

To appear in A. Egan / P. van Elswyck / D. Kinderman (eds.): *Unstructured Content*. Oxford University Press.

## **Outline of an Object-Based Truthmaker Semantics for Modals and Propositional Attitudes**

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January 28, 2019

### **Introduction**

Possible-worlds semantics certainly is the most common approach to the semantics of modals, and it is also a dominant approach to the semantics of attitude reports, at least in linguistic semantics. While philosophers have discussed problems with possible-worlds semantics for quite some time, possible-worlds semantics continues to have a range of attractive features that have made it persevere as a central tool of analysis in formal semantics. First of all, possible-worlds semantics appears to have the very general advantage of allowing for a unified compositional semantics of intensional and extensional expressions of various sorts, in the tradition of Montague Grammar. In addition, possible-worlds semantics appears to have more specific advantages, such as being a suitable basis for accounting for various sorts of connections between modals and attitude reports, for the way presuppositions are satisfied in attitude reports and in modal sentences, and for how utterances of sentences of different sorts contribute to the discourse context or common ground, which is standardly construed in terms of possible worlds (as set of worlds, a context set).

The main shortcomings of possible-worlds semantics are well-known, foremost the identification of the meanings of logically equivalent sentences and more generally the problem of sets of possible worlds giving a too coarse-grained notion of content. The need for a more fine-grained notion of content, especially for attitude reports, was the motivation for an alternative, structured conception of content, replacing sets of worlds by structured propositions, n-tuples of objects or concepts. The structured- propositions view comes with its own problems, however. For one thing, it raises serious conceptual problems (the unity of

propositions problem, the arbitrariness of the order of propositional constituents). Moreover, it is tailored for attitude reports of a certain sort but not modals, and is hard to make use of for general semantic purposes, such as compositionality.

A third approach to the semantics of attitude reports makes use of situations rather than entire worlds, an approach that also gives a more fine-grained notion of content, though of a different sort. One recent version of such an approach is truthmaker semantics (Fine 2017, to appear a, b). Truthmaker semantics is based on the relation of exact truthmaking or satisfaction between a situation or action and a sentence, as well as a corresponding relation of exact falsmaking or violation. Truthmaker semantics has been applied to a range of semantic and logical topics, including conditionals and deontic modals, but not attitude verbs and modals in general.

This paper gives an outline of an approach to the semantics of attitude verbs and modals that I call *object-based truthmaker semantics*. Object-based truthmaker semantics carries the various advantages of truthmaker semantics, making use of situations or actions in the role of exact truthmaker or satisfiers, though not just of sentences, but also of a range of objects which I call *modal and attitudinal objects*, entities of the sort of obligations, permissions, claims, requests, and judgments. Object-based truthmaker avoids the problems of possible-worlds semantics, yet aims to retain similar advantages, in particular in providing a unified semantics of modals and attitude reports and a way of dealing with the connections between modals and attitude reports and the contribution of sentences to a discourse context. In addition to avoiding a too coarse-grained notion of context, it also has specific advantages, for example providing a better account of modals in embedded contexts (harmonic modals).

Object-based truthmaker semantics is based on an ontology of modal and attitudinal objects, entities like permissions, obligations, claims, requests, and judgments. These objects are considered the primary content bearers (bearers of truth or satisfaction conditions), not propositions. Unlike in Fine's sentence-based truthmaker semantics, object-based truthmaker semantics assigns truthmakers (situations or actions) not just to sentences, but also to modal and attitudinal objects. More precisely, each modal or attitudinal object is assigned a set of truthmakers or satisfiers and a set of falsmakers or violators.

Object-based truthmaker semantics assigns very different logical forms to attitude reports and modal sentences than the standard view does. The standard view is that clauses when they are embedded under an attitude verb act as singular terms standing for propositions. The present view is that such clauses act semantically as predicates of the attitudinal object associated with the attitude verb. The standard view is that modal predicates act as quantifiers

over possible worlds and that what I will call the *sentential unit* associated with the modal predicate (complement clause, subject clause, or preajacent) acts as the scope of such a quantifier. The present view is that the sentential unit associated with a modal predicate acts as a predicate of the relevant modal object. Clauses act as a predicates of modal or attitudinal objects by giving their truthmaking or satisfaction conditions, which, I argue, are best cast in terms of truthmaker semantics.

This paper will first give a general outline of object-based truthmaker semantics against the background of the standard semantic view of attitude reports and modals and then apply object-based truthmaker semantics to different sorts of attitude and modal predicates. The applications will concern besides attitude reports and modal sentences in general, the semantics of different types of attitude verbs, performative and descriptive uses of modals, modals embedded under attitude verbs, and dynamic aspects of meaning,. The paper will not give a more thorough discussion of the syntactic basis of the semantic analyses that are presented and does not aim for a fully developed compositional semantics.

## **1. Standard views of propositional attitude and modals**

### **1. 1. The relational analysis of attitude reports and the standard analysis of modals**

The standard analysis of clausal complements of attitude verbs as in (1a) takes them to be terms standing for propositions, which in turn will be arguments of the embedding attitude verb. This is what I call the *Relational Analysis* (Moltmann 2003, 2013a), given for (1a) in (1b):

- (1) a. John believes that Mary is happy.  
       b. believe(John, [*that Mary is happy*])

Propositions are entities that are generally taken to play three roles: to be the (primary) bearers of truth values, to be the meanings of sentences (or referents of embedded clauses), and to be the contents or ‘objects’ of propositional attitudes.

There are two standard views about the content of propositional attitudes: the possible-worlds view, on which the content of propositional attitudes consists in a set of worlds, and the structured propositions view, according to which that content consists in a structured proposition, such as, in a very simple case, a pair consisting of a property and an object.

While there are various difficulties for both views, the second view has gained more popularity among philosophers, whereas the first view is generally adopted by linguists. One reason for the attraction of the possible-worlds view to linguists is a range of connections between attitude reports and modals that can, it appears, be easily formulated within the possible-worlds view.

The standard view of modals consists in the Quantificational Analysis according to which a modal of necessity as in (2a) has the meaning given in (2b), and a modal of possibility as in (3a) the meaning given in (3b):

(2) a. John needs to leave.

b.  $\forall w(w \in f(w_0) \rightarrow [John\ leave]^w = \text{true})$

(3) a. John is allowed to leave.

b.  $\exists w(w \in f(w_0) \ \& \ [John\ leave]^w = \text{true})$

The contextually given function  $f$  maps the world of evaluation  $w_0$  to the relevant set of world. The quantificational account of modals was extended to verbs expressing belief and knowledge by Hintikka, and the Hintikka-style analysis has since become a common approach to the semantics of attitude verbs in natural language semantics. Thus (4a), on that view, has the truth conditions in (4b), where  $bel_{w,j}$  is the set of worlds compatible with what John believes in  $w$ :

(4) a. John believes that  $S$

b.  $\forall w'(w' \in bel_{w,j} \rightarrow [S]^{w'} = \text{true})$

(4b) can be reformulated straightforwardly in terms of the relational analysis, making use of a proposition  $p$  (the set of worlds in which the sentence  $S$  is true) as an argument of the attitude verb:

(5) believe( $J, p$ ) iff  $\forall w'(w' \in bel_{w,j} \rightarrow w' \in p)$ .

