augmentation generation – which I have introduced). But providing analyses of interesting concepts is always a difficult enterprise. What must be remembered, therefore, is that the tenability of the intuitive concept should not depend on the success of any particular analysis." [Goldman 1970: p. 38]

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[11] For the difference, and relationship, between logical and semantic relations (taken as conceptual relations) see Löbner (2013: 191–196).

[12] Logical relations derive from conceptual relations; for example it derives from the concepts of 'perceive' and 'hear' that 'x hears y' logically entails 'x perceives y'. But conversely, no particular conceptual relation derives from entailment. Thus, Goldman's condition (3iiia) does not tell us how the categorizations of a and a' are conceptually related, for example in the way that a' of type A' is done *by* doing some a of type A.

[13] McLaughlin & Bennett (2014) give the following definition: A set of properties A supervenes upon another set B just in case no two things can differ with respect to A-properties without also differing with respect to their B-properties.

It appears uncontroversial to consider the rich analysis of doings like the ones indicated in the examples as “real” in the sense that if one agent acts in a particular situation and we consider a multi-level conceptualization adequate, then all the act-types, to us, are “really” enacted in his one doing. Thus, Goldman’s theory of human action can be considered a contribution to ontology, and metaphysics, of the world *as it is perceived and conceived by human cognitive agents*, i.e. of what is *real for us*.

2.5 Goldman's Theory of Human Action applied to cognitive representation

In view of the two quotes cited, we will apply Goldman's theory to the cognitive representation of human action. If, to us, an act constitutes a whole cascade of act-TTs, it will be assumed that our cognitive representation has the structure of a cascade. The act-TTs that form the cascade are related by the relation resulting from level-generation, that is, the relation we will call c-constitution below. We assume that level-generation is a fundamental cognitive mechanism, ubiquitously at work in our cognitive systems. Whenever somebody acts, we will try to interpret their action at levels beyond the pure doing, coming up with a view that, for example, explains the action as the result of pursuing certain intentions; we will try to relate the action to ourselves as some type of act towards us; we will often appraise the action as positive or negative in various regards; we will take it as constituting *inter*action with us, and so on. All these views amount to the addition of cascade levels to the doing. Thus, there are quite general level-generations we will apply, like the following:

(6)	a.	x does a/A	↥ x does b/'pursue intention Y'	intentionality
	b.	x does a/A	↥ x does b/'do sth. I like'	appraisal
	c.	x does a/A	↥ x does b/'direct a/A at me'	interaction
	d.	x does a/A	↥ x does b/'prepare situation of type S'	sequentiality
	e.	x does a/A	↥ x does b/'react to situation of type S'	sequentiality

In view of such examples, it is hard to imagine that we do *not* level-generate whenever we observe the actions of others, or plan and execute our own. It is even plausible to assume that level-generation as a cognitive process very often is automatic, not involving any conscious reasoning.

Construing Goldman's as a theory of cognitive representation of action will enable us below to apply it to semantics – which we take to be part of a theory of cognitive representations, too, in this case of linguistic meanings. But before we turn to this aspect, we will restate the basic points of the theory in terms of act-TTs, and also undertake a slight revision of Goldman's view of "augmentation generation".

3 Cascades

3.1 Level-generation and augmentation generation

We first turn to the discussion of Goldman's fourth type of level-generation, what he calls "augmentation generation". Goldman (1970: p. 28ff) gives three types of example for augmentation generation. They can be characterized as follows:

(7) **Subtypes of augmentation generation**

a. **Compound generation**
Two or more acts by the same agent and at the same time ("co-temporal" acts) jointly generate an act of doing all these things in one.
Ex. 's jumps', 's shoots' *generates* 'x jump-shoots' [p. 28]

b. **Manner augmentation** [our term]
An act generates doing this act in a particular manner.

Exx.: 's says "hello" ' *generates* 's says "hello" loudly'
's runs' *generates* 's runs at 8 m.p.h.' [p. 28f]

c. **Argument augmentation** [our term]
An act generates another act distinguished by the specification of an additional argument:
Exx.: 's extends his arm' *generates* 's extends his arm out the car window'
's moves his queen' *generates* 's moves his queen to king-knight-seven' [p. 34]

Goldman himself was not entirely convinced that augmentation generation is of the same kind as the other types of level-generation (cf. his discussion p. 28ff). Related to the conceptual level, augmentation in all varieties mentioned is enrichment of a given act-type concept: the original concept is maintained and information added such as to form a concept that is more specific. Crucially, the application of the augmented concept must be narrower. If a concept A+ is an enriched version of a concept A, then A+ unilaterally logically entails A, that is, A applies to all cases to which A+ applies, but not conversely. This is one point in which augmentation differs from the three other types of level-generation. Secondly, the relation resulting from augmentation obtains independently of the circumstances.

However, there are also crucial points of commonality. First, concepts for act-types in an act-tree are concepts that model an act-token in general form. These concepts will have an act component and specify for it an agent and an act-time. If we add any condition to such a concept, the specification of the agent and the act-time will be preserved. Thus pairs a/A and a+/A+ related by augmentation automatically fulfil the constraint for level-generated act pairs that they have the same agent and the same temporal extension.

Second, if a/A and a+/A+ are related by augmentation, A and A+ are concepts for different types of action, and the conditions added to the concept may be crucial for the causation of certain other things. Thus a/A and a+/A+ have different causal properties. Since one aim of the theory of level-generation is to capture the causal relations of an act-token as categorized in this way or another, augmentation is a relevant mechanism.

We will therefore proceed as follows: we integrate augmentation into act-tree structures, but set it apart from the other types of level-generation as a process of its own kind.

Augmentation is a very general conceptual process that just adds information to a given cognitive representation. The corresponding relation, commonly called "subsumption", obtains between two concepts A and B whenever B constitutes an enrichment of A, or if A "subsumes" B. As a cognitive process, it is certainly as basic and ubiquitous as level-generation. It takes place whenever we add to existent cognitive representations.

The definition in (8a) defines the general notion as a relation between concepts in general; it applies to act-types in particular. The definition is generalized in (8b) as to cover Goldman's compound generation. (8c) defines the derived notion of an act a+/A+ being more specific than an act a/A; in the case of compound generation, the relation holds between each component act and the compound act.

(8) **Augmentation**

a. A concept A+ is an augmentation of the concept A, or: A properly subsumes A+
$A \sqsubset A+$
iff A+ is A with conditions added such that there are cases where A applies, but not A+, while A always applies if A+ applies.

b. For n>1, the concept A+ is an augmentation of the concepts $A_1, \ldots, A_n$,
$A_1, \ldots, A_n \sqsubset A+$
iff A+ is an augmentation of each act concept $A_1, \ldots, A_n$.

c. An act-TT a+/A+ is **more specific** than an act-TT a/A,
iff $A \sqsubset A+$.

By referring to the act tokens as "a" and "a+", it is not implied that they are different as such. In fact, by the very definition, if a+ is a token of act-type A+, then it also is a token of all act-types A that subsume A+. The notation for the act tokens is chosen for convenience in order to fit in with the distinction of act tokens involved in c-constitution.

3.2 The cascade relations

We define "cascades" basically as Goldmanian act trees. This term is preferred because we want to maintain the option to extend the notion to representations of things other than acts.

(9) **Act cascades**
An act cascade is a tree structure of act-TTs that are related by level-generation and/or augmentation.

According to this definition, act-cascades are identical with Goldmanian act-trees, but they are considered to be not all produced by sub-types of "level-generation". Rather we distinguish level-generation in the narrower sense (to be called c-constitution below) from augmentation as two different relations involved.

3.2.1 Relational properties of level-generation and augmentation

The relation of “level-generation is intended to be asymmetric, irreflexive, and transitive” (Goldman 1970: p.22). Since it is irreflexive, no act generates itself. Asymmetry prevents two acts from generating each other. Due to transitivity, if a/A generates b/B and b/B generates c/C, then a/A generates c/C. As a consequence of transitivity, level-generation may result in chains, and due to irreflexivity and asymmetry the chains cannot contain loops. (If loops are not excluded, acts in a loop would generate themselves and generate their generators.)

Transitivity has two important consequences. First we may combine a given sequence of level-generations into one larger step. For example in (1a) we might skip some of the levels; somebody might warn the agent: "if you flip this switch, you'll ruin your night!" Second, it may conversely be possible that a given step be broken down into several smaller steps. For instance, one might analyze the level-generation of 'flip the light switch' ↥ 'turn on the light' into more steps that take account of what the agent does on the electrical level, like closing an electric circuit and thereby providing electricity to the bulb in a lamp, heating a wire and making it radiate light. A fine-grained analysis like this might matter under circumstances where the attempt to turn on the light fails because the electric power supply has broken down, the switch doesn't work, a fuse is blown, there is no bulb in the lamp, or the wire in the bulb is broken.

