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On the Lumping Semantics of Counterfactuals

MAKOTO KANAZAWA
National Institute of Informatics

STEFAN KAUFMANN
Northwestern University

STANLEY PETERS
Stanford University

Abstract

Kratzer (1981) discussed a *naïve premise semantics* of counterfactual conditionals, pointed to an empirical inadequacy of this interpretation, and presented a modification—partition semantics—which Lewis (1981) proved equivalent to Pollock's (1976) version of his *ordering semantics*. Subsequently, Kratzer (1989) proposed *lumping semantics*, a different modification of premise semantics, and argued it remedies empirical failings of ordering semantics as well as of naïve premise semantics. We show that lumping semantics yields truth conditions for counterfactuals that are not only different from what she claims they are, but also inferior to those of the earlier versions of premise semantics.

1 INTRODUCTION

Counterfactuals pose some of the most recalcitrant problems for truth-conditional semantic analysis. The long and rich tradition of writings on this topic, despite substantial advances in many directions, has so far failed to deliver a formally explicit and intuitively accurate account of how their truth conditions depend on those of their constituents and other non-conditional sentences. Among the most influential writings in this area are those of Kratzer (1981, 1989), the latest of which puts forward a theory centred around the novel notion of *lumping*, which, she argues, solves a number of problems with previous accounts.

Given the initial appeal of the use of lumping in Kratzer's (1989) semantics and its wide influence in linguistics, it is both surprising and worth pointing out that it seems to be in fundamental conflict with other features of her semantics, depriving the theory of much of its predictive power. In this paper, we carefully examine the logical consequences of the lumping semantics, and show that the predictions that it makes about counterfactuals are quite different from the ones Kratzer ascribes to it. Although we do not offer a counterproposal of our own, we hope our analysis proves useful for any future attempts to develop a viable theory of counterfactuals that makes crucial use of a notion like lumping.

We can best explain Kratzer's motivations for her 1989 theory as well as present our formal analysis of it by contrasting it with the two earlier theories of counterfactuals discussed in Kratzer 1981. The three theories are all closely related and belong to the class of premise semantics. Each of the three interpretations recognizes dual counterfactual connectives, the *would*-conditional and the *might*-conditional, for which we introduce corresponding pairs of binary connectives $\Box\!\!\rightarrow$ and $\Diamond\!\!\rightarrow$, respectively. We let the six connectives

(1) a. $\overset{n}{\Box\!\!\rightarrow}$, $\overset{n}{\Diamond\!\!\rightarrow}$
b. $\overset{p}{\Box\!\!\rightarrow}$, $\overset{p}{\Diamond\!\!\rightarrow}$
c. $\overset{l}{\Box\!\!\rightarrow}$, $\overset{l}{\Diamond\!\!\rightarrow}$

denote the paired conditionals under the three semantic interpretations. Our main result is that, under certain conditions, the lumping semantics of Kratzer (1989) is truth-functional. Specifically, $\varphi \overset{l}{\Box\!\!\rightarrow} \psi$ is equivalent to the material conditional $\varphi \rightarrow \psi$, and $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is equivalent to the conjunction $\varphi \wedge \psi$.

It suffices to describe the propositional language since the critical problem with the lumping semantics for conditionals already arises in this case. Models $\mathcal{M}$ will be ordered pairs $\langle W, V\rangle$ of a non-empty set W of possible worlds and a function V mapping propositional variables to subsets of W. For each $w \in W$ and propositional variable p, $[\![p]\!]_w^{\mathcal{M}} = 1$ if $w \in V(p)$ and $[\![p]\!]_w^{\mathcal{M}} = 0$ if $w \notin V(p)$. Below we will refer to propositions by variable names, writing 'p' instead of '$V(p)$'.

The semantics of truth-functional connectives is as usual: For all formulas φ, ψ and $w \in W$, we set

(2) $[\![\varphi \wedge \psi]\!]_w^{\mathcal{M}} = 1 \Leftrightarrow [\![\varphi]\!]_w^{\mathcal{M}} = [\![\psi]\!]_w^{\mathcal{M}} = 1$

(3) $[\![\varphi \vee \psi]\!]_w^{\mathcal{M}} = 0 \Leftrightarrow [\![\varphi]\!]_w^{\mathcal{M}} = [\![\psi]\!]_w^{\mathcal{M}} = 0$

(4) $[\![\varphi \rightarrow \psi]\!]_w^{\mathcal{M}} = 0 \Leftrightarrow [\![\varphi]\!]_w^{\mathcal{M}} = 1$ and $[\![\psi]\!]_w^{\mathcal{M}} = 0$

(5) $[\![\neg\varphi]\!]_w^{\mathcal{M}} = 1 \Leftrightarrow [\![\varphi]\!]_w^{\mathcal{M}} = 0$

We suppress the superscript henceforth because no confusion can arise.

2 PRELIMINARIES

2.1 *Background*

Most current theories of conditionals are based on a simple intuition: A conditional asserts that its consequent follows when its antecedent is added to a certain body of premises. This idea was first made explicit in Ramsey's (1929) influential statement about indicative conditionals, which inspired much subsequent work (cf. Stalnaker, 1968). It is also at the center of Goodman's (1947) theory of counterfactuals, a close predecessor of Kratzer's premise semantics.

Goodman noted about examples like (6) that while they generally assert that some connection holds between the propositions expressed by their constituent clauses, it is rarely the case that the second *follows* from the first.

(6) If that match had been scratched, it would have lighted.

The scratching of the match does not in itself guarantee its lighting: In addition, oxygen has to be present, the match has to be dry, etc. 'The first problem' in the interpretation of counterfactuals, Goodman writes, 'is . . . to specify what sentences are meant to be taken in conjunction with the antecedent as a basis for inferring the consequent'.[1] Clearly, for instance, sentences which contradict the antecedent should be excluded, since otherwise many false counterfactuals would come out vacuously true.

Less obvious, but far more vexing to Goodman, is the fact that speakers consistently exclude other sentences for non-logical reasons. Why, for instance, is it easy to believe that (6) is true, but unnatural to conclude (7) from the fact that the match did not light?

(7) If the match had been scratched, it would have been wet.

Goodman was unable to offer an answer to this and related questions that would not make circular reference to counterfactuals: His rule bluntly calls for the selection of those true sentences that would not be false if the antecedent were true. However, his suggestions inspired much subsequent work by authors who continued to grapple with the problem (Rescher 1964; Veltman 1976; Pollock 1981, and others). Kratzer's writings on premise semantics contribute to this line of research.

[1] Goodman's second problem—that of defining 'natural or physical or causal laws'—will not concern us in this paper.