The modal analysis of attitude verbs has generally been applied only to attitude verbs that are taken to involve universal quantification over worlds, such as belief and knowledge.<sup>1</sup> It is not obvious in fact that there are verbs expressing mental attitudes that are correlates of modals of possibility and thus would involve not universal, but existential quantification over worlds. Perhaps there are uses of *think* that functions that way (thinking in the sense of taking a possibility into consideration), and there are verbs like *hypothesize*. Clearly, though, there are speech act verbs that correspond to modals of possibility, acts of giving permission as well as acts of inviting or offering: permissions, invitations, and offers are associated with possibility, not necessity.

## 2. The attraction of the possible-worlds view of modals and propositional attitudes

The possible-worlds account of content is most plausible for implicit beliefs, including those of animals and small children, where not a particular structure of thought matters but rather the agent's dispositions regarding particular circumstances (Stalnaker 1984). However, the view is much less plausible for various other attitudes, involving mental or illocutionary acts.

Possible-worlds semantics, though, has been attractive to formal semanticists for other reasons. First, possible-worlds semantics, it appears, allows for a unified compositional semantics of the sentential units (clausal complements or subjects or prejacent) associated with both attitudinal and modal predicates. Sentential units on that view always stand for sets of possible worlds, which are obtained compositionally from possible-world-based meanings of subsentential expressions.

Possible worlds have also played an important role for representing the common ground. The common ground is generally conceived as a unstructured content of what the interlocutors take for granted, as a set of worlds or context set. The common ground plays a central role in theories of presuppositions, in the so-called the satisfaction theory of presupposition projection (Heim 1983). On the satisfaction theory, the presuppositions of a sentence *S* need to be true in the worlds of the common ground *C* (a set of worlds) in order for *C* to be updated with the proposition *p* expressed by *S* (a set of worlds) with *C* (which means intersecting *p* with *C*). Complex sentences such as conjunctions and conditionals involve complex conditions on updating. Updating a context set *C* with the utterance of a conjunction

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<sup>1</sup> Some attitude verbs have been considered imposing an ordering of preference along worlds such as *want*, *wish*, *be happy* (Heim 1992).

$S \& S'$  consist in first intersecting  $C$  with the proposition expressed by  $S$  and then intersecting the result with the proposition expressed by  $S'$ .

In addition to the primary context set representing what is shared by the interlocutors, various *secondary context sets* need to be distinguished, representing what the interlocutors take the content of a particular type of attitude of a particular agent to be.

Further additions to the context set (or the context sets) are needed in order to account for updating with questions as well as with imperatives and performatively used deontic modals, that is, modals that put a requirement in place, rather than describing it, as possibly below:<sup>2</sup>

(6) You must leave.

Thus, Portner (2004) proposes to augment the common ground with a sets of issues (sets of propositions) for updating with questions, as well as a *to do*-list (a set of properties or action types) for updating with imperatives and performatively used deontic modals (or several such lists, cf. Portner 20007).

There are also particular connections among propositional attitudes and modals. I will focus on just two. One of them consists in that attitude or illocutionary act reports may permit particular inferences to modal sentences such as, under suitable circumstances, the inferences below:

(7) John asked Mary to leave.

Mary must leave.

(8) John offered Mary to use the house.

Mary may use the house.

Another connection between attitude reports and modals is so-called harmonic modals (Kratzer 2016). Harmonic modals are occurrences of modals in the complement clause of an attitude verb that appear to resume the modal force associated with the reported attitude rather than contributing to a modal content of that attitude:

(9) John insisted that Mary should leave.

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<sup>2</sup> For more on the notion of a performative use of a modal see Portner (2007).

Again, possible-worlds semantics appears to be suited to capture this sort of connection between modals and propositional attitudes (Section 4.2.).

Other sorts of connections between attitude reports and modals include the interpretation of epistemic modals in complement clauses of attitude reports (Pranav/ Hacquard 2013).

### 1.3. The structured-propositions view

Structured propositions have been proposed as an alternative to propositions as sets of worlds since they give a more fine-grained notion of content. A structured proposition is generally conceived of as an n-tuple consisting of meanings of elementary constituents. Thus, a simple type of structured proposition, as the meaning of the subject-predicate sentence *Mary is happy*, would be a pair consisting of a property (the property of being happy) and an object (Mary). With structured propositions as their meanings, two sentences that are logically equivalent but involve significantly different syntactic structures are distinguished, as are sentences that about different objects or involve different properties. Though structured propositions appear more suited than sets of worlds for the content of propositional attitudes, structured propositions come with conceptual problems of their own, especially the problem of the unity of propositions: truth conditions for structured propositions need to be stipulated, and are not inherent in the nature of structured propositions as such (Jubien 2001, Moltmann 2003b, 2014, Soames 2010, Hanks 2011). Moreover, the structured-propositions view imposes a fineness of grain that is not generally considered needed for the semantics of modals, and even perhaps the semantics of various sorts of implicit attitudes, and sometimes even for explicit attitudes. Thus the distinction between an active and a passive sentence often does not matter even more explicit attitudes. Furthermore, construing the objects of at least some attitudes as structured propositions could not permit accounting for the connections between propositional attitudes and modals that were mentioned in the last section.

Yet, it appears that for certain sorts of attitude reports a highly fine-grained, structured notion of content is unavoidable, especially reports with verbs of saying (including (occurrent) *think*, Moltmann 2017b). The sensitivity of reports of acts of saying to syntactic structure and perhaps even choice of words can be enforced by the use of *literally* as below:

(10) John literally said that S.

However, if for verbs of saying, the particular choice of words as well as the syntactic structure of the complement clause may matter, this should not so much motivate a particular conception of sentence meaning as such (structure propositions as opposed to sets of worlds). Rather it motivates a view according to which the complement of verbs of saying contributes differently to the characterization of the reported attitude than the complement of other attitude verbs, namely by specifying the structure of the product of a locutionary act, rather than just providing a propositional content (or the truth or satisfaction conditions of the reported attitudinal object) (Moltmann 2017b). In what follows, therefore I will set aside verbs of saying, as they arguably involve a rather different overall semantics than other attitude verbs.

## 2. Truthmaker semantics

Truthmaker semantics, as recently developed by Fine (2017, to appear a, b), gives a notion of content that is more fine-grained than that of possible-worlds semantics, but yet not as fine-grained as that of the structured-propositions view. In particular, content is not taken to reflect syntactic structure in the way structured propositions do. The following is a very brief outline of Fine's truthmaker semantics, which should suffice for the present purposes.

Truthmaker semantics is based situations and actions (rather than entire worlds), as well as the relation of exact truthmaking or satisfaction holding between situations or actions and sentences. More precisely, truthmaker semantics involves a domain of situations or actions containing actual, possible as well as impossible situations and actions. This domain is ordered by a part relation and is closed under fusion. A situation or action  $s$  stands in the relation  $\Vdash$  of exact truthmaking (or exact satisfaction) to a sentence  $S$  just in case  $s$  is wholly relevant for the truth of  $S$ .  $\Vdash$  applies to both declarative and imperative sentences: declarative sentences are made true by situations that are their exact truthmakers, imperatives are complied with by actions that are their exact satisfiers. The following standard conditions on the truthmaking of sentences with conjunctions, disjunctions, and existential quantification then hold:<sup>3</sup>

(11) a.  $s \Vdash S \text{ and } S'$  iff for some  $s'$  and  $s''$ ,  $s = \text{sum}(s', s'')$  and  $s' \Vdash S$  and  $s'' \Vdash S'$ .

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<sup>3</sup> The truthmaking condition for sentences with universal quantification and conditionals are less obvious and would require a lot more exposition.



b.  $s \Vdash S \text{ or } S' \text{ iff } s \Vdash S \text{ or } s \Vdash S'$

(12) For a one-place property  $P$ ,  $s \Vdash \exists x S \text{ iff } s \Vdash S[x/d]$  for some individual  $d$ .