Asymmetry, irreflexivity, and transitivity hold for generalized level-generation comprising the causative, conventional, and simple type. It also holds for augmentation as defined in (8) (note that the condition of genuine augmentation leads to irreflexivity). It is these logical properties of level generation and augmentation that give rise to tree structures of the type encountered with cascades.

3.2.2 The relations **c-by** and **c-in**

Goldman mentions that there are the two options of paraphrasing the downward relationship between h/H and l/L, using a *by* or an *in* paraphrase: ‘Agent does h/H *by* doing l/L’ or ‘Agent does h/H *in* doing l/L.’[14] He does not elaborate on the question as to when one or the other type of paraphrase is adequate. Kearns (2003) discusses *in* vs. *by* paraphrases in connection with certain action predicate types, to be discussed in 5.2 on "criterion predicates". What we refer to as lower and higher level, she calls 'host' and 'parasite', respectively. According to her, an *in* paraphrase expresses that “the host simply realizes the parasite” [p. 602];

[14] I will use ‘L’, ‘L1’, ‘L2’, … for lower cascade levels, and ‘H’, ‘H1’, ‘H2’, … for higher levels.

while a *by* paraphrase expresses that "the causative parasite is not realized simply in the occurrence of the one action performed, but requires also a consequential upshot" [p. 615]. It is not clear from her discussion either when which of the two paraphrases applies. Still, Kearns' observation that the *in* paraphrase applies when the generating act *simply realizes* the generated act seems to be a valid generalization. We would say, for example, in the case of (10) that the casting of the speaker *is* the mistake.

(10) *All through The Graduate Nichols thought he'd made a mistake in casting me.* [BNC C9U 495]

By contrast, cases of generation where a *by* paraphrase is adequate seem to not allow for the equation, in this sense, of generating and generated act:

(11) *Our aim is to reduce the number of new HIV infections by giving young people the facts about AIDS and by encouraging them to think about their future.* [BNC A01 532]

Clearly, giving young people the facts about AIDS *is* not, in itself, a reduction of the number of HIV infections, rather it is a possible *means* of achieving that.

We conclude that there are two distinct inverse cascade relations that can be described by using *in* or *by*, respectively. These are alternative inverses of the relation of level-generation. We index the relations with the subscript 'c' for the given circumstances since these relations, like level-generation, only hold under circumstances.

(12) The downward relation **c-in**

h/H **c-in** l/L , iff

Under the given circumstances c,

- the agent, **in** doing l/L, exemplifies an act h of type H;
- doing h/H **consists in** exemplifying an act l of type L;
- the agent's doing l/L **counts as** / **amounts to** / **means** exemplifying an act h of type H.

(13) The downward relation **c-by**

h/H **c-by** l/L, iff

Under the given circumstances,

- the agent, **by** doing l/L, exemplifies an act h of type H;
- doing h/H **is effected** / **accomplished by** exemplifying an act l of type L

A simple intuitive description of the relation between the generating act l/L and the generated act h/H derives from these definitions: Under the given circumstances, doing L is a way, or a *method*, for doing H. Sæbø (2016) uses the term 'method' in this connection, and we adopt his terminology.

3.2.3 The relation of c-constitution

Rather than striving for a general sufficient formal definition of level-generation, we will apply the notion to the more concrete variants listed above. We will also introduce a different term: the notion of level-generation emphasizes the *process* of creating additional categorizations for a given act-token. In the following we will focus rather on the conceptual *relation* between the act-TTs related by level-generation, and speak of "c-constitution". Under the given circumstances c, an act-TT l/L c-constitutes an act h of type H if and only if l/L level-generates an act of type H. Thus, the following definition of c-constitution can *mutatis mutandis* be taken as a definition of level-generation:

(14) **The relation c-const**

Let l/L and h/H be two acts such that

(i) l and h are acts by the same agent that occupy the same time,
but l and h are not co-temporal

(ii) l and h are not on the same level

Under given circumstances c, an act l/L **c-constitutes** h/H

l/L **c-const** h/H, or l/L ↥ h/H

iff one of the following two relations holds:
h/H **c-in** l/L – In doing l/L, the agent exemplifies an act h of type H, or
h/H **c-by** l/L – By doing l/L, the agent exemplifies an act h of type H.

3.3 The double nature of the notions of level-generation and c-constitution

Goldman's notion of level-generation is of a double nature. It can be considered a relation between act-tokens (as act-TTs) *and* a relation between act-types. When we define level-generation and augmentation as relations between act-tokens-of-a-type l/L and h/H, there is a concomitant relation between exemplified act-types: between the act-type L exemplified with l, and the act-type H exemplified with h. Using the notation 'A\a' for an "act-type A exemplified by a token a", we can alternatively define the cascade relations between exemplified act-types L\l and H\h. These obtain iff the "ingredients" l, L, h, and H fulfil the conditions that define the relations between l/L and h/H. Since the TT-relation and the type-relation are just two sides of the same coin, we will use the notions of c-constitution and level-generation freely for both.

In addition to the token-type duality, level-generation can be taken either as a cognitive process or as the resulting relation between two act-types. Again, these are two sides of the same coin. Goldman's terms 'level-generation' and 'augmentation' relate to the process side of the coin, while his definition in (4) defines level-generation in terms of relations between the act-tokens. We chose to define c-constitution and subsumption as relations rather than processes.

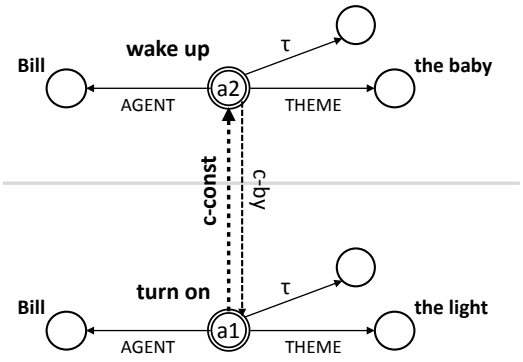
4 Cascades and frames

4.1 Barsalou frames

We will now integrate the notion of cascades in to the framework of cognitive representations based on Barsalou frames. As a working hypothesis, we adopt Barsalou's Frame Hypothesis, according to which Barsalou frames constitute the universal format of concept representation in human cognition.[15] We assume that lexical meanings are concepts stored in long-term memory and that compositional meanings are concepts formed as the result of syntactic and semantic processing, essentially by unification.

According to Löbner's (2017) formal theory of Barsalou frames, a *frame structure* is a network of nodes, related by functional attributes. The nodes represent individuals in a global universe of discourse. The attributes are functions that for individuals of an appropriate type return another individual of the same or another type, as value. For example, the attribute SIZE returns the individual size for all individuals that have size; the attribute MOTHER returns the mother for every animal with parents; the attribute HEAD returns the head for those things that have a head. The values of attributes may carry their own attributes; thus frame structures are in principle recursive. In a frame, type restrictions may be imposed on the nodes, i.e. conditions to the extent that the entity represented by the node belong to a certain subset of the universe. The frame structures defined in Löbner (2017) are first-order in that the underlying ontology provides a universe of discourse, the set of all individuals, and the attributes are functions that return individuals to individuals. The universe does not contain second-order entities such as properties, relations, attributes, or first-order frames. Frame structures can be translated into an appropriate first-order predicate logic language (Löbner 2017 for details).

[15] See Barsalou (1992) for the original source, and Löbner (2014) for the application to language.



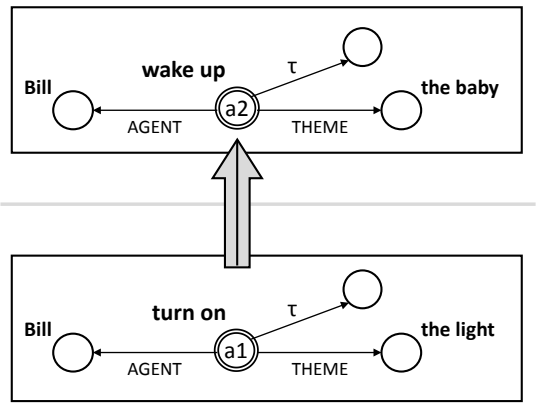


Fig. 2 Cascade formed by two frames
Fig. 2a: C-constitution as act-to-act relation

Fig. 2b: C-constitution as frame-to-frame relation

Frames are usually represented by frame diagrams (see examples below), or else by attribute value matrices. We use the former. There is always a distinguished central node that represents the individual described by the whole frame. Frames have the same double nature as Goldmanian act-TTs. A frame can be read as a description of the individual for which the central node stands and to which the frame structure applies. This is the token-of-a-type view on frames. Alternatively, we can read a frame as a complex description of a type *qua* description of a potential token of the type – the type-of-a-token view.