2.2 *Basic apparatus*

Central to Kratzer's theory is the notion of a premise set. Intuitively, the premise sets associated with a counterfactual at a possible world w represent ways of adding sentences that are true at w to the antecedent, maintaining consistency.

We write $\text{Prem}_w(\varphi)$ for the set of premise sets associated with φ at world w. $\text{Prem}_w(\varphi)$ determines the truth values at w of both *would*-counterfactuals and *might*-counterfactuals with antecedent φ. Kratzer's truth conditions can be reproduced as follows.[2]

Definition 1 (*would*-counterfactual)
$[\![\varphi \Box\!\!\rightarrow \psi]\!]_w = 1$ iff
$$\forall X \in \text{Prem}_w(\varphi)\, \exists Y \in \text{Prem}_w(\varphi)[X \subseteq Y \wedge \bigcap Y \cap W \subseteq \psi]$$

> 'The would-counterfactual $\varphi \Box\!\!\rightarrow \psi$ is true at w if and only if every set in $\text{Prem}_w(\varphi)$ has a superset in $\text{Prem}_w(\varphi)$ which entails ψ.'

Definition 2 (*might*-counterfactual)
$[\![\varphi \Diamond\!\!\rightarrow \psi]\!]_w = 1$ iff
$$\exists X \in \text{Prem}_w(\varphi)\, \forall Y \in \text{Prem}_w(\varphi)[X \subseteq Y \rightarrow \bigcap Y \cap \psi \cap W \neq \varnothing]$$

> 'The might-conditional $\varphi \Diamond\!\!\rightarrow \psi$ is true at w if and only if there is a set in $\text{Prem}_w(\varphi)$ all of whose supersets in $\text{Prem}_w(\varphi)$ are consistent with ψ.'

Remark 1
$\varphi \Box\!\!\rightarrow \psi$ iff $\neg(\varphi \Diamond\!\!\rightarrow \neg\psi)$, as intended.

All versions of Kratzer's theory follow this schema. The difference lies in the definition of Prem_w. In all three versions, Prem_w depends on a parameter $f(w)$ which identifies the set of propositions relevant to the truth of counterfactuals at w. Kratzer showed that the most naïve implementation of the account is empirically inadequate and sought to improve on it by imposing further conditions on membership in $\text{Prem}_w(\varphi)$. We will discuss three versions of the theory below, distinguishing between them using superscripts: Prem^n, Prem^p and Prem^l give rise to $\overset{n}{\Box\!\!\rightarrow}$, $\overset{p}{\Box\!\!\rightarrow}$ and $\overset{l}{\Box\!\!\rightarrow}$, respectively.

[2] The intersection with W is redundant as long as the universe of the model consists only of worlds. We include it here for the sake of generality because the definitions for lumping semantics below will employ a richer ontology.

3 NAÏVE PREMISE SEMANTICS

In the simplest version of the account, the set $\mathrm{Prem}^n_w(\varphi)$ of premise sets associated with antecedent φ at w represents *all* possible ways of adding true sentences to the antecedent, maintaining consistency. Thus the only conditions imposed on each member X of $\mathrm{Prem}^n_w(\varphi)$ are that (i) all propositions in X other than φ be true at w; (ii) X be consistent; and (iii) φ be in X. More concisely:

Definition 3 (Naïve premise set)
$\mathrm{Prem}^n_w(\varphi) = \{X \subseteq f(w) \cup \{\varphi\} \mid \bigcap X \neq \varnothing \text{ and } \varphi \in X\}$,
where $f(w) = \{p \in \mathscr{P}(W) \mid w \in p\}$.[3]

The truth conditions for the connectives $\overset{n}{\Box\!\!\rightarrow}$ and $\overset{n}{\Diamond\!\!\rightarrow}$ are as given by Definitions 1 and 2, respectively, where $\mathrm{Prem}^n_w(\varphi)$ is substituted for $\mathrm{Prem}_w(\varphi)$.[4]

Kratzer (1981) discusses at some length the implications of this definition, in particular the predictions it makes about the truth values of *would*-counterfactuals. It turns out that naïve premise semantics, which she considers the "most intuitive" analysis of counterfactuals, is deeply flawed.

Suppose $w \in W$ is like the actual world in that the Atlantic Ocean is not drying up, and suppose further that Paula is buying a pound of apples. Then the analysis predicts that (8a), interpreted as (8b), is true at w. Intuitively, however, sentence (8a) seems to be false in w.

(8) a. If Paula weren't buying a pound of apples, the Atlantic Ocean might be drying up
b. (Paula isn't buying a pound of apples) $\overset{n}{\Diamond\!\!\rightarrow}$ (the Atlantic Ocean is drying up)

This unwelcome consequence is part of a much larger problem which is deeply entrenched in naïve premise semantics: For any false sentence ψ that is consistent with the negation of a true sentence φ, $\neg\varphi \overset{n}{\Diamond\!\!\rightarrow} \psi$ is true. This fact follows from the following equivalences, which were first shown by Veltman (1976):

Proposition 1
(9) $\varphi \overset{n}{\Box\!\!\rightarrow} \psi \Leftrightarrow (\varphi \rightarrow \psi) \wedge (\neg\varphi \rightarrow \Box(\varphi \rightarrow \psi))$
(10) $\varphi \overset{n}{\Diamond\!\!\rightarrow} \psi \Leftrightarrow (\varphi \wedge \psi) \vee (\neg\varphi \wedge \Diamond(\varphi \wedge \psi))$

[3] $\mathscr{P}(W)$ denotes the power set of W.
[4] For $\overset{n}{\Diamond\!\!\rightarrow}$, see Kratzer (1979). Only $\overset{n}{\Box\!\!\rightarrow}$ is discussed in Kratzer (1981).

Thus at a world at which φ is true, $\varphi \overset{n}{\Box\!\!\rightarrow} \psi$ and $\varphi \overset{n}{\Diamond\!\!\rightarrow} \psi$ are both materially equivalent to ψ, the consequent. This part seems reasonable and is shared with many other logics of conditionals. More problematic is that at a world at which φ is false, $\varphi \overset{n}{\Box\!\!\rightarrow} \psi$ comes down to strict implication, and $\varphi \overset{n}{\Diamond\!\!\rightarrow} \psi$ to the statement that φ and ψ are logically consistent.

The problem with (8), discussed above, follows from (10). Kratzer (1981) discusses a different but related problem which arises from the equivalence in (9). Naïve premise semantics is, alas, very naïve indeed.

4 PARTITION SEMANTICS

To address the above difficulties, Kratzer (1981) proposed a repair for naïve premise semantics. Rather than treating *all* true sentences equally for purposes of constructing premise sets, she argued, one has to take into account the fact that speakers, in interpreting counterfactuals, entertain a more coarse-grained conception of the world, analyzing it into agglomerations of facts rather than atomic truths.