Truthmaker semantics assigns sentences not only truthmakers or satisfiers, but also falsifiers or violators. Making use of the relation of (exact) falsification or violation allows a straightforward formulation of the truthmaking conditions of negative sentences: a truthmaker for  $\neg S$  is a falsifier for  $S$ . With  $\Vdash$  as the relation of (exact) falsification or violation, the condition on negation is given below:

(13)  $s \Vdash \text{not } S \text{ iff } s \not\Vdash S$

Also complex sentences are assigned both verification and falsification conditions. For conjunctions and disjunctions the falsification conditions are those below:

(14) a.  $s \Vdash S \text{ and } S' \text{ iff } s \Vdash S \text{ or } s \Vdash S'$

b.  $s \Vdash S \text{ or } S' \text{ iff for some } s' \text{ and } s'', s = \text{sum}(s', s'') \text{ and } s' \Vdash S \text{ and } s'' \Vdash S'$

A sentence  $S$  then has as its meaning a pair  $\langle \text{pos}(S), \text{neg}(S) \rangle$  consisting of a *positive denotation*, the set  $\text{pos}(S)$  of verifiers of  $S$ , and a *negative denotation*, the set  $\text{neg}(S)$  of falsifiers of  $S$ . In truthmaker semantics, logically equivalent sentences have different semantic values as long as they have different subject matters (i.e. are about different entities or more generally describe different situations).

Truthmaker semantics as developed by Fine assigns content only to sentences and has not been developed so as to allow for an application to attitude reports and modals in general.<sup>4</sup> An obvious way in which one might try to apply truthmaker semantics to attitude reports would be to take the truth-maker-based meanings of sentences to be the arguments of the attitudinal relation. This means (15a) would be analysed in (15b):

(15) a. John believes that  $S$ .

b.  $\text{believe}(\text{John}, \langle \text{pos}(S), \text{neg}(S) \rangle)$

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<sup>44</sup> Fine (to appear a, b) applies truthmaker semantics to deontic modality focusing on logical, rather than linguistic aspects.

However, there are a range of reasons why such an analysis would be unsatisfactory. One reason is that it could hardly be used to account for the connections between modals and attitude reports. Another reason is that (15b) would fall under the Relational Analysis of attitude reports, which is associated with a range of philosophical and linguistic difficulties, as will be discussed in the next section.

### **3. Problems for the Relational Analysis of attitude reports and the importance of modal and attitudinal objects**

The Relational Analysis on which attitude verbs take propositions as arguments allow for more or less fine-grained notions of content: a proposition may be construed as a set of worlds or as a structured propositions of some sort. There are a range of philosophical and linguistic difficulties, however, for the Relational Analysis.<sup>5</sup> I will just mention them briefly, since they are elaborated elsewhere in the literature and my own previous work.

[1] The Relational Analysis fails to make a distinction between the content and the object of an attitude, treating propositions as things agents have attitudes to, rather than as the contents of attitudes that agents engage in.

[2] Abstract propositions raise a number of conceptual problems, which are a major topic of discussion in contemporary philosophy of language. Those problems include the problem of the graspability of propositions and the problem of how propositions as abstract objects can be true or false

[3] The Relational Analysis has difficulty accounting for the Substitution Problem, the problem of the unacceptability of (16b) as an inference from (16a), and the Objectivization Effect, the difference in the understanding between (17a) and (17b):

(16) a. John assumed that S

b. ?? John assumed the proposition that S.

(17) a. John fears that S.

b. John fears the proposition that S.

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<sup>5</sup> See Moltmann (2003b, 2013 chap 4, 2014) and reference therein.

[4] The Relational Analysis has difficulties accounting for the semantics of nominal constructions. Clausal complements of nouns as in (18) do not behave like arguments, since they are not obligatory even if the verb requires a complement:

(18) John's request that S

Semantically, the *that*-clause in (18) seems to stand for what the entire NP stands for (a request), rather than providing an object entering a thematic relation to the noun *request*. Yet, the clausal complement would stand for a proposition and a proposition is not the same thing as a request. For example, a request can be fulfilled or ignored, but a proposition cannot (at least not in the same sense) (See Section 4).<sup>6</sup>

[5] Another general problem for the Relational Analysis comes from the semantic behavior of what I call *special quantifiers* (Moltmann 2003a, b, 2013). Special quantifiers (and pronouns), which include *something*, *everything*, *that*, and *what*, have the ability of taking the position of clauses (as well as predicative and other nonreferential complements). In the complement position of attitude verbs, they are generally taken to stand for propositions, the shared content of attitudes of different agents, as below:

(19) John assumed the same thing as Mary.

However, predicates acting as restrictors of special quantifiers as complement of attitude verbs are not generally understood as predicates of propositions, but rather of attitudinal objects:

(20) a. John asserted something shocking.

b. John demanded something impossible to comply with.

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<sup>6</sup> The syntactic status of clausal complements of nouns, though, is far from obvious and there is a significant syntactic controversy surrounding it. Some researchers assimilate them to relative clauses (Arsenevič 2009, Moulton 2009, Kayne 2010). Others have argued against such assimilation (de Cuba 2017). The present view that clauses asemantically act as predicates, would go along well with the view that clausal complements of nouns, and even verbs, are relative clauses, but it is compatible with a different syntactic analysis of complement clauses, as long as the analysis permits them to be in some way interpreted as properties. Note that even some relative clauses, unrestrictive relative clauses, have been analysed not as semantic predicates, but as (E-type) pronouns. See Cinque (2008) for discussion and further references.

*Shocking* and *impossible to comply with* express properties that can be attributed to attitudinal objects (assertions, demands), but not abstract propositions (which cannot be ‘shocking’, or ‘impossible to comply with’).

The same point can be made for the special relative pronoun *what* in reports of sharing as below:

(21) John asserted what Mary asserted.

There are particular constraints on reports on sharing that are not compatible with the Relational Analysis (Moltmann 2003a, b, 2013). Roughly, the two attitude verbs in such a report need to involve the same force, but may differ in certain other respects such as strength:

(22) a. ??? John promised what Mary asserted, that he will come back.

b. ??? John asserted what Mary demanded, that he will be back in an hour.

(23) a. John suggested what Mary asserted.

b. John requested what Mary demanded.

The constraints on quantifier restrictions and on reports of sharing support the view that special quantifiers are *nominalizing quantifiers*, ranging not over force-neutral propositions, but entities like assertions, demands, and promises, suggestions, and requests, that is attitudinal objects (or kinds of them) (Moltmann 2003a, b, 2013).

#### **4. The ontology of modal and attitudinal objects**

Object-based truthmaker semantics pursue an alternative to the propositions-based Relational Analysis of attitude reports as well as to the Quantificational Analysis of modal sentences. It is an alternative that is based on a novel ontology of attitudinal and modal objects, which is what this section will briefly expand on.

Attitudinal and modal objects are part of the ontology implicit in natural language: they act as semantic values of nouns (especially deverbal nominalizations) and of special quantifiers, as referents associated with *that*-clauses in certain contexts, and as implicit arguments of predicates. The characteristic properties of attitudinal and modal objects are reflected in the semantics of those constructions, though there are also various language-independent intuitions that give support to modal and attitudinal objects.

Modal and attitudinal objects generally have a limited life span and may display other features of concreteness. But they also share three content-related properties, which distinguish them from related entities, in particular from acts and propositions:

[1] Attitudinal and modal objects are bearers of truth or satisfaction condition.