In the context of the present paper, we exclusively deal with frames for actions. Actions are a particular type of individuals in the universe, a subtype of events. All events have an attribute τ for the time they occupy; therefore every action frame has this attribute on the central act node. Actions have an agent whence the act node in an action frame carries an attribute AGENT. For the current discussion in the context of a theory of human action, we will assume that agents are persons. An action frame may contain more attributes of the act, corresponding to more semantic roles such as THEME, PATIENT, INSTRUMENT, GOAL etc.[16]

4.2 Cascades in frame theory

The question arises if cascades are another variant of frames. Löbner (2017) admits only for first-order attributes in frames. The cascade relations c-constitution, c-in, c-by, and subsumption, however, are essentially and irreducibly second-order, because they relate types, i.e. whole first-order frames. Apart from that, the upward relations are not functions. Due to transitivity, a level-generating act-token does not project to a uniquely defined token it generates. In addition, level-generation may branch upwards. Thus the cascade relations cannot figure as attributes *within* first-order frames. We will integrate them into frame theory as second-order relations between first-order frames.

Let us consider a simple two-level cascade for illustrating the interplay of frame representation and c-constitution:

(15) 'Bill turns on the light' **c-const** 'Bill wakes up the baby'

The two cascade diagrams in Fig. 2 each contain the frames for 'Bill turns on the light' and for 'Bill wakes up the baby' at the lower and the upper level, respectively. The two frames are parallel in structure. They have a central act node that represents an act of the type indicated by the type label. In both frames, the action

[16] For more elaborate verb frames, see for example Kallmeyer & Osswald (2013), Naumann (2013), Gamerschlag et al. (2014), Löbner (2017). Verb frames that only display attributes for semantic roles are a gross simplification of what the decomposition of lexical verb meanings ultimately calls for. However, one is always free to reduce frame representations to what is needed in the context of discussion. For the needs of this paper, case frames like the ones used suffice.

node carries the attributes AGENT and τ. Both frames have a THEME attribute on the central node, of different nature. The two frames are related by c-constitution whence, necessarily the attribute AGENT and τ both take the same value in the lower and the upper frame.

The left cascade diagram adopts the token view on c-constitution. The two frames are read as representations of the TTs a1/'Bill turns on the light', and a2/'Bill wakes up the baby'. The dashed upward arrow stands for the relation of c-constitution between the two acts, the downward arrow for the c-by relation.[17] In the right diagram, the type view is adopted. The frames are enclosed in rectangles to mark them as conceptual units. They are to be read as representations of the exemplified act-types 'Bill turns on the light'\a1 and 'Bill wakes up the baby'\a2. A different type of arrow connects the two frames, not their central nodes. Both depictions are equivalent; they highlight two different sides of cascade formation. In the following we will use the left type of diagram.

5 Cascades and verb classes

5.1 Verbs of basic and non-basic action

The meaning of a verb describes a type of situation; for action verbs, it describes a type of act. The distinction between basic and non-basic act-types (2.3.3) therefore immediately carries over to verbs. If one takes a look at corpus and dictionary data, it turns out that non-basicness of action verbs is the rule rather than the exception. Table 1 displays the most frequent 100 English action verbs, among the 156 most frequent verbs in all. The table was obtained by checking the entries in the online Oxford Dictionary of English[18] (ODE) for the most frequent English verbs in the online British National Corpus. A verb was counted as an action verb if the first sense in the dictionary entry has an agentive, non-stative description. It was classified as non-basic if the definition was in terms of multiple synchronous or sequential action, if the method was left open, or if a cascade-like definition is given ("do --- by doing …"). In addition, we marked verbs of social action with italics. Social action is necessarily non-basic, as its social character derives from social rules. For any type of social action, a generating physical act is required that under circumstances will count as that type of social action.[19] We classified verbs as social if the sense description mentions interaction with other persons; verbs of social action are written in italics.

Among the one-hundred action verbs, there is not a single example of a clearly basic act verb. One verb might be a candidate: The ODE describes the first sense of *stay* as 'remain in the same place';[20] however, if *stay* is an action verb at all (rather than stative), it is a borderline case, and the fact that it seems basic may just be due to it not involving doing anything. Certain verbs in the list may appear basic, but they aren't. For example *say* is not basic because saying something involves a complex cascade of actions, starting from the basic acts of what we do with our articulatory organs in order to produce speech sounds; the sound productions may or may not constitute productions of linguistic sounds like vowels and consonants; even if they do, they need not necessarily constitute acts of ultimately producing ordinary words and grammatical sentences. (We will come back to this special case of action in 6.1.) Even a seemingly elementary verb like *sit* is not basic (as an action verb): depending on what the agent sits on, a chair, a bike, a swing, etc. the action requires very

[17] In the following cascade diagrams we will omit the downward arrows and the labeling of the upward arrows with "c-const".

[18] Oxford Dictionary of English: https://en.oxforddictionaries.com/

[19] See, for example, Searle (1995) on the distinction of what he calls "brute facts" and "institutional facts". The latter form our social reality. They are what they are by social agreement. Constitutive rules of the form "X counts as Y in context C" [p.28] create the social reality, including social action. This concept closely resembles Goldman's notion of conventional level-generation, but Searle does not refer to Goldman's work.

[20] https://en.oxforddictionaries.com/definition/stay, accessed Jan 15 2018.

01	*say*	go	make	take	come	*give*	look	use	*tell*	put
11	work	leave	*show*	*ask*	try	*call*	*provide*	keep	hold	turn
21	bring	begin	follow	*help*	write	run	set	move	play	*pay*
31	*meet*	*lead*	*allow*	carry	produce	*talk*	*offer*	consider	*suggest*	let
41	sit	continue	add	change	*buy*	*speak*	*send*	decide	*win*	*describe*
51	*agree*	build	read	reach	open	*spend*	return	draw	create	*sell*
61	cause	walk	accept	wait	pass	lie	apply	base	raise	increase
71	*report*	watch	learn	cover	*explain*	*claim*	break	support	form	cut
81	reduce	*establish*	*join*	bear	achieve	seek	deal	choose	fail	*serve*
91	*represent*	kill	drive	*discuss*	place	*argue*	*prove*	*introduce*	pick	enjoy

Table 1: 100 most frequent English action verbs (verbs of social action are written in italics)

different physical activities; *sit* may also mean 'sit up' from a lying position – asking for yet different physical action. Apart from these senses, there is the transitive use of *sit* as in *sit the child on one's shoulder*. Even if certain verbs denote action that is closely related to a particular body part, like *kick*, they are not necessarily basic, as one can, for example, kick with various parts of the foot, with one's shin, or one's knee, i.e. variants of kicking that are executed by different more basic types of action.

As a result it appears that there may be no basic-act verbs at all among the 100 most frequent English verbs. Are there any basic-act verbs in English, verbs that invariantly denote basic action rather than what is accomplished by type of more basic action? The verbs in Goldman's basic action examples in (5) – *extend*, *move*, *bend*, *shrug*, *open*, *turn*, *pucker*, *wrinkle* – are not in themselves verbs of basic action. In Goldman's examples, they are all transitive verbs and their basicness depends on the choice of a particular body-part as the object argument. For types of object other than one's own body-parts ('move the table', 'turn the pan-cake', 'open the door'), there would be various methods of enactment possible. Some of the verbs have intransitive action uses – *move*, *bend*, *shrug*, and *turn*; among them, *shrug* is a candidate for a basic-action verb because to shrug is the same as to shrug one's shoulder; maybe *bend* is another one.

It is not surprising that there are so few verbs that denote basic acts. The vocabulary of natural language serves communication in, and about, our reality, and this is to a large part social reality. Verbs of action are used in order to describe what people do. If we were restricted to verbs of basic action, it would be extremely hard, if not impossible, to describe what people are really doing. Quite generally, it seems, we communicate about what people do on considerably advanced levels of cascading. Verbs like *help* supply a good illustration of the 'abstractness' of action concepts. Ranking 24 in the above list, it is central vocabulary. According to the analysis in Engelberg (2005), the verb means essentially 'do something for somebody that improves their situation'. The concept of helping leaves open what the generating action would be concretely; in fact, an action of almost any type may constitute help in one situation, and the contrary in another, and the very same act-token may constitute help for one person and a big problem for another. In social life, improving others' situation is of utmost importance; it applies to all kinds of situation in our complex lives; we *need* general verbs like this.

For another source on basicness or nonbasicness, one may take a look at Levin's (1993) *English Verb Classes and Alternations*, where a comprehensive collection of semantic verb classes is compiled and described. There are 49 major classes distinguished, almost all of them action verbs – not a single class is basic-action.