Formally, Kratzer assumes that only some of the propositions that are true at the world w of evaluation are relevant to the truth of counterfactuals. These relevant propositions are determined by a partition function f. The only condition imposed on f is that the propositions it selects, taken together, uniquely identify w.

Definition 4 (Partition function)
A function f: $W \rightarrow \mathscr{P}(\mathscr{P}(W))$ is a partition function if and only if for every $w \in W$, $\bigcap f(w) = \{w\}$.

The set of premise sets for partition semantics is defined in terms of f in the same way as that for naïve semantics. In partition semantics, f is supposed to be indeterminate and allowed to vary from context to context, so it constitutes a new parameter in the definition of the premise sets.

Definition 5 (Partition premise set)
Let f be a partition function. Then
$\text{prem}^p_w(\varphi) = \{X \subseteq f(w) \cup \{\varphi\} \mid \bigcap X \neq \varnothing \text{ and } \varphi \in X\}$.

The truth definitions of counterfactuals remain the same as in Definitions 1 and 2. The resulting truth values now depend, via Prem^p_w, on the partition function.

Naïve premise semantics is a special case of partition semantics. As before, at worlds at which φ is true, the conditionals $\varphi \overset{p}{\Box\!\!\rightarrow} \psi$ and

$\varphi \overset{p}{\diamond\!\!\rightarrow} \psi$ are both materially equivalent to ψ.[5] However, where the antecedent is false, the choice of f determines whether they are equivalent to $\Box(\varphi \rightarrow \psi)$ and $\Diamond(\varphi \wedge \psi)$ (if $f(w) = \{p \in \mathscr{P}(W) \mid w \in p\}$ or $f(w) = \{\{w\}\}$ for all w) or to some other propositions. Kratzer suggests that, in practice, the range of possible partitions may be further restricted by our 'modes of cognition' (p. 211).

Lewis (1981) showed that this version of Kratzer's semantics is equivalent to a version of his own ordering semantics in terms of similarity between possible worlds, as formulated by Pollock (1976).[6] While this result attests to the significant expressive power of Kratzer's theory, it also shows that the latter shares with ordering semantics a number of unwelcome features. Consider the following illustration, discussed in Kratzer (1989):

(11) Let a world w be such that
  a. a zebra escaped;
  b. it was caged with another zebra;
  c. a giraffe was also in the same cage.

In such a world, the sentence in (12a), interpreted as (12b), is predicted to be false, given the intuitive understanding of similarity between worlds.

(12) a. If a different animal had escaped, it might have been a giraffe.
  b. (a different animal escaped) $\overset{p}{\diamond\!\!\rightarrow}$ (it was a giraffe)

The reason behind this prediction is not hard to understand. Given that a zebra escaped in w, among all the possible worlds in which a different animal escaped, the ones where the other zebra escaped are more similar to w than any where the escaped animal was of a different species. Intuitively, however, sentence (12a) seems true in w. The lesson from examples like this is that the relation of 'similarity' between worlds that yields the right truth conditions in ordering semantics does not always correspond to the most intuitive notion of similarity. But if the former is simply a theoretical construct, then ordering semantics cannot make concrete predictions about the truth values of particular counterfactuals about which our intuitions are relatively sharp (see Kratzer 1989; 626).

[5] This is due to the requirement that $\bigcap f(w) = \{w\}$

[6] There are minor differences with Lewis' original (1973) formulation, which he argues are immaterial for the resulting semantic theory.

5 LUMPING SEMANTICS

Examples like (12) above pose challenges to both premise semantics and ordering semantics. Kratzer (1989) set out to find further ways of refining the theory in order to solve these problems while preserving the advantages of partition semantics over naïve premise semantics. Her proffered solution is lumping semantics.

This time, she changes both the set $f(w)$ of propositions relevant to the truth of counterfactuals and the way the set of premise sets is defined in terms of $f(w)$. The main point of her new strategy is to require premise sets to be closed under certain conditions, providing fewer opportunities for premise sets to be consistent with the consequent of a *might*-conditional—to address the problem of (8)—while eliminating the bias toward a different zebra escaping rather than a giraffe—to address the problem of (12).

To implement a suitable closure condition on premise sets, she introduces the concept of lumping—a relation between propositions relative to a possible world and fully determined by its internal structure. To represent this structure, Kratzer takes up the concept of a situation, introduced by Barwise and Perry (1983). Though she conceives of situations as partial worlds, she models them with total models (unlike Barwise and Perry), borrowing from the ontological inventory of David Armstrong's theory of states of affairs (see Armstrong 1978, 1997).

We will reproduce the details of Kratzer's proposal only to the extent that they are needed for our discussion below. We start with the definition of a situation model.

Definition 6 (Situation Model)
A situation model is a triple $\mathcal{M} = \langle S, \leqslant, V\rangle$, where
S is a non-empty set (of situations);
$\leqslant$ is a partial order on S satisfying the following condition: For all $s \in S$ there is a unique $s' \in S$ such that $s \leqslant s'$ and for all $s'' \in S$, if $s \leqslant s''$ then $s'' \leqslant s'$;
V is a function mapping propositional variables to subsets of S.

We will continue to use propositional variables to refer to their denotations, writing 'p' instead of '$V(p)$'. No confusion is likely to arise from this.

Situations are the carriers of truth:

Definition 7 (Truth)
A proposition p is *true* in a situation $s \in S$ if and only if $s \in p$.

Definition 6 ensures that for each situation s there is a unique maximal situation s' such that $s \leqslant s'$. We follow Kratzer in calling these maximal situations 'worlds'.

Definition 8 (Worlds)
For each $s \in S$, let $w_s \in S$ be the maximal situation such that $s \leqslant w_s$. The set of *worlds* in $\mathcal{M}$ is the set $W = \{w_s \mid s \in S\}$.

As Kratzer points out (p. 615), truth is the only logical property in whose definition the partiality of situations comes into play. Other notions are defined solely in terms of worlds. (In the following definitions, if $A = \varnothing$, we let $\bigcap A = S$.)

Definition 9 (Consistency)
A set of propositions $A \subseteq \mathscr{P}(S)$ is consistent if and only if $\bigcap A \cap W \neq \varnothing$.

Definition 10 (Logical consequence)
A proposition $p \in \mathscr{P}(S)$ logically follows from a set of propositions $A \subseteq \mathscr{P}(S)$ if and only if $\bigcap A \cap W \subseteq p$.

Not all propositions may be expressed by sentences of natural languages. Kratzer tentatively assumes that propositions that are expressible in natural language must be persistent. This property is defined as follows.

Definition 11 (Persistence)
A proposition $p \subseteq S$ is persistent if and only if for all $s, s' \in S$, if $s \in p$ and $s \leqslant s'$, then $s' \in p$.