[2] Attitudinal and modal objects enter exact or close similarity relations just on the basis of being the same in content.

[3] The part structure of attitudinal and modal is based on partial content only.

These properties sharply distinguish attitudinal and modal objects from actions and, at least in part, from propositions.

Ad [1]: Attitudinal and modal objects generally have truth conditions, or rather, more generally, satisfaction conditions. This is reflected in the great range of predicates of satisfaction to that can apply to attitudinal and modal objects (*was satisfied, was fulfilled, was executed, was followed, was broken, was complied with*). The applicability of such predicates sharply distinguishes attitudinal and modal objects both from sentences, propositions and ‘mental representations’ and from actions. Thus, neither sentences, propositions, mental representations or acts can be ‘fulfilled’, ‘satisfied’ or ‘broken’ (Ulrich 1979, Moltmann 2017a).<sup>7</sup>

Ad [2]: For two attitudinal or modal objects of the same type to be exactly similar or ‘the same’, it suffices that they be the same in content. This is how *John’s thought is the same as Mary’s, John’s promise is the same as Bill’s, John’s obligation is the same as Joe’s* are understood (Moltmann 2013, Chap. 4, 2014, 2017a). Obviously this condition fails to obtain for actions.

Ad [3]: Unlike actions, attitudinal and modal objects have a part structure that is strictly based on partial content (Moltmann 2017a, c). Thus, the expression *part of* when applied to attitudinal and modal objects (as in *part of the claim / thought / promise / request / obligation/need*) can pick out only a partial content, not a temporal part.

Some attitudinal objects are products of acts in the sense of Twardowski’s (1911) distinction between actions and products. Thus, a claim is the (illocutionary) product of an act of claiming, a promise the (illocutionary) product of an act of promising, and a decision a

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<sup>7</sup> Predicates of satisfaction clearly show that nominalizations of attitude verbs like *decision, promise* and *request* cannot be viewed as ambiguous between standing for propositions and standing for acts, as the standard view would have it (e.g. Pustejovsky 1995). Rather they unambiguously stand for entities of a third kind, attitudinal objects.

(cognitive) product of an act of deciding.<sup>8</sup> Cognitive and illocutionary products generally do not last longer than the acts that produce them, and like the corresponding acts, they come with a ‘force’, not just a content. However, products have fundamentally different sorts of properties from acts (only some of which were noted by Twardowski 1911). Most importantly, they have the properties [1] - [3]. Modal products (not recognized as such by Twardowski) are modal objects produced by actions, the same actions that may have produced illocutionary products. Thus the same act (of demanding) may produce a demand and an obligation. Modal products share the properties [1] – [3] with cognitive and illocutionary products, but may endure past the act that establishes them (Moltmann 2017a).

Representational properties (including satisfaction conditions) are characteristic of all attitudinal and modal objects, including those that do not result from acts, such as state-like attitudinal objects (intentions, beliefs, desires, fears), and light permissions or obligations (Section 5.2.). This means that the representational ability of modal and attitudinal objects should not be viewed as resulting from intentional acts, but is better to be attributed to primitive intentionality, as the hallmark of the mental.

There is also language-independent support for attitudinal and modal objects. Thus, attitudinal objects such as beliefs, intentions, judgments, and decisions carry a content and play causal roles, which propositions can’t (we are made to act by a decision, an intention, a fear, not a proposition). Moreover, attitudinal and modal objects, rather than propositions, appear to act as the content-bearing objects of memory (decisions, intentions, fears, thoughts, and obligations are what we remember, not propositions).

Kinds of attitudinal objects also play an important role in the semantics of attitude reports and modal sentences, and they likewise are well-reflected in natural language: explicitly with terms of the sort *the thought that S*, *the claim that S* etc. and implicitly in the semantics of special quantifiers and pronouns. Two particular attitudinal objects (of the same sort) belong to the same kind just in case they are exactly or closely similar (‘are the same’), which means they are the same in content. Thus, if John’s thought is the same as Mary’s thought, John and Mary share a belief, and if John’s claim is the same as Mary’s, they made the same claim.

## **5. Motivations for object-based truthmaker semantics**

### **5.1. Intentionality and truthmaking as a matter of mental**

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<sup>8</sup> Products in Twardowski’s sense are best understood as artifacts that lack a material realization or, in the case of decisions, a physical realization, ‘abstract’ artifacts in Thomasson’s (1999) sense (Moltmann 2014, 2017).

On the present view, sentences embedded under attitude verbs act as predicates of attitudinal objects specifying their satisfaction conditions. Propositions as entities that are both the meanings of sentences (in a context) and the objects of attitudes then play no longer a role. Problems for propositions such as how propositions have truth conditions and can be grasped therefore no longer arise.

In object-based truthmaker semantics, truthmaking applies to both sentences and attitudinal objects, which allows linking truthmaker semantics to the intentionality of the mind. Attitudinal objects such as intentions and decisions come with inherent satisfaction or realization conditions, and are satisfied or realized not by worlds or world states, but rather by actions.<sup>9</sup> Object-based truthmaker semantics accounts for the fact that it may depend on the particular attitudinal or modal object what the satisfiers in question are, say, actions or situations. Moreover, as Searle (1983) points out, intentions and requests do not take just actions as satisfiers, but rather actions ‘by way of’ realizing or fulfilling the intention or request, that is, actions with a particular gloss that makes reference to the intention or request itself. Thus, to use Searle’s example, doing something that accidentally kills my neighbor is not an action that fulfills my intention to kill my neighbor, rather only an action with the intention of doing so is. Other attitudinal or modal objects (hopes, beliefs, or epistemic modal objects, for example) do not require their satisfiers or truth makers to be of that sort.

## **5.2. Heavy and light permissions**

Another important case that shows well how truthmakers depend on the type of modal or attitudinal object is the distinction between heavy and light permissions. Heavy and light permissions are two different types of objects, at least on the present view. Heavy permissions generally are the products of particular acts of permitting, whereas light permissions are states of what is explicitly or implicitly permitted. Heavy permissions have different satisfaction conditions from light permissions. Heavy permissions have as satisfiers only actions meeting what is explicitly permitted, whereas light permissions have as satisfiers also actions that are just not in violation of what is obligatory and in that sense are implicitly permitted. It thus depends on the type of modal object in question what actions count as satisfiers.

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<sup>9</sup> In fact, a rudimentary truthmaker semantics for mental states and products has been put forward by Searle (1983), for whom intentions and decisions (which come with a world-word/mind direction of fit) have actions as satisfiers, and beliefs, judgments, desires etc. have states of affairs as truthmakers or satisfiers.

The distinction between the two sorts of permissions is well-reflected English, in the contrast between simple predicates (*be* + impersonal adjectival passive) as in (24a), which display the light reading (as well as a heavy one), and complex predicates (light verb + nominal), as in (24b, c), which display the heavy reading:

- (24) a. *Mary is permitted to take a walk.*  
       b. *Mary has permission to take a walk.*  
       c. *John gave permission for Mary to take a walk.*

The possible-worlds-based account would give the same semantics to the two sorts of permission sentences: for a permission sentence such as (24a) or (24c) to be true, the clausal complement would have to be true in *some* world compatible with the agent's obligations. But having a permission means more than that: it means that there was an act whose content is, at least in part, given by the complement clause and whose product, the permission, can be taken up by performing the act described by the complement clause. Moreover, giving or receiving a permission does involve a change, but not in the set of worlds compatible with what the agent is obliged to do. Rather it involves a change in a set of options to act that are at the agent's disposal. The complex predicates in (24a, b) involve explicit reference to a permission, the product of an act of permitting, and the complement clause serves to give the content of that product. By contrast, (24a) contains a stative predicate *is permitted* describing a deontic state, rather than the product of an act, and it is that state that the complement relates to. The heavy reading thus will go along with the compositional semantics of complex predicates as in (24a, b), and the light reading with that of a simple stative predicate.