5.2 Criterion predicates

Goldman's theory of action was not really taken up in semantic theories of verb meaning.[21] There is, though, a small thread of discussion on the semantic analysis of *by* gerunds where a two-level view on the meaning

[21] The theory was taken up and developed further in Clark's (1996) theory of communication. However, he did not apply the notion of level-generation to verb semantics.

of selected types of action verb is adopted. The discussion starts out with Kearns (2003). Kearns distinguishes two special classes of action predicates which she dubs “causative upshots” and “criterion predicates”. Causative upshots are transitive predicates like *cure the patient* or *convince s.o.* [p. 599]; they denote the achievement of some sort of change by doing something more concrete, e.g. curing someone by administering a certain treatment, or convincing someone by presenting evidence. Criterion predicates are often intransitive and not inherently causative; this class includes predicates such as *make a mistake*, *break the law*, *score a goal*, or *prove the theorem*. As with *help*, the predicate requires that something be done that fulfils a given criterion, while the method is left open. For both types, in Kearns' terms, there is a “host” and a “parasite” [p. 600f]. The “more abstract” parasite, the causative upshot or criterion predicate, is implemented by the “more concrete” host. For example, the host is a theft and the parasite is ‘breaking-the-law’; the parasite is ‘curing-the-patient’ and the host administering the treatment. Clearly, Kearns’ host level-generates the parasite. Kearns does not mention Goldman’s work, though. Her analyses are confined to two levels, and to two special classes of non-basic act-types.

The two classes of verbs are taken up in Sæbø (2008, 2016). He chooses different terms for Kearns’ causative upshots (“manner-neutral causatives” in 2008, “method-neutral causatives“ in 2016); hosts and parasites he calls concrete and abstract. Notably, the "hosts", or more concrete acts, are not basic in the sense explained above. They may be high-level act-types. What matters here, is that the two authors distinguish within one verb meaning different levels of action, related by, in fact, level-generation.

5.3 Means of explicit level-generation

There are numerous lexical and grammatical mechanisms operating on verbs and their lexical meanings to the effect of generating further cascade levels. Some of them involve word formation, for example affixation, or conversion from a different word class, others employ certain grammatical constructions or adverbials. The examples in the following are chosen for the sake of illustration; they do not provide a systematic survey, but represent just the tip of an iceberg. Almost all the cases described involve augmentation along with level-generation.

5.3.1 Adding a level of social interaction

Many lexical and grammatical processes add a further argument[22] to a given action concept. This amounts to augmentation of the underlying concept, but in addition c-constitution is involved, on top of the augmentation. We will discuss the addition of a person-type argument; this will inevitably have the effect of cascading to a level of social interaction.

Many basic types of bodily action are used as non-verbal signals for communication. For example, the verb expressions *smile*, *frown*, *raise one’s brows*, *wink*, *nod*, *shrug*, *bow*, *kneel down*, *fold one’s hands*, *scratch one’s head*, *wave one’s hand*, and others can also denote communicative action. They do so invariantly if they are used with a prepositional phrase that adds an addressee: ‘smile/wink/wave/frown *at someone*'. German has verb prefixes such as in *zu-zwinkern* (‘wink at’) or *an-lächeln* (‘smile at’) which have the same effect of adding an argument for a person addressed.[23] The concept of *zuwinkern* has the informal cascade structure in (16). (17) is an example that attests the social-level relevance of *zuzwinkern*.

(16) 'zuzwinkern': 'zwinkern' ⊏ 'zwinkern' + *addressee* ↥ 'zuzwinkern'

(17) *Mein Lieber, wenn du nicht verheiratet wärst, dann könnte ich dir jetzt <u>zu</u>zwinkern.* [DWDS]
‘My dear, if you were not married, I could now wink at you.’

[22] It is not relevant in this context to distinguish syntactically between complements and adjuncts; we will talk of ‘arguments’ in both cases.
[23] See Stiebels (1996, p. 163f) on the prefix *an-*.

The two German prefixes can also be used as prepositions marking an additional addressee argument for verbs of communication: *schreiben an* + accusative NP 'write to' or *sprechen zu* + dative NP 'speak to'.

Similar to these cases are applicative constructions (van Valin & LaPolla 1997). Japanese has several such constructions consisting of two verbs. The first verb is in the gerund *-te* form and the second a verb of possession transfer, such as *ageru* 'give upward' and *kureru* 'give downward'; the direction component is metaphorically used for expressing 'give to superior' or 'give to inferior'. A speaker will always treat the addressee as socially superior and themselves as inferior; therefore the beneficiary in the *-te ageru* construction will typically be the other, and the agent typically the self or someone related to the self. The social relation is inverted if one replaces *ageru* by *kureru*. The complex expression is used to describe doing a favor.[24]

(18) a. Japanese
mado o ake- te age- ta
window ACCUSATIVE open- GERUND give- PAST
"I opened the window for you"

b. Cascade:
'open the window' ⊏ 'open the window' + *superior addressee* ↥ 'do addressee a favor'

Thus, the construction has the structure of a criterion predicate, with the method specified. A similar construction in Mandarin is discussed in Tsai (2012). It makes use of the verb *gěi* 给 'give' that is also used as a standard verb of giving.[25]

(19) a. Mandarin (Tsai 2012, p. 5) [26]
gei wo gui- xia!
AFF me kneel- down
'Kneel down for my sake!'

Van Valin & LaPolla (1997, p. 384) describe beneficiary constructions in Lakhota with essentially the same semantics. German has a special use of the dative in such cases:[27]

(20) German
Er hat ihr die Tür aufgehalten
he has *her*.DATIVE the door kept open
'he [has] kept the door open for her'

As witnessed by the translation, English has a *for*-complement construction with the same function.

5.3.2 Adding a level of achieving a result

Predicate expressions such as *hammer flat* or *drink empty* consist of a verb of action and a predicative adjective that denotes a resulting state of the object acted upon. Resultatives of this type denote an action that is generated by an act of the type of the base verb; for example, *hammer flat* denotes a cascade of the structure 'hammer …' ↥ 'flatten', and *drink empty* a cascade 'drink …' ↥ ' $\text{empty}_{\text{verb}}$'. However, the cascade first requires an augmentation that adds the affected object. Thus, the analysis again requires two cascade steps:

(21) a. 'hammer' ⊏ 'hammer' + 'on x' ↥ 'flatten x'
b. 'drink' ⊏ 'drink' + 'from x' ↥ 'empty x'

[24] Martin (1975, pp. 597ff)
[25] Chang (Ed., 2016: p. 251f)
[26] Tone diacritics are not given in the source.
[27] Wegener (1985, pp. 94ff) on dativus commodi.

Dowty (1979), and many others since, analyzed this type of construction as causative in the sense that, for example, *drink the glass empty* means 'drink from the glass and [thereby] cause the glass to become empty' (Dowty 1979, p. 93). This is reflected by the analysis in (21) if ↥ is taken as representing the causal type of level-generation. German has a lot of particle verbs with a resultative particle such as *tot-* 'dead' in *tot-schießen* 'shoot to death', *klein-* 'small, little' in *kleinschneiden* 'cut into small pieces, chip' or *an-* 'on' in *anknipsen* 'to flick on'; these can be analysed analogously.

Van Valin & LaPolla (1997: 90) mention verbs of killing in Lakhota; they have the form of compounds with the first part indicating the method of killing, and the second a verb *t'a* that means 'dead / to die', for example *ka-t'a* 'strike to death' (*ka-* 'by striking'), *ya-t'a* 'bite to death' (*ya-* 'with the teeth'), *yu-t'a* 'strangle' (*yu-* 'with the hands'). English can generally use the addition *to death* for level-generating a predicate of killing. German has a series of verbs of killing with the prefix *er-* that does not have much of a lexical meaning on its own, but rather constructional meaning in this type of verb formation: *erschießen* ('shoot to death'), *erschlagen* ('beat to death'), *erwürgen* ('choke/stangle to death'), *erhängen* ('hang'), *erdrücken* ('crush to death'), and several more.[28] – The generating act-type fails to be specified in cases of conversion of adjectives to verbs; the adjective denotes the resulting state of the object of an unspecified action: *empty*, *fill*, *smooth*, etc. These verbs are method-neutral predicates in the sense of Sæbø (2016).