Conjunction and disjunction are defined as usual, but now relative to S rather than W.[7]

Definition 12
$[\![\varphi \wedge \psi]\!]_s = 1 \Leftrightarrow [\![\varphi]\!]_s = 1$ and $[\![\psi]\!]_s = 1$
$[\![\varphi \vee \psi]\!]_s = 1 \Leftrightarrow [\![\varphi]\!]_s = 1$ or $[\![\psi]\!]_s = 1$

Kratzer's discussion of negation is somewhat more complex, and not all of the details are relevant here. However, the following properties will be needed below: For all persistent propositions φ,

(13) a. $\neg\varphi$ is persistent.

[7] Kratzer in fact considers two different definitions of disjunction. The definition here is the one she used in her discussion of the Atlantic Ocean example (example (8) of this paper).

b. $\{\varphi, \neg\varphi\}$ is inconsistent; hence, by persistence, for all $w \in W$, if $w \in \varphi$ then there is no $s \leqslant w$ such that $s \in \neg\varphi$.
c. $W \subseteq \varphi \cup \neg\varphi$.

These conditions ensure that both Excluded Middle and Non-Contradiction are valid at the world-level.

With this background, we can turn to how Kratzer characterizes $f(w)$ and Prem^l_w.

Kratzer assumes that all propositions that are relevant to the truth of counterfactuals are persistent. In addition to persistence, she considers an open-ended list of other general properties that propositions ought to have if they are to be relevant for the truth of counterfactuals. Since this list is left incomplete, we consider a range of different choices that appear to be consistent with what Kratzer says in her paper.

Definition 13 (Relevance function)
A function $f: W \to \mathscr{P}(\mathscr{P}(S))$ is a relevance function iff for all $w \in W$, $f(w) \subseteq \{p \in \mathscr{P}(S) \mid w \in p \text{ and } p \text{ is persistent}\}$.

In addition to the two conditions in Definition 13, Kratzer requires any proposition in $f(w)$ to be graspable by humans, but does not explicate this notion formally. We will consider this requirement later. Kratzer also assumes that the set of propositions relevant to the truth of counterfactuals is further affected by the individual properties of the counterfactual considered and the context of use.[8]

Unlike in partition semantics, where f ranges over a precisely characterized set of functions, Kratzer's lumping semantics does not completely characterize the range of variation of f. It is certainly not her intention that any subset of the set of true propositions that are persistent (and satisfy the other conditions that she mentions in her paper) can be a candidate for $f(w)$; there must also be some kind of lower bound for $f(w)$. In fact, her paper seems to suggest that $f(w)$ should include all propositions that are not excluded by general conditions like persistence and human graspability and factors coming from context and the linguistic structure of the given counterfactual. She is not explicit about this, however, and we will consider all relevance functions that are not clearly excluded by considerations in her paper.

Now we turn to the definition of the crucial notion of lumping.

[8] She mentions that propositions that do not match the focus structure of the antecedent may be excluded, as well as 'generic' propositions (in the technical sense of her situation semantics) that are not law-like.

Definition 14 (Lumping)
For all $p, q \subseteq S$ and $w \in W$, p lumps q in w if and only if $w \in p$ and $p \cap \{s \mid s \leqslant w\} \subseteq q$.

We will use the notation '$p \vartriangleright_w q$' for 'p lumps q in w'.

The following property of lumping will be used repeatedly in later sections.

Remark 2
Let p and q be persistent propositions. If $w \notin p$ and $w \in q$, then $p \vee q \vartriangleright_w q$, where $\vee$ is as defined in Definition 12.

Although Kratzer (1989) does not state the above property explicitly, it is made crucial use of in her solution to the problem exemplified by (8). As we shall see, this property of lumping is responsible for some undesirable consequences (see Propositions 4 and 5).

Lumping enters the interpretation of counterfactuals as a closure condition on premise sets.

Definition 15 (Closure under lumping)
A set of propositions $A \subseteq \mathscr{P}(S)$ is closed under lumping in w (relative to $f(w)$) if and only if for all $p \in A$ and all $q \in f(w)$, if p lumps q in w, then $q \in A$.

Definition 16 (Closure under logical consequence)
A set of propositions $A \subseteq \mathscr{P}(S)$ is closed under logical consequence (relative to $f(w)$) if and only if for all $p \in f(w)$, if p logically follows from A, then $p \in A$.[9]

In addition to the requirement that a premise set X be a consistent subset of $f(w) \cup \{\varphi\}$ that contains φ, which is shared with Definitions 3 and 5, Definition 17 requires that (i) X be closed under lumping in w and (ii) $X \cap f(w)$ be closed under logical consequence.[10]

[9] Kratzer speaks of "strong closure under logical consequence", which is equivalent to closure under logical consequence. The weak notion of closure under logical consequence she has in mind is defined as follows:

$$\forall p \in A \, \forall q \in f(w)[p \cap W \subseteq q \rightarrow q \in A]$$

According to this definition, the empty set of propositions, for example, is weakly closed under logical consequence, although it is not strongly so closed.

[10] The condition of strong closure under logical consequence is motivated by examples like our (6) and (7) above, originally due to Goodman. Kratzer (1989, Section 5.2, pages 640–642) discusses a variant of the example and points out an undesirable premise set which would not be ruled out by closure under lumping alone, even in combination with weak closure under logical consequence.

Definition 17 (Lumping premise set)
Let f be a relevance function.

$$\begin{aligned}\mathrm{Prem}^l_w(\varphi) = \Big\{X \subseteq f(w) \cup \{\varphi\} \mid \bigcap X \cap W \neq \varnothing \wedge \varphi \in X \wedge \\ \forall p \in X\, \forall q \in f(w)[p \rhd_w q \rightarrow q \in X] \wedge \\ \forall p \in f(w)\Big[\bigcap(X \cap f(w)) \cap W \subseteq p \rightarrow p \in X \cap f(w)\Big]\Big\}\end{aligned}$$

The counterfactual connectives $\overset{l}{\Box\!\!\rightarrow}$ and $\overset{l}{\Diamond\!\!\rightarrow}$ are again defined as in Definitions 1 and 2 above. Similarly to the partition semantics for conditionals, the connectives $\overset{l}{\Box\!\!\rightarrow}$, $\overset{l}{\Diamond\!\!\rightarrow}$ inherit via Prem^l_w a dependence on the relevance function f.

Kratzer (1989) argued that the definitions reproduced in this section solve problems of the sort exemplified in (12) as well as (8).