Also propositional attitudes display such contrasts:

- (25) a. *John thought that S.*  
       b. *John had the thought that S.*  
 (26) a. *John assumed that S.*  
       b. *John made the assumption that S.*

Whereas (25a) and (26a) may just describe dispositional states of John, (25b) and (26b) describe actions leading to cognitive products.

## 5.2. Underspecification of content



Another important advantage of object-based truthmaker semantics concerns the possibility of underspecification of the content of certain types of attitudinal or modal objects by the complement clause or associated sentential unit. One relevant case that has been discussed in the literature is the underspecification of a desire as in the desire report below (Fara Graff 2014):

(27) a. Fiona wants to catch a fish.

Fiona's desire, according to (27a) is not satisfied if she catches any fish whatsoever, but, most likely, only a fish she can eat. Note that the speaker uttering (27a) need not know what the exact constraints are that Fiona's desire may impose on what satisfies it.

Also certain types of modals allow for this sort of underspecification, in particular teleological and deontic modals as below:

(27) b. Fiona needs to catch a fish (in order to have something for dinner).

c. John needs to write a letter (and therefore cannot be disturbed).

The need reported in (27b) may exhibit the very same underspecification as the desire reported in (27a). The speaker need to know about the particular conditions imposed on the satisfaction of the need, the kind of fish Mary needs to catch in (27b) and the sort of letter John has to write in (27c).

The underspecification of desire reports constitutes a serious problem for the standard view according to which the clausal complement of an attitude verb gives the full truth or satisfaction conditions for the reported attitude (Fara Graff 2014). By contrast, it is unproblematic for the present analysis of attitude reports within object-based truthmaker semantics. The underspecification exhibited in (27a) as well as in (27b, c) simply means that what the satisfiers in question are depends on the particular attitudinal or modal object in question, not the sentence used to characterize it (which may give only necessary, not sufficient conditions for its satisfaction). That is, the reported desire or need itself may come with constraints as to what will satisfy it, constraints that may be given only partially by the complement clause (or sentential unit).

Not all attitudes and modals permit such underspecification, though. Thus, with *claim* and *believe*, as below, the clausal complement must give the full truth conditions of the reported

belief or claim (possibly together with particular ‘unarticulated constituents’, which have to be part of the speaker’s intended meaning):

(28) a. John believes that Fiona caught a fish.

b. John claimed Fiona caught a fish.

The intuition about (28a,b) is that John’s belief or claim is true just in case Fiona catches any fish whatsoever (at the relevant time); the belief or claim could not be false, say, because Fiona caught a dead fish. With *claim* and *believe*, the complement clause does not give a partial content of the reported attitudinal object, but rather (together with its unarticulated constituents) its complete content.

The relevant sort of underspecification is also unavailable for epistemic modals, as below:

(28) c. Fiona must have caught a fish.

The epistemic state reported in (28c) is correct just in case Fiona caught some fish or another, not just in case she catches a suitable one.

What distinguishes attitude verbs and modals that allow the complement clause (or sentential unit) to give partial truth or satisfaction conditions of the reported attitudinal or modal object from those that requires it to give its full truth or satisfaction conditions? It appears that the difference resides in whether an attitudinal or modal object has satisfaction conditions as opposed to truth conditions. A desire and a need can only be satisfied and not be true. By contrast, a claim and a belief can only be true, not satisfied, and so for an epistemic state associated with an epistemic modal. Satisfaction conditions and truth conditions go along with different directions of fit, to use Searle’s (1969, 1983) term.<sup>10</sup> Desires (and deontic or teleological modal objects) have a world-word/mind direction of fit, whereas claims and beliefs (and epistemic modal objects) have a word/mind world direction of fit. That is, the aim of a desire or need is to have the world match the representation, whereas the aim of a belief, claim, or epistemic state is to have the representation match the world.<sup>11</sup>

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<sup>10</sup> This is discussed in greater detail in Moltmann (2018).

<sup>11</sup> One might think that the difference consists in the nature of the satisfiers: desires and need, as in (27a, b) have actions as satisfiers, whereas truth-directed attitudinal objects have situations as verifiers. However, the relevant sort of underspecification appears not only with desires whose satisfaction is obtained by actions of the relevant agent. It also appears with desires whose satisfaction is obtained by situations, as in *John wants to receive enough milk*, *John wants Millie to drink milk*, *John would like there to be enough milk for everyone on earth* etc.

Of course, the challenge then is to explain why a particular direction of fit goes along with the possibility of the relevant sort of underspecification. This is something to be left for future research. In the present context, we will have to settle on simply positing two distinct meanings of clauses, depending on the direction of fit of the attitudinal or modal object associated with the embedding predicate.

## 6. Sentences as predicates of modal and attitudinal objects

We can turn to the formal semantics of clauses as predicates of content bearers (attitudinal or modal objects), specifying their truth or satisfaction conditions. For the semantics of attitude reports, I will make use of Davidsonian event semantics (Davidson 1967). Davidsonian event arguments of an attitude verb will be the events, acts or states described by the attitude verb. I will assume, certainly simplifying, that there is a unique attitudinal object *att-obj*(*e*) associated with a Davidsonian event argument *e* of an attitude verb.<sup>12</sup> The clausal complement of the attitude verb will then be predicated of the attitudinal object associated with the event argument as below:

(29) a. John claimed that S.

b.  $\exists e(\text{claim}(e, \text{John}) \ \& \ [\textit{that S}](\textit{att-obj}(e)))$

The semantics of attitude reports in (29b) is (almost) overtly reflected in the corresponding complex-predicate construction in (30), which involves explicit reference to an attitudinal object (or a kind of attitudinal object):<sup>13</sup>

(30) John made the claim that S.

Clausal modifiers of nominalizations of attitude verbs will act as predicates of the attitudinal object described by the nominalization, as in (31b) for (31a):

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Moreover, the underspecification appears with hope, where fulfilment conditions may not involve any action on the part of the agent (*John hopes that there is milk in the fridge*, *John hope that there was milk in the fridge*, *when Millie got home yesterday*, *John hopes that Bill caught a fish* etc).

<sup>12</sup> See Moltmann (2019) for more on the relation of the Davidsonian event argument of the verb and the relevant attitudinal object.

<sup>13</sup> In fact, languages tend to show an alternation between the simple and the complex-predicate construction, which further motivates the semantics in (29b) (Moltmann 2017a, 2018a).

(31) a. John's claim that  $S$

b.  $\lambda d[\text{claim}(d, \text{John}) \ \& \ [S](d)]$

What is the property that sentences as predicates of modal or attitudinal object express? In the case of modal and attitudinal objects with a world-word/mind direction of fit, the clause will give a partial specification of satisfaction conditions. This means that it would express the given property below, where  $\Vdash$  is the relation of exact truthmaking or satisfaction now holding between situations or actions  $s$  and modal or attitudinal objects  $d$  (as well as sentences):

(32)  $[S] = \lambda d[\forall s(s \Vdash d \rightarrow \exists s'(s' \Vdash S \ \& \ s < s')) \ \& \ \forall s'(s' \Vdash S \rightarrow \exists s(s \Vdash d \ \& \ s < s'))]$

According to (32), a sentence  $S$  expresses the property that holds of a modal or attitudinal object  $d$  just in case every satisfier of  $d$  is part of a satisfiers of  $S$  and every satisfier of  $S$  contains a satisfier of  $d$  as part – which just means that the content of  $S$  is a partial content of the content of  $d$  (Yablo 2015, Fine 2017).