5.3.3 Adding an evaluative level

A further type of cascade extension adds an evaluating aspect to the action-verb concept. German has a productive word formation pattern that derives from almost arbitrary verbs of action a verb used to express this action and failing to produce the intended result; these verbs have been dubbed 'erratic' verbs (see Fleischhauer 2016: 293). One variant of the derivation adds the prefix *ver-* to a transitive verb and yields another transitive verb (*die Hecke verschneiden*, 'cut the hedge in the wrong way' [29]); a second type adds the same prefix and the verb is reflexivized as to form an intransitive predication (*sich verschneiden* 'cut in the wrong way'). This derivation adds an evaluation of the doing as a failure: 'cut' ↥ 'fail'. Thus, this is another mechanism that produces criterion predicates. English has some erratic verbs with the prefix *mis-*: *misunderstand, misdirect, mishear*, but the pattern is far less productive than the German one.[30]

Other constructions across languages serve the generation of a level of 'doing too much': cf. English *overcook*, *overheat*, *overpay* etc. Russian uses the prefix *pere-* in a similar way (*pere-gret'* 'overheat').[31] Japanese has verb compounds with the second verb *-sugi-ru* 'exceed', for example *nomi-*('drink')*-sugi-ru* 'drink too much'.[32]

A two-verb construction in Mandarin with the second verb 玩 *wán* 'play' can be used to express the level-generation of acting for fun:

(22) Mandarin (Liu Fan, from the BCC corpus)

Wǒ	*xiàwǔ*	*chūqù*	*hé*	*péngyǒu*	*guàngjiē*	*wán*	*ne*
I	afternoon	go.out	with	friend	go.shopping	play	PRT

'I go out to shopping with my friend for fun.'

German has a very productive adverb formation that adds *-weise* to an adjective or a present participle stem. This type of adverb is used for evaluating an act, or more generally an event or a state. Examples include *dummerweise* 'stupidly', *erstaunlicherweise* 'surprisingly', *unnötigerweise* ('unnecessarily'), *glücklicherweise*

[28] Stiebels (1996, p. 232 ff.)
[29] Stiebels' example in her discussion of this derivation (1996, p. 143–148).
[30] Goldman (1970: p. 17) mentions erratic misspeak, miscalculate, and miscount as examples of act-types that "preclude intentionality".
[31] See Zinova (2016: 146ff) on a frame analysis of the meanings of *pere-*.
[32] Martin (1975: 434–438) on the "excessive" construction.

('luckily'), and hundreds more. They cannot be alternatively used as manner adverbials; rather they correspond to English adverbs in sentence-initial use.

(23) German (DWDS corpus)
Dummerweise hatten wir keine Schneemäntel angezogen.
'Stupidly, we hadn't put on snow coats.'

This type of adverb projects the verb to a criterion-predication level. For example, adding *dummerweise* to a verb V, has the effect of [V] ↥ 'do something stupid'.

5.4 Implicit level-generation

It may be worthwhile considering cases of "integrated" augmentation generation of the types discussed above as they provide a glimpse into the decompositional structure of certain types of action concept.

Evaluation. One group with an integrated specific evaluation is constituted by verbs of forbidden action, e.g. *lie*, *steal*, *trespass*, *rob*, *rape*, *murder*, and many others. These add to the concept of a particular type of action a level 'do something forbidden/illegal'. Thus, there is a cascade relationship between 'kill' and 'murder'. 'Murder' can project further to 'assassinate' if the victim is an important person, giving rise to elaborate cascades such as 'shoot' ↥ 'shoot at y' ↥ 'kill y' ↥ 'murder y' ↥ 'assassinate y'.

Result. Van Valin & LaPolla (1997) distinguish causative and active accomplishments, and achievements. Causative accomplishments are verbs like *kill*: the agent does something that causes somebody to die. The authors apply the following general half-formal analysis to this type of action verb [p. 188ff.].[33]

(24) [**do** x, [**predicate$_1$**(x, (y))] CAUSE [BECOME **predicate$_2$**(x) or (y)]].

This reads essentially as follows: The agent x does something of the type **predicate$_1$** which causes x or y to change into the condition denoted by **predicate$_2$**. The first part of the analysis – **do** x, [**predicate$_1$**(x, (y))] – describes an action by the agent x (that possibly involves another participant y); according to the second part – CAUSE [BECOME **predicate$_2$**(x) or (y)] – x's doing causes x or y to enter the condition described by the second predicate. The whole formula describes the constitutive condition for causal generation:

(25) **do** x, [**predicate$_1$**(x, (y))] ↥ [x CAUSE [BECOME **predicate$_2$**(x) or (y)]]

Causative achievement and accomplishment verbs with an agent argument are abundant in natural languages. Typically, the generating level of the more basic action is not specified.

Generating a level of signaling. As mentioned above, some action verbs of basic or near-basic level can be used to denote a social-level act of signaling (*smile*, *frown*, *harrumph*, *nod*, *shrug*, and others). If used in this sense, they incorporate generation of a social level. As social agents, equipped with the "sense-making machines" our minds are, we usually try to come up with a construal of the acts of others as meaningful beyond the mere act. The verbs mentioned reflect this tendency by incorporating a higher cascade level in lexicalized meaning variants.

[33] The analysis goes back to Dowty (1979), who relates to McCawley (1968) for the structure of the analysis.

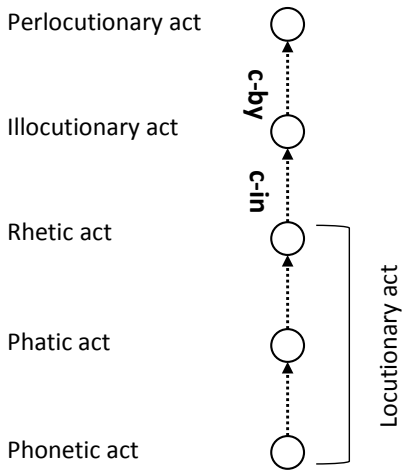


Fig. 3 Austin's speech act cascade

6 The writing cascade

We will have a brief look at Austin's (1962) speech act theory. There is a double reason for doing that: first, Austin's analysis anticipated Goldman's multi-level theory of action; Goldman mentions it as such in his introduction [p. 8]. Second, it serves as a preparation of the discussion of the writing cascade in the section following.

6.1 Austin's speech act cascade

Austin's (1962) analysis of speech acts constitutes a classical example of a cascade. Austin's analysis distinguishes five levels of action in an ordinary verbal utterance (Fig. 3). The "locutionary" level consists in saying something with a particular sense and reference in the given context of utterance. Within the locutionary act, Austin makes a finer distinction into three levels: with the "phonetic act", the speaker produces speech sounds; the "phatic act" is "the uttering of certain vocables or words, that is, noises of certain types, belonging to and as belonging to, a certain vocabulary, conforming to and as conforming to a certain grammar." (Austin 1962: p. 95); the "rhetic act" is "the performance of an act of using those vocables with a certain more-or-less definite sense and reference." [p. 95]. The phonetic act generates the phatic act, and this in turn the rhetic act. Austin continues [p. 98], "To perform a locutionary act is in general, we may say, also and *eo ipso* to perform an *illocutionar*y act". Austin calls this level the *il*locutionary act in order to emphasize that it is done *in* performing the locutionary act. He thus explicitly assumes a c-in relation between illocution and locution. The achievement of the illocutionary act – a promise, an answer to a question, etc. – only succeeds if complex "felicity conditions" [p. 25–38] are fulfilled. Austin discussed these conditions in detail, thereby offering an elaborate case study of the "circumstances" involved in these cases of level-generation.

Finally, *by* performing an illocutionary act, the speaker may execute a "perlocutionary act" that consists in causing a particular effect, for example, convincing, offending, or delighting the addressee. Austin calls it *per*locution because it is done *by* performing the illocution [p. 108]. "[T]he perlocutionary act always includes some consequences" [p. 107]. Unlike the lower four levels of a speech act, the perlocutionary act may or may not be intended. The nature of the four level-generations is a combination of conventional and simple for phatic, rhetic, and illocutionary act; the level-generation of the perlocutionary act from the illocutionary act is causal; it does not involve convention [p. 121].