5.1 *Lumping semantics and closure under logical consequence*

A little excursion is in order here to remark on the last line in the characterization of $\mathrm{Prem}^l_w(\varphi)$, which requires closure under logical consequence to hold of $X \cap f(w)$. Given the informal characterization of the lumping semantics in Kratzer 1989, it seems to us that Definition 17 is what Kratzer intends, but the actual formalization that she gives is slightly different:

Definition 18 (Lumping premise set—Kratzer's version)
Let f be a relevance function.

$$\begin{aligned}\mathrm{Prem}^l_w(\varphi) = \Big\{X \subseteq f(w) \cup \{\varphi\} \mid \bigcap X \cap W \neq \varnothing \wedge \varphi \in X \wedge \\ \forall p \in X \forall q \in f(w)[p \rhd_w q \rightarrow q \in X] \wedge \\ \forall p \in f(w)\Big[\bigcap(X - \{\varphi\}) \cap W \subseteq p \rightarrow p \in X - \{\varphi\}\Big]\Big\}\end{aligned}$$

Instead of $X \cap f(w)$, Kratzer requires $X - \{\varphi\}$ to be closed under logical consequence. If φ is false at w, $\varphi \notin f(w)$, so for any $X \subseteq f(w) \cup \{\varphi\}$, $X \cap f(w) = X - \{\varphi\}$, and the two definitions are equivalent. However, if φ is true at w, in all likelihood it is a member of $f(w)$, so $X \cap f(w) = X$ and $X - \{\varphi\}$ differ.

Suppose both φ and $\varphi \wedge \chi$, for some proposition χ, are true at w. Clearly $\varphi \wedge \chi$ can be added to the antecedent consistently. One would therefore expect, given the intuitive truth definitions Kratzer states informally, that the set $X = \{\varphi, \varphi \wedge \chi\}$ should be able to be extended to a premise set. However, all supersets of X fail the test for closure under logical consequence under Definition 18.

It seems to us that this is not what Kratzer intends. Surely, $\mathrm{Prem}^{l}_{w}(\varphi)$, defined in this way, fails to capture *all* ways to add true propositions to the antecedent, maintaining consistency. If this were indeed what Kratzer intends, the conceptual difference from the intuitive paraphrase would have semantic repercussions, contrary to Kratzer's claim (p. 635) that the condition of closure under lumping is the only substantive change from the earlier versions in Kratzer (1989). Suppose Paula is buying a pound of Golden Delicious and nothing else. Then the counterfactual in (14a), interpreted as in (14b), is predicted by Kratzer's definition to be false if there are worlds like ours in which she is buying some other variety of apples instead.

(14) a. If Paula were buying a pound of apples, she would be buying a pound of Golden Delicious.
b. (Paula is buying a pound of apples) $\overset{l}{\Box\!\!\rightarrow}$ (Paula is buying a pound of Golden Delicious)

The counterfactual is false because the true sentence *Paula is buying a pound of Golden Delicious*, as well as all others which entail the antecedent of (14a), is barred from membership in any premise set by the condition of closure under logical consequence as defined in Definition18. The same is not true of either naïve premise semantics or partition semantics, both of which, as we saw, make the counterfactual equivalent to its consequent at worlds in which its antecedent is true.

Whether one finds this outcome agreeable or not, it is not the end of the story. Notice that closure under lumping makes the situation even worse. One could maintain, as Kratzer would, that *Paula is buying a pound of Golden Delicious* is lumped by the antecedent of (14a) and should therefore be included in all premise sets. But this means that *no* premise set at all can be closed under both lumping and logical consequence in the way Definition 18 requires, so that the *might*-counterfactual in (15a) is false as well.

(15) a. If Paula were buying a pound of apples, she might be buying a pound of Golden Delicious.
b. (Paula is buying a pound of apples) $\overset{l}{\Diamond\!\!\rightarrow}$ (Paula is buying a pound of Golden Delicious)

Below, we will proceed with Definition 17 instead of 18, assuming that this is what Kratzer had in mind. The exact formulation of our results depends on this small change, but since the two definitions are equivalent for counterfactuals with false antecedents, it does not affect what the results say about such counterfactuals, which are the more interesting case.

5.2 *Some properties of lumping semantics*

We noted earlier that both naïve premise semantics and partition semantics make the *might*- and *would*-conditionals materially equivalent to the consequent when the antecedent is true. Although this property seems desirable, it is not shared by lumping semantics. In lumping semantics, when the antecedent is true, the truth of the consequent implies the truth of the *might*-conditional, but not of the *would*-conditional. The dual of this fact is that when the antecedent is true, the falsity of the consequent implies the falsity of the *would*-conditional, but not of the *might*-conditional.

Lemma 1
Suppose φ is true at w. Then $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $f(w) \cup \{\varphi\}$ is consistent with ψ.

Proof. Let $Z_w = f(w) \cup \{\varphi\}$. Then $Z_w \in \text{Prem}^l_w(\varphi)$. To see this, note that

- $Z_w \subseteq f(w) \cup \{\varphi\}$;
- since $w \in \bigcap f(w)$ and $w \in \varphi$, $w \in \bigcap Z_w \cap W$, so $\bigcap Z_w \cap W \neq \varnothing$
- $\varphi \in Z_w$;
- every proposition in $f(w)$ lumped in w by any member of Z_w is in $f(w)$ and thus in Z_w;
- every proposition in $f(w)$ that logically follows from $Z_w \cap f(w)$ is in $f(w)$ and hence in $Z_w \cap f(w) = f(w)$.

Clearly, for any $X \in \text{Prem}^l_w(\varphi)$. $X \subseteq Z_w$, and for any $Y \subseteq f(w) \cup \{\varphi\}$ such that $Z_w \subseteq Y$, $Y = Z_w$. This means that the truth definition of $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ given in Definition 2:

$$\exists X \in \text{Prem}^l_w(\varphi)\, \forall Y \in \text{Prem}^l_w(\varphi)[X \subseteq Y \rightarrow \bigcap Y \cap \psi \cap W \neq \varnothing]$$

is equivalent to

$$\bigcap Z_w \cap \psi \cap W \neq \varnothing,$$

which says that $f(w) \cup \{\varphi\}$ is consistent with ψ. □

Lemma 2
If φ and ψ are true at w, then $\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi$ is true at w.

Proof. Suppose φ and ψ are true at w. Since all propositions in $f(w)$ are true at w, $w \in \bigcap (f(w) \cup \{\varphi\}) \cap \psi$, so $f(w) \cup \{\varphi\}$ is consistent with ψ. Therefore, by Lemma 1, $\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi$ is true at w. □

In case φ and $\neg\psi$ are true at w, $\neg(\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi)$ is true at w if and only if $\neg\psi$ logically follows from $f(w) \cup \{\varphi\}$. As a special case, we have

Lemma 3
Suppose φ and $\neg\psi$ are true at w, and $\neg\psi \in f(w)$. Then $\neg(\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi)$ is true at w.