(32) cannot yet be adequate, though, since it would not allow distinguishing necessity and possibility semantically. Given (32), a permission (for Mary to enter the house) could be a modal object with the very same satisfaction conditions as an obligation (for Mary to enter the house). But the permission for Mary to enter the house is not an obligation for Mary to enter the house.

What distinguishes a permission from an obligation? Permissions allow for certain actions, those they permit. Obligations allow for certain actions, those that comply with them, but they also exclude certain actions, those that violate them. The permission for Mary to enter the house allows for actions of Mary entering the house, but does not exclude any other actions. By contrast, the obligation for Mary to enter the house allows for actions of Mary entering the house and excludes actions of Mary's not doing so. This means that permissions have only satisfiers, whereas obligations have both satisfiers and violators.

Also illocutionary products are distinguished in that way. An offer or an invitation has only satisfiers, but no violators. By contrast, a request or an order has both satisfiers and violators.

To account for that difference between modal forces requires modifying (32) by adding a condition on the falsification or violation of the modal or attitudinal object, namely that every falsifier of the sentence also be a falsifier or violator of the modal or attitudinal object. The modified meaning of a sentence  $S$  then is as follows, where the relation of falsification or violation  $\Vdash$  now also obtains between actions or situations and modal or attitudinal objects:

$$(33) [S] = \lambda d[\forall s(s \Vdash d \rightarrow \exists s'(s' \Vdash S \ \& \ s < s')) \ \& \ \forall s'(s' \Vdash S \rightarrow \exists s(s \Vdash d \ \& \ s < s')) \ \& \ (\text{neg}(d) \neq \emptyset) \rightarrow \forall s(s \Vdash S \rightarrow s \Vdash d)]$$

That is, a sentence  $S$  expresses the property that holds of a modal or attitudinal object  $d$  just in case the content of  $S$  is a partial content of  $d$  and every falsifier of  $S$  is a violator of  $d$ , should there be a violator of  $d$ .

On this account, sentences conveying necessity and sentences conveying possibility will have exactly the same logical form; but they involve different sorts of modal or attitudinal objects with different satisfaction and violation conditions. This is given for (34a) and (34b) in (35a) and (35b) respectively, based on the same meaning of the complement clause in (36):

(34) a. John asked Mary to leave the house.

b. John allowed Mary to leave the house.

(35) a.  $\exists e(\text{ask}(e, j, m) \ \& \ [Mary \ leave \ the \ house](\text{att-obj}(e)))$

b.  $\exists e(\text{allow}(e, j, m) \ \& \ [Mary \ leave \ the \ house](\text{att-obj}(e)))$

$$(36) [Mary \ to \ leave \ the \ house] = \lambda d[\forall s(s \Vdash d \rightarrow \exists s'(s' \Vdash Mary \ leave \ the \ house \ \& \ s < s')) \ \& \ \forall s'(s' \Vdash Mary \ to \ leave \ the \ house \rightarrow \exists s(s \Vdash d \ \& \ s < s')) \ \& \ (\text{neg}(d) \neq \emptyset) \rightarrow \forall s(s \Vdash Mary \ to \ leave \ the \ house \rightarrow s \Vdash d,$$

Similarly, modal sentences involve predication of the sentential unit associated with the modal predicate of the modal object (which may be taken to be the event argument itself).

(37a) and (38a) will then have the logical forms in (37b) and (38b) respectively:

(37) a. John needs to leave.

b.  $\exists d(\text{need}(d) \ \& \ [John \ to \ leave](d))$

(38) a. John is permitted to leave.

b.  $\exists d(\text{is \ permitted}(d) \ \& \ [John \ to \ leave](d))$

Unlike possible-worlds semantics, this gives an adequate account of heavy permissions (and obligations). If the object  $d$  is a permission, the sentential unit will specify which sorts of actions will be exact satisfiers of  $d$ , it will not just say what is true in some world in which the permission is satisfied.

If the modal or attitudinal object has a world-word/mind direction of fit, the sentential unit will give its full truth or satisfaction conditions. In this case, the meaning of the sentential unit will be as below:<sup>14</sup>

$$(39) [S] = \lambda d[\forall s(s \Vdash d \leftrightarrow s \Vdash S) \ \& \ \forall s(s \Vdash d \rightarrow s \Vdash S)]$$

Of course, making the meaning of an embedded clause dependent on the embedding predicate (the direction of fit of the associated modal or attitudinal object) is unsatisfactory and goes against compositionality. There must be a reason why the role of a sentential unit specifying either the partial or the complete content depends on the direction of fit of the attitudinal or modal object, and thus ultimately the polysemy reflected in (33) and (39) will have to give way to a different account.

## 7. The semantics of different types of attitude verbs

Not all attitude verbs involve a semantics on which their clausal complement is just predicated of the attitudinal object associated with the event argument of the verb. Some attitude verbs involve a semantics on which the clausal complement in addition serves as a predicate of a contextually given attitudinal object, for example a claim, suggestion or guess relevant in the discourse context. This is the case with what Cattell (1978) called *response-stance verbs*, verbs such as *repeat*, *confirm*, *agree*, and *remind*, as in the sentences below:

- (40) a. John repeated that it will rain.  
       b. John confirmed that it was raining.  
       c. John agreed to surrender.

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<sup>14</sup>The sentence  $S$  may be truth-conditionally incomplete by containing unarticulated constituents that are part of the speaker's intention when uttering the sentence and need to be understood as such by the addressee. This means that  $S$  should in fact be relativized to a context of utterance  $c$  specifying implicit elements meant to be part of the content of the utterance of the sentence.

d. John reminded Mary to return the keys.

In general, response-stance verbs have a clausal complement that serves to characterize both the reported attitudinal object and a contextually given attitudinal object. Thus, in (40a) the complement clause gives the content of two attitudinal objects: John's assertion (or perhaps just act of saying) and a contextually given claim, which may be John's or another person's previous claim. In (40b), the clausal complement gives the satisfaction condition of John's assertion as well as a previous assertive act with a much weaker illocutionary force. In (40c), the infinitival complement specifies actions as satisfiers of John's statement of intent as well as, say, a previous request. In (40d), the complement clause gives the satisfaction conditions of Mary's intention (as target of John's locutionary act) as well as those of a previous thought or intention of Mary's. The lexical meaning of the verb constrains the nature of the contextually attitudinal object and its relation to the attitudinal object of the reported agent.