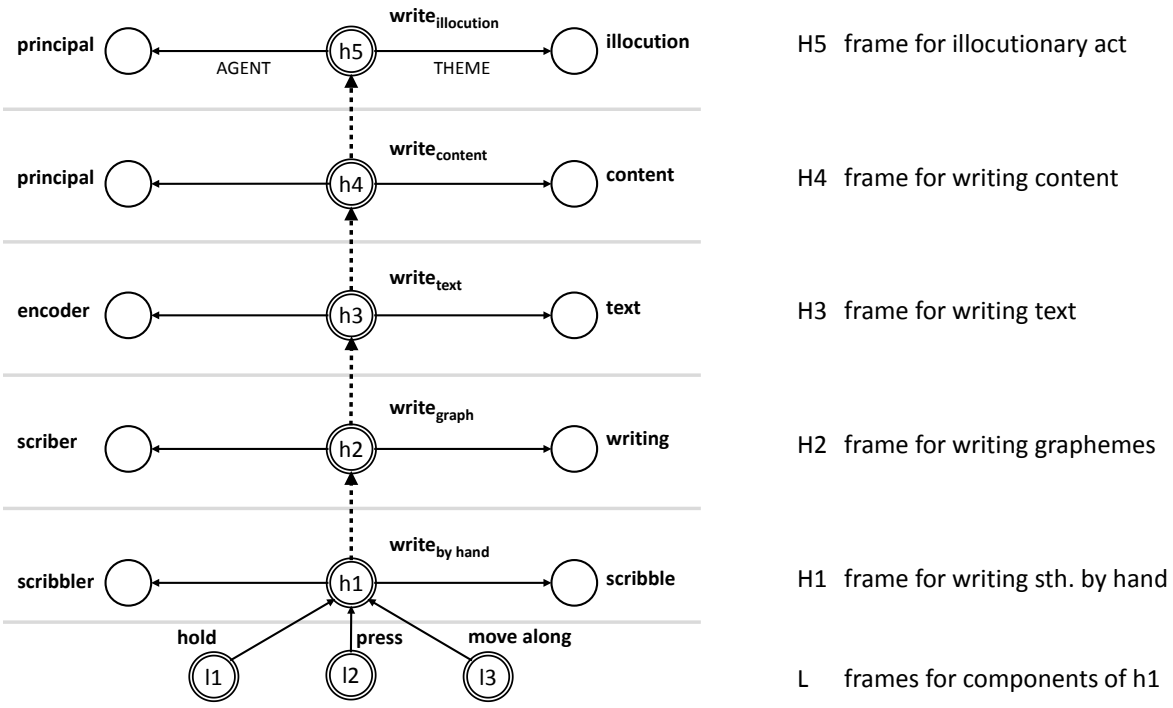


Fig. 4 The cascade for writing by hand

6.2 The cascade structure of writing by hand

We will now proceed to an example that is suitable to illustrate and discuss central aspects of applying the cascade approach to verb semantics. Fig. 4 displays a cascade for the concept of writing by hand. It is roughly analogous to Austin's cascade, but we will elaborate it more, commenting on the single-level frames and their relationships. The writing cascade has a lowest level of three co-temporal acts; compound augmentation integrates them into the act-type at the first level that can be called writing, Level H1 'write by hand', in the sense of producing visible lines and shapes. The agent holds a writing implement in their hand, presses its writing part on some surface, and moves it along leaving a visible trace. For reasons of space, the three frames for the acts of holding, pressing, and moving along are only represented by their central act nodes. In fact, they share the agent among them and the action time with the higher-level frames; they also have the same theme argument (i.e. the pen or other writing implement); the acts of pressing and moving share the surface as a third argument.[34] [35]

The higher Levels H1 to H5 consist of action frames that each have an AGENT and a PRODUCT attribute (the attribute arrows are labeled accordingly only in the highest level) . If Level H1 produces perceptible forms of writing on the surface, it generates Level H2 'write$_{graph}$' of producing graphemes. Graphemes, in turn, may or may not constitute linguistic text: under circumstances, Level H2 generates Level H3 'write$_{text}$'. Again under circumstances, writing text constitutes a fourth Level H4 'write$_{content}$'. Writing verbal content corresponds to the locutionary level in Austin's cascade. To this level adds an illocutionary level H5 'write$_{illocution}$', for example,

[34] That the three acts must have identical values for the attributes AGENT and τ, follows from the condition that they be unified to one act frame by compound augmentation; the unification requires that nodes for the same things have values if the same type. If we assume that we are dealing with a particular act-token, this means that the values must be identical.

[35] Actually, the process of handwriting is even more complex; usually, the pen will not be in continuous contact with the surface since writing certain graphemes, words, or sequences of words may require to lift the implement and move it to a different position on the surface.

an application, an excuse, a reply, a request, etc. The specific type labels for the agents will be explained in 6.4.

At each cascade level, the act is embedded in a different context, and each context comes with different requirements. The context of Level H1 is the same as, for example, the context of drawing. The agent needs a surface such as a sheet of paper and they need a pen or other implement, maybe along with ink, paint, etc. The agent needs to be able to hold the implement and move it along on the surface at some level of motor control. The product at Level H1 can be copied or scanned; if properly processed, it can be stored on an electronic device; the agent determines readability in terms of the size of writing, the visibility of the writing material on the surface, the durability of the product; they may be concerned with highlighting parts of the writing by different color or style. At Level H2, the agent bothers about a writing system and a writing style. They need to command the skill of writing. The Level 3 agent is concerned with choosing a language, with orthography and grammar; they need be in command of the language. At Level H4, the agent produces content, whereby the author potentially relates to other content and its authors; for larger texts, the author is concerned with aspects such as coherence and structure which are crucial for comprehensibility. Obviously, producing text involves more abilities than just knowing the language. It is at the illocutionary level that the agent enters interaction with a reader addressee, possibly initiating or continuing a sequential exchange; the agent at this level will choose an appropriate type of text, a style and a tone of expression, which requires the relevant social competence. At each level, different criteria of successful action obtain. And each level is motivated and informed by what it serves to level-generate.

6.3 Types of products and levels of manner modification

At each level, the writing activity brings about different types of product, for example, lines, letters and characters, words, coherent text, illocutions, etc. This amounts to different selectional restrictions for each level. Correspondingly, if the verb *write* is complemented with a direct object such as *whorls, e's*, *"mama", "I'm to the cafeteria"*, *a receipt*, etc., an appropriate level within the cascade will be selected for application. If one were to describe the selectional restrictions for the theme argument of *write* in a single-level approach, one would run into a heterogeneous type assignment for the product argument.[36]

The level-distinction is equally relevant for the analysis of manner modification. (26) lists manner modifiers of *write* that are level-specific; others like *slowly* or *beautifully* may apply at more than one level.

(26) Manner modifiers of *write* and the cascade-levels they relate to

H1	*swiftly*, *shakily*
H2	*small*, *illegibly*
H3	*ungrammatically*, *coherently*, *in Dutch*
H4	*incomprehensibly*, *redundantly*, *laconically*
H5	*urgently*

Without requiring disambiguation or coercion, the verb combines with any-level modifiers or product specifications. Simultaneous relation to different levels is possible. The following example constitutes a case of what is called “copredication”:

(27) *She used to write her private letters* [H4] *very slowly* [H1] *on her typewriter* [H1].

[36] One approach dealing with this problem is the assumption of “dot objects“ (see for example Pustejovsky 2009, Asher 2011). Dot objects are of a composite type, such as *physical_object • information* for ‘book’. There is a vague connection between this approach and cascade theory, if the notion of cascade is extended to objects (see below), but the relationship is too unclear to be addressed here. The dot-objects approach raises many questions: What is the ontological character of dot objects – are they one object or more? Which types can be combined to form dot types? Which relationships obtain between the elements of a dot object? What is the relationship of the elements to the whole?

6.4 Agencies at cascade levels

In Goldman's theory, the agents of the acts in a cascade are presupposed to be the same. But even so, they are in different *roles*, a fact we blurred by the use the same generalized attribute AGENT at all levels, instead of the more specific role attributes that actually apply. In the case of writing by hand, these are:

(28)

Level	Agent's role
L	the one who holds the writing implement in hand
	the one who presses its writing part on the surface
	the one who moves it along on the surface
H1	the scribbler
H2	the scriber
H3	the encoder of the text
H4	the author of the content
H5	the performer of a written illocutionary act

Goffman (1979) introduced the notion of "footing" in order to distinguish different roles that the participants of a verbal communication can take in.[37] There are producer footings and recipient footings. On the producer's side, Goffman distinguishes the roles of "principal", "author", and "animator". The principal is the one on whose behalf an utterance is made, the one responsible. The author chooses the words, the animator produces the verbal signals. In everyday communication, the three roles are usually enacted by the same person, but in institutional settings, like press conferences, public speeches, court trials, examinations, and countless others, the producer footings may be distributed among more than one person, present or absent; ghostwriters choose the words they don't utter themselves, attorneys speak on behalf of their clients, a typist types words not their own. Agentship can in principle be delegated down the cascade if the higher-level agent is in a position to do so. A lower-level agent is responsible to one of the higher-level delegators; ultimately, the principal will be held responsible for the performance of all the agents involved at the lower levels. These considerations may lead to a generalization of level-generation that allows for delegation of agency down the cascade, instead of strict identity of agents. In the realm of social interaction, delegated agency is a common phenomenon. For example, I may help somebody by delegating helpful action to a third party; I may pay a debt by having a third person pay who owes me money; I may break the law by making my subordinates do something illegal, and so on. In the diagram of the writing cascade in Fig. 4, the agent nodes are labeled according to Goffman's distinctions

If agency does not split, there is a relation more specific than identity between the agent roles at the different levels – if these agents are not considered just persons but persons-in-a-particular-role. Let us assume that Erica holds a pen and moves it along a piece of paper. As such she is already in three roles, implementing the penholder, the one who presses the pen upon the paper, and the one who moves it along on the paper. If she produces script, she thereby implements a 'writer-by-hand'. The implementation cascades upwards if Erica is successful in writing graphemes, thereby producing text, content, an illocution. The agent at a given generator level implements the agent at the generated higher level. Like the relation of c-constitution, the implementation is successful only under circumstances. We will therefore talk of "c-implementation".