The following is a direct consequence of Lemmas 2 and 3.

Lemma 4
Suppose $\{\neg\psi\} \cap \{p \in \mathscr{P}(S) \mid w \in p\} \subseteq f(w)$. If φ is true at w, $\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi$ is true at w iff *ψ is true at w.*

The above lemmas will be useful in our analysis of lumping semantics.

6 TRIVIALITY OF LUMPING SEMANTICS

In this section, we show that lumping semantics becomes trivial for a large class of relevance functions that are not clearly ruled out; for these relevance functions, lumping semantics makes both types of counterfactuals truth-functional.

Proposition 2
Suppose that $\{W, \{w\}\} \subseteq f(w)$. Then $\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi$ is true at w iff $\varphi \wedge \psi$ is true at w.

Proof. Case 1. φ is true at w. If ψ is true at w, then $\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi$ is true by Lemma 2. If ψ is false at w, ψ is inconsistent with $\{W, \{w\}\}$ and hence with $f(w) \cup \{\varphi\}$. By Lemma 1, $\varphi \overset{l}{\diamondsuit\!\!\rightarrow} \psi$ is false at w.

Case 2. φ is false at w. Suppose $X \in \mathrm{Prem}^l_w(\varphi)$. Then we have

- X is consistent;
- φ is in X;
- for all propositions p in X, all propositions in $f(w)$ that are lumped by p in w are in X;
- all propositions in $f(w)$ that logically follow from $X \cap f(w)$ are in $X \cap f(w)$.

Since W is in $f(w)$ and logically follows from $X \cap f(w)$, W must be in X. Since $\{w\}$ is in $f(w)$ and $W \rhd_w \{w\}$, $\{w\}$ must also be in X. But since $\varphi \in X$ and $w \notin \varphi$, we have $\bigcap X = \varnothing$, contradicting the consistency of X. Therefore, $\mathrm{Prem}_w^l(\varphi) = \varnothing$. This means that $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is false at w.

In both cases we have shown that $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $\varphi \wedge \psi$ is true at w. □

Proposition 3
Under the same assumption, $\varphi \overset{l}{\Box\!\!\rightarrow} \psi$ is true at w iff $\varphi \rightarrow \psi$ is true at w.

Proof. By definition, $\varphi \overset{l}{\Box\!\!\rightarrow} \psi \Leftrightarrow \neg(\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi)$. By Proposition 2, $\neg(\varphi \overset{l}{\Diamond\!\!\rightarrow} \neg\psi) \Leftrightarrow \neg(\varphi \wedge \neg\psi)$. By propositional calculus, $\neg(\varphi \wedge \neg\psi) \Leftrightarrow (\varphi \rightarrow \psi)$. □

Note that the condition on $f(w)$ in Propositions 2 and 3 can be relaxed substantially. In place of W and $\{w\}$, one can use any propositions p and q such that $W \subseteq p$ and $p \cap \{s \mid s \leqslant w\} \subseteq q \subseteq \{s \mid s \leqslant w\}$ and the proof goes through in the exact same way.

One possible objection to Propositions 2 and 3 and the above generalization of them is that propositions like $\{w\}$ that are true only in one world should be excluded from the values of f by the condition of human graspability. According to this objection, such propositions are too specific to be a possible object of belief and thus not graspable by humans.[11] Independent of the plausibility of this objection, we can show that it has little merit, as the following formulation demonstrates.

Proposition 4
Suppose that $\{\varphi \vee \neg\varphi, \neg\varphi, \neg\psi\} \cap \{p \in \mathscr{P}(S) \mid w \in p\} \subseteq f(w)$, where $\vee$ is defined in Definition 12 and $\neg$ satisfies (13). Then $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $\varphi \wedge \psi$ is true at w, and $\varphi \overset{l}{\Box\!\!\rightarrow} \psi$ is true at w iff $\varphi \rightarrow \psi$ is true at w.

Proof. Clearly, the second half follows from the first, so it suffices to show that

(i) If φ is true at w, $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff ψ is true at w.
(ii) If φ is false at w, $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is false at w.

Part (i) follows from the assumption that $\{\neg\psi\} \cap \{p \in \mathscr{P}(S) \mid w \in p\} \subseteq f(w)$ by Lemma 4.

[11] Kratzer voices this objection in her posting titled 'Lumps of thought: A reply' at http://semanticsarchive.net. The notion of human graspability seems to be related to the notion of *naturalness* employed by Kratzer 2002. See the Addendum below for some discussion.

To prove (ii), we use the assumption that $\{\varphi \vee \neg\varphi, \neg\varphi\} \cap \{p \in \mathscr{P}(S) \mid w \in p\} \subseteq f(w)$. Suppose $w \in \neg\varphi$. For any $X \in \mathrm{Prem}^l_w(\varphi)$, $\varphi \vee \neg\varphi \in X$ by closure under logical consequence. Since $\varphi \vee \neg\varphi \rhd_w \neg\varphi$, $\neg\varphi \in X$, which contradicts $\varphi \in X$ and $\bigcap X \cap W \neq \varnothing$. This shows that $\mathrm{Prem}^l_w(\varphi) = \varnothing$ and $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is false at w. □

Note that the assumption $\{\varphi \vee \neg\varphi, \neg\varphi\} \cap \{p \in \mathscr{P}(S) \mid \ w \in p\} \subseteq f(w)$ alone leads to the counterintuitive prediction that $\neg\varphi$ implies $\neg(\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi)$.

Propositions like $\varphi \vee \neg\varphi$, $\neg\varphi$, $\neg\psi$ are certainly graspable by humans if φ and ψ are, so the condition of human graspability cannot save lumping semantics from triviality. Incidentally, Propositions 2 and 3, on the one hand, and Proposition 4, on the other, make different kinds of claim. Propositions 2 and 3 say that all counterfactuals are truth-functional with respect to a certain broad class of relevance functions. Proposition 4 makes a weaker kind of claim, that if $f(w)$ contains certain propositions, one particular counterfactual is truth-functional with respect to $f(w)$. Nevertheless, Proposition 4 reveals a surprising (and in our opinion undesirable) feature of lumping semantics in that at least one true proposition in $\{\varphi \vee \neg\varphi, \neg\varphi, \neg\psi\}$ must be ruled out as irrelevant to the truth of $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ and $\varphi \overset{l}{\Box\!\!\rightarrow} \psi$ so as not to give them counterintuitive truth values.

Propositions 2–4 show that there is a strong tension between closure under lumping and closure under logical consequence, which can very easily make lumping semantics break down.