The logical form of a sentence with a response-stance verb cannot simply be as in (41b) for (41a), where *d* is the relevant contextually given content bearer:

(41) a. John agreed that *S*.

b.  $\exists e(\text{agree}(e, \text{John}) \ \& \ [\textit{that S}](\text{att-obj}(e)) \ \& \ [\textit{that S}](d))$

That is because the act reported in (41a) would not be an act of agreeing without the contextually given speech act. Rather the predication of the complement clause of two different attitudinal objects would involve lexical decomposition of the verb's content, as schematically below:

(41) c.  $\exists e'(C_1(e) \ \& \ [\textit{that S}](\text{att-obj}(e)) \ \& \ C_2(d) \ \& \ R(\text{att-obj}(e), d))$

In (41c), the lexical content of the attitude verbs is decomposed into two conditions  $C_1$  and  $C_2$  (for the two attitudinal objects) as well as a relation  $R$  (holding between the two attitudinal objects). Alternatively, the logical form of (41a) could be that in (41d), where *agree* is now a three-place predicate taking the contextually given attitudinal object as a third argument:

(41) d.  $\exists e(\text{agree}(e, \text{John}, d) \ \& \ [\textit{that S}](\text{att-obj}(e)) \ \& \ [\textit{that S}](d))$

There is specific support for (41d), and that is the general substitutability of the clausal complement by an NP explicitly referring to the contextually given attitudinal object (plus sometimes a preposition):

- (42) a. John agreed with the request to leave.  
 b. John repeated the claim that it is raining.  
 c. John confirmed the speculation that it was raining.  
 d. John reminded Mary of the requirement / request to return the key.

Further support for (41d) comes from the observation that response-stance verbs permit a reading of adverbs like *partly* quantifying over parts of the content of the contextually given attitudinal object:

- (43) John partly confirmed that Mary is incompetent.

The same sort of reading of *partly* is generally available with transitive verbs, as below:

- (44) a. John partly ate the cake.  
 b. John partly liked the concert.

Such a reading, however, is unavailable with what Cattell (1978) calls *volunteered-stance verbs*, verbs such as *claim*, and *think* (Moltmann 2017c):

- (45) a. ??? John partly claims that Mary is incompetent.  
 b. ??? John partly thinks that that the students are talented

(45a) has a conceivable reading on which it means that John claims that Mary is partly incompetent, and (45b) on which it means that John thinks that only some of the students are talented. Those readings should be available if *claim* and *think* were to take propositions (the putative referents of their clausal complements) as arguments. The unavailability of such a reading makes again clear that clausal complements of attitude verbs (of the volunteered stance sort) do not provide arguments of the attitude verb.

Response-stance verbs pattern together with factive verbs with respect to their syntactic behavior (for example adjunct extraction) (Cattell 1978). However, the analyses in (40c, d)



are inapplicable to factive verbs. With factive verbs such as *know*, *recognize*, *note*, the clausal complement more plausibly characterizes a fact (however that may be conceived), in addition to characterizing the content of a mental state or act. Some factive verbs allow for substitution of the clausal complement by an explicit fact description (*notice that S*  $\rightarrow$  *notice the fact that S*, *recognize that S*  $\rightarrow$  *recognize the fact that S*). Others do not (*see that S* does not imply *see the fact that S*, *realize that S* does not imply *realize the fact that S*). The analogy of response-stance verbs and factive verbs requires a greater discussion of their syntax and semantics, but the present purposes was simply to outline the sort of semantics that factive verbs may have within object-based truthmaker semantics.

There are two options for a semantic analysis of factive verbs. One option is that *that*-clauses, at least with factive verbs not allowing substitution by an explicit fact description, act as predicates of the epistemic attitudinal object as well as involving a condition on the truth of the complement. For that purpose, I will make use of a world of evaluation for the entire sentence. The condition on the truth of the clausal complement then consist in the requirement that the set of situations that are part of the world of evaluation and the positive extension of the complement clause be nonempty:

(46) a. John realizes that S.

b.  $\exists e(\text{realizes}(e, \text{John}) \ \& \ [\text{that S}](\text{att-object}(e)) \ \& \ \text{pos}(\text{that S}) \cap \{s|s < w\} \neq \emptyset)$

Here the clausal complement does not have a predicative function but figures only in the condition (or presupposition) on the truth of the clausal complement.

Another option would be to allow non-worldly facts to be modal objects of a sort, namely modal objects whose satisfiers are situations that are part of the actual world. If we take F to be a world-relative sortal for such factive modal objects, then the logical form of (46c):

(46) c.  $\exists d \exists e(\text{realize}(e, \text{John}) \ \& \ [\text{that S}](\text{att-obj}(e)) \ \& \ \text{that S}(d) \ \& \ F_w(d))$

Alternatively, more suited for factive verbs allowing for substitution of their complement, it could be as below, where *f* is a world-relative operator mapping the semantic value of a sentence onto the factive modal object:

(46)  $\exists e(\text{realize}(e, \text{John}, f_w([S]))$

There are also good reasons to assume that clausal subjects with a predicate like *is true* or *is correct* give the content of a contextually given content-bearer (a claim, rumor, or suggestion) (Moltmann 2018b). Thus, a sentence like (47a) is generally understood in such a way that *that S* serves to give the truth conditions of a contextually given attitudinal object, a claim or speculation (note that *correct* does not apply to a proposition, referred to as such):

(47) a. That S is correct.

This means that (47a) has the logical form in (47b), for the relevant contextually given attitudinal object *d*:

(47) b.  $\text{true}([\text{that } S](d))$

Other clausal subjects may instead be predicated of an object that is an implicit argument of the verb or closely related to it. Thus, the clausal subjects of *is possible* is best viewed as acting as a predicate of the modal object, itself here considered the Davidsonian event argument. This gives the logical of (48a) as in (48b):

(48) a. That John will be late is possible.

b.  $\exists e(\text{possible}(e) \ \& \ [\text{that John will be late}](e))$

Of course, a particular semantic role of a clausal subject would have to be based on particular semantically identifiable features. In the present context of an outline of object-based truthmaker semantics, the aim, though, was simply to show the plausibility of clausal subjects serving particular semantic roles which are not that of standing for a proposition.

## **8. Object-based truthmaker semantics and the connections between modals and propositional attitudes**

### **8.1. Inferential connections between modals and attitude reports**

The present approach objects accounts straightforwardly for inferential connections between attitude reports and modal sentences. That is because attitudinal objects may entail the

existence of a modal object and attitudinal and modal object and they may share their satisfaction conditions. Thus, (8) and (9) repeated below are valid on the relevant reading because the command and the obligation share the same satisfiers.

(49) John asked Mary to leave.

Mary must leave.

(50) John offered Mary to use the house.

Mary may use the house.

Similarly, imperatives and performatively used modal sentences stand in inferential relations under suitable conditions. Thus in suitable contexts, both (51) and (52) are valid, in the sense that any act that fulfills the antecedent also satisfies the consequent:

(51) Leave the room!

You must leave the room.

(52) Take an apple!

You may take an apple.

This follows from the fact that the request or permission produced by the utterance with an imperative entails, under suitable normative conditions, the existence of a modal object of obligation or permission with the very same satisfaction conditions.

## 8.2. Harmonic modals

Object-based truthmaker semantics has a particular application to what Kratzer (2016) calls *harmonic modals*. Harmonic modals occur in clauses embedded under speech act verbs, where they do not contribute to the content of the reported speech but rather appear to just reflect the inherent modality associated with the embedding predicate:

(53) John insisted that Mary *should* leave.

There are also harmonic uses of modals of possibility, with suitable embedding verbs:

(54) a. John suggested that Bill *might* be at home.

b. The document indicates that Bill *might* be guilty.