The implementation relation is asymmetric: the writer-of-text implements a writer-of-content, but not vice versa, since text need not have content. It is also irreflexive: no role implements itself. And implementation is transitive. Thus, the c-implementation relation has essentially the same properties as c-constitution, except for the fact that it is a relation between persons and the roles they implement, rather than between

[37] See also Levinson (1988) for discussion of Goffman's notion from the point of view of linguistics.

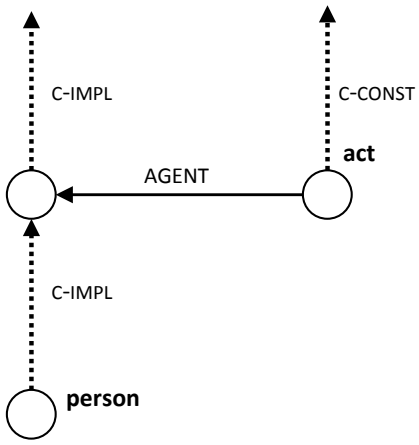


Fig. 5 The two levels of implementing an agent role

acts. In analogy to c-constitution, we consider c-implementation as a relation between TTs, in this case persons under a particular role description, for example Erica/'AGENT(a/'write$_{\text{by hand}}$'), that is "Erica in the role of the agent of an act of the type 'write$_{\text{by hand}}$' ".

C-implementation shares with c-constitution the question of grounding. Although c-implementation goes hand in hand with c-constitution of acts, the grounding of c-implementation is not just derivative from the grounding of c-constitution. Rather, for any level of action, including the basic level, taking the agent role means implementing it, for the person who acts. Hence, if B is the basic act in a cascade to perform, the c-implementation chain starts with an additional prior step, taking the form in (29a), while the act-cascade is as in (29b):

(29)	a.	person x	**c-impl**	x/agent at level L	**c-impl**	x/agent at Level H1	**c-impl**	…
	b.			l/act at level L	**c-const**	h/act at Level H1	**c-const**	…

Fig. 5 displays the two levels involved with agency: the person who implements the agent and the person in the agent role for a specific act. The act level may cascade further upwards.

We may assume that a person is implemented by a living human animal, the human animal by a human organism, the organism by biomass, and so on. This assumption would be in a line with theories that model social entities such as persons as supervenient on biological entities, and these on chemical entities, and ultimately matter. Thus, the problem of grounding persons in an implementation cascade is an ontological problem of its own that extends down below the basic level of act-cascades.

This mismatch notwithstanding, we may consider to generalize the term *c-constitution* as to also cover the c-implementation relation. It makes sense to extend the use of the term in this way: the writer-by-hand under circumstances *constitutes* a writer of graphemes, who in turn may *constitute* a writer of text, etc. In both applications of the term, to acts and to their agents, the notion of c-constitution captures the phenomenon of multi-level categorization.

6.5 Objects at cascade levels

Goldman does not impose conditions on arguments other than agents involved in the acts at different levels. In view of the writing cascade, it would be inadequate to assume identity of the products because they exemplify ontologically different types of object. Extracting the product track from the cascade yields a multi-level conceptual description of the product on its own. The product is something of a quality that originates at Level H1, it is also something of a quality that originates at Level H2, and so on. Again, there is a relation

of constituency: under circumstances, the graphemes constitute text, the text constitutes content, the content an illocution.

The difference of description that applies to the product of writing at the levels distinguished is particularly conspicuous. This will always be the case for object arguments in action cascades of creating, destroying, or changing things, like *bake*, *break*, or *repair*. However, objects in other cascades, even if they may not change, come about, or cease to exist, will be in different roles, too, analogous to the agents in a cascade. Consider the following cascade:

(30)
L Amy presses the power button on the TV remote control
↥ H1 Amy turns on the TV
↥ H2 Amy turns on the evening news
↥ H3 Amy starts her daily evening TV ritual
↥ H4 Amy breaks off the on-going conversation with her friend
↥ H5 Amy annoys her friend

And now consider the role of the TV set at the different levels:

(31)
L The TV is a remote-controllable device tuned to the particular remote control.
H1 The TV is in the role of being turned on by the telecommand. It matters whether or not the TV is in the state 'on', 'off', or 'standby'; it changes this state upon receiving the telecommand.
H2 The TV is in a state such that it receives TV broadcast programs; in particular, it is a device that delivers the evening news. It is a device of mass media communication.
H3 The TV is in the role of the device that enables Amy to have her daily evening TV ritual. It serves Amy's habits in a particular way.
H4 The TV and its program, when watched by Amy, make continuing her conversation impossible. To Amy, the TV and its program is something that at this moment is more important than continuing her conversation.
H5 The TV and its program are a disruptive element to Amy's friend.

6.6 C-constitution generalized

We argued above that the cascade relations are second-order because they are relations between act-types. We now see that there is a much stronger argument for the second-order view: c-constitution between acts necessarily comes along with c-constitution of agencies and potential further arguments of the acts if they are shared between levels. These other tracks of c-constitution are conceptualized as roles of the arguments involved. Hence, c-constitution is a *multitrack* condition. Fig. 6 displays a three-track sub-configuration cascade that would apply to the writing example. Notably, the tracks in an action cascade intrinsically harmonize. To each of them the same circumstances – the "c" parameter of c-constitution – are relevant, and with them the level-specific contexts. The diagram highlights the multitude of c-const relations, the three tracks can alternatively be considered the components of the one complex inter-level relation indicated by the ⇮ arrow in Fig. 2b.

7 Reference and composition

The assumption that action-verb meanings are concepts with a cascade structure has far-reaching consequences not only for a theory of cognitive representation and decomposition, but also for the theory of reference and composition.

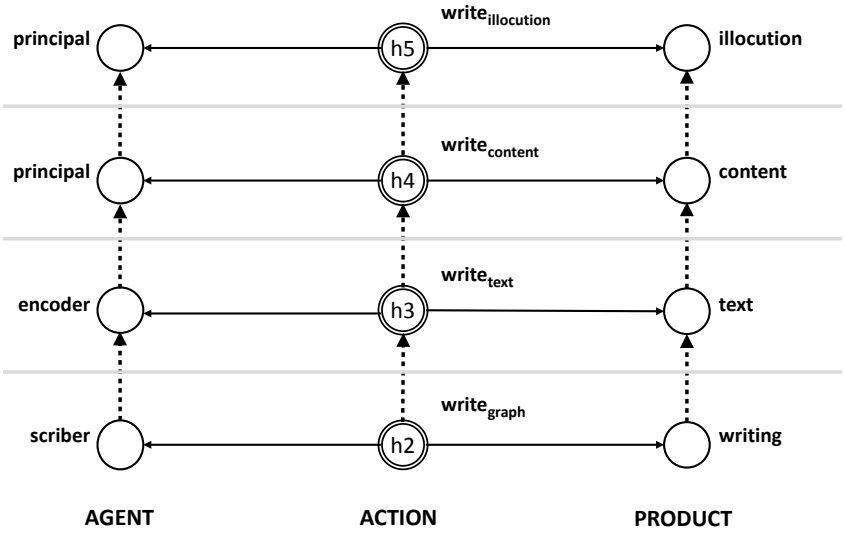


Fig. 6 Three tracks of c-constituency in a cascade

7.1 Meaning and reference of the verb *write*

We call activities at all Levels H1 to H5 of the writing cascade "writing", regardless if the higher levels are actually achieved. If we refer to a level higher than H1, a choice of alternative methods at Levels L and H1 is available, such as writing with a typewriter, or by using a computer with a keyboard, a smart phone with a touch screen etc. Thus, for present-day English, it is not to be assumed that the cascade in Fig. 4 represents the *lexical meaning* of the verb, as the lexical entry must not fix the method of writing. That does not mean that the level of the writing method is absent from the concept; it cannot be absent because it is required for logical reasons (no higher-level acts without appropriate generating lower-level acts). The method of writing is present in the lexical concept, but it is not specified.

What we are dealing with here is not polysemy, that is, different senses on a par with each other. Rather, it is a case of one sense with a complex internal cascade structure. Of course, this does not mean to say that action verbs with a cascade structure meaning cannot be polysemous in addition.

When the verb *write* is used referentially, it refers to a cascade of act-TTs. The cascade need not be implemented completely. The completion can be confined to any level from H1 to H5 if some of the higher levels do not come about due to circumstances or because the agent did not intend to achieve them.