7 DISCUSSION

The results in the preceding section show that various claims that Kratzer makes about the predictions of lumping semantics cannot be taken at face value. The propositions relevant to the truth of counterfactuals must be restricted to a very small set, much smaller than Kratzer's paper suggests, in order for lumping semantics to have any chance of assigning reasonable truth conditions to counterfactuals. We think that the general nature of our argument calls into question the existence of any reasonable restriction on the set of propositions relevant to the truth of counterfactuals that saves lumping semantics from counterintuitive predictions; the possibility remains, however, that some clever restriction may solve the problems.

Kratzer leaves many important details of her semantics to be spelled out. In particular, she does not explicitly provide any condition on $f(w)$ to the effect that some propositions must be in it. There is one passage in her paper, however, that suggests that she has in mind a condition requiring certain propositions to be in $f(w)$, which we can show leads to a disastrous result similar to Propositions 2–4. In discussing example (8), she seems to assume that $\varphi \vee \psi$ and φ are relevant to the truth of $\neg\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$, where $\vee$ is as defined in Definition 12. In her discussion, φ and ψ are unrelated propositions like *Paula is buying a pound of apples* and *the Atlantic Ocean is drying up*, but let us see what happens when the assumption just stated is applied to the case $\psi = \neg\varphi$. Analogously to part (ii) of the proof of Proposition 4, we can show that whenever φ is true, $\neg\varphi \overset{l}{\Diamond\!\!\rightarrow} \neg\varphi$ must be false. This runs counter to intuition when $\neg\varphi$ is true in some other possible world, as can be seen in the following example.

(16) a. If Paula were not buying a pound of apples, she might not be buying a pound of apples.

b. $\neg$(Paula is buying a pound of apples) $\overset{l}{\Diamond\!\!\rightarrow}$ $\neg$(Paula is buying a pound of apples)

If there is a world like ours in which Paula is not buying a pound of apples, (16a) is intuitively true.

It might be instructive at this point to consider what happens if one decides to exclude from $f(w)$ propositions like W and $\varphi \vee \neg\varphi$ which are true in all possible worlds, even though none of the considerations in Kratzer's paper point in this direction. Although one might think it is not unreasonable to suppose that tautologies, being uninformative, should be excluded from premise sets, the following proposition is an indication that not much would be gained by this move.

Proposition 5

Suppose that (i) $f(w)$ contains no propositions that are true in all possible worlds; (ii) whenever p is in $f(w)$, $(p \wedge \varphi) \vee (p \wedge \neg\varphi)$ is in $f(w)$[12] *and moreover, if $\neg\varphi$ is true at w, $p \wedge \neg\varphi$ is also in $f(w)$; and (iii) if $\neg\psi$ is true at w, $\neg\psi$ is in $f(w)$. Then, $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $\varphi \overset{n}{\Diamond\!\!\rightarrow} \psi$ is true at w, and $\varphi \overset{l}{\Box\!\!\rightarrow} \psi$ is true at w iff $\varphi \overset{n}{\Box\!\!\rightarrow} \psi$ is true at w.*

Proof. Suppose that φ is true at w. Then by condition (iii) and Lemma 4, $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w if and only if ψ is true at w.

[12] Note that p and $(p \wedge \varphi) \vee (p \wedge \neg\varphi)$ do not necessarily stand for the same proposition in a situation model.

Suppose now that φ is false at w. Firstly, we show that $\mathrm{Prem}_w^l(\varphi) \subseteq \{\{\varphi\}\}$. Suppose to the contrary that for some $X \in \mathrm{Prem}_w^l(\varphi)$, $X \neq \{\varphi\}$. Let $p \in X - \{\varphi\}$. Then $(p \wedge \varphi) \vee (p \wedge \neg\varphi) \in X$ by condition (ii) and closure under logical consequence. Since φ is false at w, closure under lumping implies that $p \wedge \neg\varphi \in X$, making X inconsistent. This contradicts $X \in \mathrm{Prem}_w^l(\varphi)$. Secondly, we show that $\{\varphi\} \in \mathrm{Prem}_w^l(\varphi)$ iff φ is consistent. To see this, note that $\{\varphi\}$ is closed under lumping in w because φ is false at w, and $\{\varphi\} \cap f(w) = \emptyset$ is closed under logical consequence relative to $f(w)$ because $f(w)$ contains no propositions that are true in all possible worlds. Finally, we show that $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $\Diamond\ (\varphi \wedge \psi)$ is true at w. In case φ is consistent, $\mathrm{Prem}_w^l(\varphi) = \{\{\varphi\}\}$ and $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $\varphi \cap \psi \neq \emptyset$, that is, iff $\Diamond\ (\varphi \wedge \psi)$ is true at w. In case φ is inconsistent, $\mathrm{Prem}_w^l(\varphi) = \emptyset$ and both $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ and $\Diamond\ (\varphi \wedge \psi)$ are false at w.

By Proposition 1, we have shown that $\varphi \overset{l}{\Diamond\!\!\rightarrow} \psi$ is true at w iff $\varphi \overset{n}{\Diamond\!\!\rightarrow} \psi$ is true at w. □

8 CONCLUSION

We have shown that Kratzer's (1989) lumping semantics fails to achieve the expressed aim of providing 'a theory of counterfactuals that is able to make more concrete predictions with respect to particular examples' (p. 626) than earlier theories. We have to conclude that either her theory makes wrong predictions because not enough propositions are excluded from the set of relevant propositions, or it fails to make any concrete predictions because we have no good idea how to restrict that set.

We can also conclude that lumping semantics is a significant step backward compared to partition semantics. As Kratzer (1981) stresses, the latter theory provides a reasonable 'logic' for counterfactuals; it predicts the validity of certain intuitively acceptable forms of inference involving counterfactuals, while correctly predicting the invalidity of other forms of inference. In contrast, lumping semantics fails to validate simple laws like $\Diamond\varphi \Leftrightarrow (\varphi \Diamond\!\!\rightarrow \varphi)$ and $\Diamond\ \varphi \wedge (\varphi \Box\!\!\rightarrow \psi) \Rightarrow \varphi \Diamond\!\!\rightarrow \psi$.

What is striking is how little value Kratzer's incorporation of lumping actually brings to premise semantics. The requirement of closure under lumping, together with closure under logical consequence, introduces a host of new problems that even naïve premise semantics did not face.[13] The parameter of a relevance function f, which is intended to be context-dependent and indeterminate, is then burdened with the dual task of keeping those new problems at bay *and* yielding better predictions than the pre-lumping versions of the theory. Our analysis has cast into serious doubt whether there exists any choice of f that can meet this demand, but we have not settled this question. Even if the answer turns out—to our surprise—to be positive, it remains to be seen whether the resulting theory retains the initial appeal of the introduction of lumping to the premise semantics of counterfactuals.

ADDENDUM

Recently, Kratzer (2002) offered an entirely different approach to the same kinds of problems that motivated lumping semantics. In this addendum, we very briefly discuss some aspects of this paper that are relevant to our analysis of lumping semantics.