For Kratzer, harmonic modals spell out the inherent modality of the content-bearing object of which the clause is to be predicated (an insistence, suggestion, indication in (53, 54)). Her account of harmonic modals is based on a possible-worlds-based property of the meaning of clauses. Focusing on modals of necessity as in (53), she proposes that the ‘harmonic’ modal in the embedded clause spells out universal quantification over the possible worlds that make up the content  $f(d)$  of the content-bearing object  $d$ , as below:

(55)  $\lambda d[\forall w(w \in f(d) \rightarrow [Mary\ leave]^w = \text{true})]$

The problem for such a possible worlds-based account, though, and that is that it is inapplicable to modals of possibility, as in (54a, b) (Moltmann 2019b). Thus, (56) does not make sense as the meaning of the clauses in (54a-c), with the existential quantifier spelling out the contribution of *could* or *might*:

(56)  $\lambda d[\exists w(w \in f(d) \ \& \ [S]^w = \text{true})]$

In (54a), the *that*-clause does not just specify what is the case in some world in which John’s offer is taken up; it specifies (at least) what is the case in all the worlds in which the offer is taken up. Similarly in (54b), the *that*-clause does not just say what is the case in some world compatible with what document says, but what is the case in all such worlds.

Object-based truthmaker semantics allows for a straightforward account of harmonic modals of both necessity and possibility (Moltmann 2019b). On this account, harmonic modals are considered performative uses of modals in embedded contexts. In object-based truthmaker semantics, sentences with a performative use of a modal such as (57a, b) will express properties of modal products meant to be produced by uttering the sentence, as in (58a, b) (Moltmann 2017a):

(57) a. You must leave!

b. You may leave!

(58) a.  $\lambda d[\text{must}(d) \ \& \ [(\text{addressee})\ leave](d)]$

b.  $\lambda d[\text{may}(d) \ \& \ [(\text{addressee})\ leave](d)]$

With a harmonic modal acting as a performative modal in an embedded context, (53) will simply have logical form in (59b) based on the meaning of the embedded clause in (59a), and (54b) the one in (60b), based on (60a):

(59) a. [*that Mary should leave*] =  $\lambda d[\text{should}(d) \ \& \ [\text{Mary leave}](d)]$

b.  $\exists e(\text{insist}(e, \text{John}) \ \& \ [\text{that Mary should leave}](\text{modal-product}(e)))$

(60) a. [*that Bill might be guilty*] =  $\lambda d[\text{might}(d) \ \& \ [\text{Bill be guilty}](d)]$

b.  $\exists e(\text{indicate}(e, \text{the document}) \ \& \ [\text{that Bill might be guilty}](\text{modal-product}(e)))$

A modal product can be produced by the very same illocutionary act as an illocutionary product, and it will have the very same satisfaction conditions as the illocutionary product (Moltmann 2017a). An act of demanding produces a demand as well as possibly an obligation, and an act of permitting a permission as an illocutionary product and a permission as a modal product.

Thus, harmonic modals are a phenomenon where object-based truthmaker semantics appears to have a significant advantage over possible-worlds semantics with its quantificational analysis of modals.

## 9. Object-based truthmaker semantics and the dynamic semantic perspective

Possible worlds are generally used to represent the common ground, the target of updating with the utterance of sentences, given a dynamic semantic perspective. Thus, possible worlds are generally used to represent the context set, the target of updating with declarative sentences, as well as a to-do list, the target of updating with the utterance of imperative or deontic modal sentences on a performative use.<sup>15</sup> Such a dynamic perspective can be recast within the terms of object-based truthmaker semantics roughly along the following lines.

Rather than making use of a context set as a set of worlds, the common ground will contain an attitudinal object of acceptance as the target for updating by declarative sentences, or perhaps rather a modal object, as has recently been argued (Geurts 2018). Such an attitudinal or modal object will of course have a collective agent (the interlocutors) (or

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<sup>15</sup> Possible worlds are also used in dynamic semantics (of the nonrepresentational sort), that is, theories according to which the meaning of sentences is a function from contexts to contexts. I will set dynamic semantic theories aside for present purposes.

perhaps the speaker identifying himself with everyone in the discourse, generic ‘one’). A *to do*-list is naturally considered a (deontic) modal object that has future possible actions or situations involving the relevant agent as satisfiers. Of course, as there may be various *to do*-lists as part of the common ground (Portner 2007), there can be various modal objects as targets of imperatives or modal sentences of different strengths and forces. Also, of course, a set of issues (the target for updating with questions) may be construed as an attitudinal or modal object, one whose satisfiers are, say, attitudinal objects of assertion. The common ground will thus consist of various attitudinal and modal objects (with collective, generic, or particular agents) that will be the target for updating with the utterance of sentences of different types.

Updating itself then means the following. With the utterance of an independent sentence  $S$  a speaker produces an attitudinal or modal object  $d$  whose truth or satisfaction conditions are given by  $S$ . Updating the common ground  $C$  with  $d$  will consist, roughly, in the fusion of  $d$  with the relevant modal or attitudinal object in  $C$ .<sup>16</sup> The operation of fusion  $\odot$  on modal or attitudinal objects is given below, based on the operation  $\vee$  of fusion of situations or actions (somewhat simplifying the definition given in Moltmann 2018a):

(61) For modal or attitudinal objects  $d_1$  and  $d_2$  of the same type, the fusion  $d_1$  and  $d_2$ ,

$$d_1 \odot d_2 = \text{the modal or attitudinal object } d \text{ that has } d_1 \text{ and } d_2 \text{ as parts and that is such that } \text{pos}(d) = \{s_1 \vee s_2 \mid s_1 \in \text{pos}(d_1) \ \& \ s_2 \in \text{pos}(d_2)\} \text{ and } \text{neg}(d) = \{s \mid s \in \text{neg}(d_1) \vee s \in \text{neg}(d_2)\}$$

Updating the common ground, actually, may not just consist in the fusion of  $d$  with the relevant attitudinal or modal object from the common ground, but may require mapping  $d$  onto a closely related object  $d'$  with same satisfaction conditions as  $d$ , but that matches the modal or attitudinal force of  $d'$ . This is needed in particular for objects that are assertions, which can undergo fusion only with an attitudinal object of the same force, say acceptance. If  $S$  carries presuppositions, then before applying fusion with an object  $o$  from the common ground, it needs to be verified that the presuppositions of  $S$  are entailed by  $o$ . How is entailment here to be understood? Attitudinal and modal objects (and sentences) enter entailment relations in virtue of standing in relations of partial content.

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<sup>16</sup> See Moltmann (2018a) for the operation of fusion applied to attitudinal or modal objects.

Note that the common ground may contain attitudinal objects of explicit and of implicit acceptance, for different sorts of presuppositions (anaphoric and non-anaphoric ones).

Also the updating conditions of complex sentences can be recast in terms of object-based truthmaker semantics. For example, updating of a common ground  $C$  with an attitudinal or modal object  $a$  with conjunctive content  $S$  and  $S'$  will involve fusion of the relevant object  $o$  in  $C$  with first  $d$  and then fusion of the result with  $d'$ , where  $d$ 's is that part of  $a$  whose content is given by  $S$  and  $d'$  is that part of  $a$  whose content is given by  $S'$ .<sup>17</sup>

While a more detailed and formal development of this way of updating and a comparison with the standard account will have to await another occasion, one overall advantage of it obviously is that the common ground will now consist in modal and attitudinal objects whose content is more fine-grained than the possible worlds-based notion of a context set.

## 10. Summary

Possible-worlds semantics has been a dominant approach in formal semantics, despite its obvious shortcomings, since it appears particularly suited for a compositional analysis of natural language sentences in a context of discourse. This paper has given a broad outline of an alternative approach, object-based truthmaker semantics. This approach provides a more fine-grained notion of content while being able, it appears, to capture various connections between modal and attitude verbs and to recast insights of the dynamic perspective meaning. Of course, this general outline awaits numerous elaborations of empirical and formal detail, as well as more thorough comparisons with standard approaches for particular applications.

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<sup>17</sup>See Moltmann (2018a) for more on content-based parts of attitudinal or modal objects.

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