7.2 Cascades and composition

If we consider semantic meanings to be concepts, for example frame cascades for verbs of action, and if we are provided with explicit models of these concepts, we are in a position to ground a theory of semantic composition on the given decomposition. Semantic composition can then be modeled in more detail and more precisely. Also, if we know more about the meanings of words, we can start to model the interaction of semantic information with context knowledge. Using the example of the verb *write*, we will illustrate some of the general perspectives of semantic composition that emerge from the cascade model. These are, again, novel to semantic theory.

Let us assume we are to interpret a simple sentence with the verb *write* in finite use, with a subject and a direct object.

(32) *Martha wrote the statement.*

The lexical meaning of the name *Martha*, when taken as a person name, is a very simple frame: There is a central referential node typed as 'person' with one attribute, NAME, that carries the value 'Martha', basically an English sound and written form; we may add a GENDER attribute to the central node with the value 'female' if we consider it adequate to assume that the bearer's gender constitute part of the meaning of the name *Martha*. The subject DP in (32) specifies the agent argument of the verb. Now, there are five agent nodes in the writing cascade that belong to an act typed as some level of writing. The frame for *Martha* can be unified with any one of them. What about the remaining four agent nodes? They will essentially be taken care of by the c-constitution requirements. In the simpler case of one-party agency, Martha is the agent at all levels, i.e. the scribbler, the scriber, the encoder, and the principal at the same time. If we allow for footing splits, the conditions are more involved: the level-agent is either Martha herself, or somebody who delegates this level to Martha or someone who Martha delegates this level to.

In addition to the full five-level readings of *write*, there is the possibility that the writing cascade may be implemented only up to a level lower than H5. Thus, there are three degrees of freedom given for the composition of verb and subject NP: (i) choice of the overall expansion of the writing cascade up to a level less than or equal H5; (ii) selection of a level for the agent; (iii) selection of the agent's role in a footing structure. This amounts to a vast number of readings on this part alone.

Dealing with the direct object in (32) is less complex because in most cases the specification will select a particular level of the cascade. In the given case, the product is Level H5, an illocution. In order to be able to select the appropriate level for unifying the product node with the frame for *the statement*, we need to know that statements are illocutions, that is, we need an according frame representation of the noun *statement*. As to the remaining four object nodes in the cascade, again the c-const relation will take care; for any product at a Level n+1, the product at Level n must support the higher-level product type. We may, however, also have product specifications that leave the type open, such as *it* or *that*. Depending on how the reference of the pronoun is determined in the given context, it might result in selecting a different level than was chosen for the agent. Therefore, the number of readings due to handling the agent argument possibly multiplies with the number of levels on account of level-selection for the object specification.

As is natural when one works with frames, we assume that the basic mechanism of semantic composition is unification.[38] Unification is restricted by the conditions that the type information on the nodes unified be compatible. In the case of level-specific object specifications or modifiers, this condition accounts for how these "find" their level to apply to. If there is more than one pair of nodes that fit, there may be more than one way of unification. We therefore have to accept that semantic composition is not deterministic. Although this is a bitter pill to swallow for some theoretical orientations in semantics, this consequence is after all welcome. All the readings possible are potentially "real". If there are several readings to a sentence without it containing ambiguous lexical items, the compositional theory must account for them accordingly. Thus, the multilevel approach is on the one hand considerably more complex, but on the other it is able to account for the semantic data in a much more differentiated way, and hence more adequately.

Bitter pill or not, one should realize that the classical model of semantic composition is not a psychologically realistic model (and never was meant to be). In a realistic approach to semantic processing, the semantic agent will not only process linguistic information (i.e. basically the syntactic structure and the lexical meanings), but also draw on contextual knowledge *during* the process of composition, not only after it is finished. Aiming not at abstract sentence meaning, but at utterance meaning, that is, meaning plus reference in the

[38] According to the formal semantics view of composition, predicate expressions have open argument slots in their meaning to be "saturated" with the arguments. If we apply this view to the cascade approach, one level will be selected for the agent argument to saturate and a possibly different level for the product argument. The other agent slots and product slots are existentially saturated and imposed type conditions emanating from the c-const relations obtaining to the saturated nodes.

given context, the composing subject will merge the semantic information as early as possible with contextual information about the referents. For example, when faced with the sentence *Martha wrote the statement*, in a context where they know who Martha is, what statement is at issue, and which writing footing Martha can have, they may come up with one possible reading only. It is in this connection, where the dependence of c-constitution on the circumstances comes to bear crucially. The c-parameter in every cascade link *calls for* the inclusion of contextual knowledge in the compositional process; knowledge of the circumstances is necessary in order to decide which cascade levels are actually accomplished.

8 Conclusion: Cascades in cognition, semantics, life, and metaphysics

We started out from Goldman's theory of level-generation and act-trees. Taken as the psychological notion Goldman intended, level-generation provides the ground for a novel theory of the cognitive representation of action concepts. According to this approach, tokens and types of human action are conceptualized in multilevel cascade structures (the occasional basic acts notwithstanding). Cascade concepts of action applied to single tokens of acts are complex structures that categorize an act simultaneously as different types of action, organized into a tree structure of levels. These are not levels of generality, but of constituency: lower-level acts constitute higher-level acts, where constituency is generally dependent on circumstances that make it possible.

In a second step, Goldman's theory was applied to action *verb* concepts in natural language. Almost all action verbs denote non-basic action and therefore cascades of action. Some examples of everyday activities such as writing call for cascaded concepts of as much as six or more levels. Thus, the repertoire of natural language verb meanings provides ample evidence for Goldman's multilevel view on action categorization. As a theory of the structure of semantic verb concepts, the cascade approach has far-reaching consequences for a theory of decomposition of verb meanings and for the theory of semantic composition.

A closer look at the participants in the acts within a cascade reveals that there are analogous constituency relationships between the respective participants at different levels. There is a track of stepwise upwards implementation of agency in terms of the finer-grained level-specific agent roles. A parallel track obtains for other participants involved through cascade levels. This finding suggests that the multilevel conceptualization of human action induces cascades not only for action itself, but also for agents and objects involved.

A radical induction from these findings might be this: All human categorization is, at least potentially, multilevel in the sense of cascade theory. Whatever we categorize, we categorize at potentially more than one level. This is owed to the fact that the bits and pieces of reality, or to be precise: of what is reality to us as human cognitive subjects always matters in many different contexts. The brief glimpse at upward cascading mechanisms in the verbal lexicon (2.3) gave an impression of where cascading expands to: in many cases it is a projection into the realm of social action and interaction; in others, cascading conquers the realm of appraised action (with respect to personal or socially shared values). This might be taken as an indication that there may be macrolevels across specific action types. Acquiring a vocabulary of verbs for human action with cascade structure meanings will help the members of a language community to synchronize their cascade level distinctions for single types of action as well as for overarching macrolevels. Clark's (1996) theory of language use is a detailed study of how conversational interactants synchronize their multilevel views of the interaction they are engaged in.

In his introduction to Goldman (1970), Goldman relates his theory of action to the ontological debate about the question whether, say, flipping a switch and thereby turning on the light is one act or two. The problem dissolves, if one applies the psychological perspective Goldman made more explicit later. From this perspective, his theory is not about just act-tokens, but about act-tokens-of-a-type, what we dubbed "act-

TTs". There is no doubt that, if somebody does something – one doing – they potentially (if not necessarily) enact in one a whole cascade of doings. All the acts in a cascade *really* are enacted; they *really* are as what they are categorized at each cascade level. This is reality *to us* as we cognitively construe the world. For psychology and in particular for the analysis of verbal communication – and thereby for semantics and pragmatics – this is the relevant notion of reality.

The higher levels of an action cascade can be considered as corresponding to as many respects in which the doing has *meaning* (in a nontechnical sense). Likewise, persons in roles matter at the level of action that defines this role, and so do objects involved in action. Conversely, acts, persons, and objects can be viewed as lacking meaning to us as long as they, for us, do not c-constitute anything at a higher level. Of course, what carries meaning to a subject is first of all a personal issue. There are, however, socially established ways of c-constitution that will be anticipated by persons in social interaction.

To the extent that the analysis of semantic concepts can provide evidence for the cascade theory, it can be regarded as a contribution to the philosophical program of natural language metaphysics and ontology[39]: the approach to ground a theory of the world and the things there are in semantic analysis.

Linking the cascade theory of action to observations on the meanings of action verbs is not only an application of the theory; these observations conversely provide support for cognitive theory: if so many lexical verb concepts turn out to be multilevel, this must be due to the way in which our mind works.

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[39] See for example Moltmann (2017).

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Online corpora

BCC Beijing Language and Culture University Chinese Corpus. http://bcc.blcu.edu.cn/lang/en
BNC BNCweb. British National Corpus online. http://bncweb.lancs.ac.uk/.
DWDS Das Wortauskunftssystem zur deutschen Sprache in Geschichte und Gegenwart. https://www.dwds.de/