Kratzer (2002) suggests that the facts that are relevant for the truth of counterfactuals 'may very well be propositional facts'. A propositional fact is the closure of a singleton proposition $\{s\}$, where s is some actual situation, under two closure conditions, namely, (i) persistence and (ii) closure under maximal similarity. Two situations are said to be maximally similar if they are qualitatively the same and preserve counterpart relationships between individuals. The requirement that a relevant proposition be closed under maximal similarity serves to rule out overly specific propositions like $\{w\}$ or $\{s \mid s' \leqslant s\}$, and the requirement that it be generated by a singleton set serves to rule out overly general propositions like W or $\varphi \vee \neg\varphi$. Kratzer (2002) outlines how this version of premise semantics can handle examples similar to (8) and (12), which motivated the lumping semantics, without the use of lumping. Briefly, the offending proposition that

[13] We noted at the end of Section 6 that the triviality results (Proposition 2–4) stem from the tension between the two requirements of closure under lumping and closure under logical consequence. If φ is false, any true proposition lumps a proposition that is inconsistent with φ, and any set of propositions logically implies some true proposition. But closure under logical consequence is not important for most of the examples in Kratzer's paper. What happens if we change her definition of Prem^l_w and either (a) drop the requirement of closure under logical consequence altogether or (b) replace it by a weaker closure condition, like the weak closure under logical consequence mentioned in footnote 9? Both (a) and (b) have the effect of making $\{\varphi\}$ a premise set when φ is false but consistent. ($\{\varphi\}$ is closed under lumping because φ is false, and $\{\varphi\} \bigcap f(w) = \varnothing$ is weakly closed under logical consequence.) We can show that assuming $\{s \mid s \leqslant w\} \in f(w)$ makes both modifications of lumping semantics collapse to naïve premise semantics. Also, the modification by (b) collapses to naïve premise semantics under the assumption in Proposition 2 or under the assumption that conditions (ii) and (iii) in Proposition 5 hold.

cannot be in any premise set under the lumping semantics because it lumps a proposition incompatible with the antecedent is now ruled out as irrelevant under the new semantics because it does not 'correspond to a worldly fact' (i.e., it is not the closure of $\{s\}$ for some actual situation s). The 'lumpee' proposition is relevant because it is the closure of $\{s\}$, where s is the situation exemplifying the 'lumper' proposition.

Although the new semantics is not meant to be a special kind of lumping semantics, it can be understood to be such, since it can be shown that a propositional fact lumps another propositional fact only if the former is a subset of, and hence logically implies, the latter. So if $f(w)$ in the lumping semantics is taken to be (a subset of) the set of propositional facts, closure under lumping becomes redundant, and the resulting specialized version of lumping semantics becomes equivalent to the new semantics. (Note that closure under logical consequence alone is always redundant.) Of course, there is no point in having both closure under lumping and restriction to propositional facts, then.

The requirement of closure under maximal similarity seems to be related to the requirement of human graspability, although Kratzer (2002) does not explicitly mention the connection. Both notions are intended to rule out overly specific propositions—propositions that make distinctions among situations that humans supposedly cannot make. This suggests a specialization of the lumping semantics in which members of $f(w)$ are restricted to natural propositions (propositions that are both persistent and closed under maximal similarity) that are true at w. (The class of natural propositions is much broader than the class of propositional facts.) We can show that such a move will not solve the fundamental problems with the lumping semantics which we have pointed out in this paper. On the assumption that φ and ψ express natural propositions, we can replace $\{w\}$ by the closure thereof in Proposition 2 and the proof goes through as before. Propositions 4 and 5 are not affected, assuming a suitable definition of $\neg$ that preserves naturalness.

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MAKOTO KANAZAWA
National Institute of Informatics
2–1–2 Hitotsubashi, Chiyoda-ku
Tokyo 101–8430
Japan
e-mail: kanazawa@nii.ac.jp

STEFAN KAUFMANN
Department of Linguistics
Northwestern University
2016 Sheridan Road
Evanston, IL 60208
USA
e-mail: kaufmann@northwestern.edu

STANLEY PETERS
Department of Linguistics
Margaret Jacks Hall, Building 460
Stanford, CA 94305–2150
USA
e-mail: peters@csli.stanford.edu

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REFERENCES

Armstrong, D. M. (1978) *Nominalism and Realism: Universals and Scientific Realism*. Cambridge University Press. Cambridge.

Armstrong, D. M. (1997) *A World of States of Affairs*. Cambridge University Press. Cambridge.

Barwise, J. & Perry, J. (1983) *Situations and Attitudes*. MIT Press. Cambridge, MA.

Goodman, N. (1947) The problem of counterfactual conditionals. *The Journal of Philosophy* **44**:113–128.

Kratzer, A. (1979) 'Conditional necessity and possibility'. In U. Egli, R. Bäuerle & A. von Stechow (eds), *Semantics from Different Points of View*. Springer, Berlin, 117–147.

Kratzer, A. (1981) 'Partition and revision: The semantics of counterfactuals'. *Journal of Philosophical Logic*, **10**:201–216.

Kratzer, A. (1989) 'An investigation of the lumps of thought'. *Linguistics and Philosophy* **12**:607–653.

Kratzer, A. (2002) 'Facts: Particulars or information units?' *Linguistics and Philosophy* **25**:655–670.

Lewis, D. (1973) *Counterfactuals*. Harvard University Press. Cambridge, MA.

Lewis, D. (1981) 'Ordering semantics and premise semantics for counterfactuals'. *Journal of Philosophical Logic* **10**: 217–234.

Pollock, J. L. (1976) 'The "possible worlds" analysis of counterfactuals'. *Philosophical Studies* **29**:469–476.

Pollock, J. L. (1981) 'A refined theory of counterfactuals'. *Journal of Philosophical Logic* **10**:239–266.

Ramsey, F. P. (1929) 'General propositions and causality'. In R. B. Braithwaite (ed.), 1931. *The Foundations of Mathematics and other Logical Essays*, Routledge & Kegan Paul, London, 237–255.

Rescher, N. (1964) *Hypothetical Reasoning*. North-Holland. Amsterdam.

Stalnaker, R. (1968) 'A theory of conditionals'. In *Studies in Logical Theory, American Philosophical Quarterly, Monograph: 2,* Blackwell, Oxford, 98–112.

Veltman, F. (1976) 'Prejudices, presuppositions and the theory of conditionals'. In J. Groenendijk & M. Stokhof (eds), *Proceedings of the First Amsterdam Colloquium [=Amsterdam Papers in Formal Grammar, Vol. 1]*, Centrale Interfaculteit, Universiteit van Amsterdam, 248–281.