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INFORMATION RELEVANCE AND SOCIAL DECISIONMAKING: SOME PRINCIPLES AND RESULTS OF DECISION-THEORETIC SEMANTICS

ARTHUR MERIN

ABSTRACT. This paper submits an approach to meaning with a focus on broadly non-truth-conditional aspects of natural language. 'Pragmatics' is interpreted not as a label for aspects of meaning left residual by 'semantics', but substantively, in the way of C.S. Peirce and F.P. Ramsey, as a synonym for decision-theory. We outline (i) basic assumptions, (ii) some relations to other approaches, (iii) a range of results wide enough to justify the term 'approach'. The phenomena addressed include those widely treated under labels 'conversational implicature' (both particularized and generalized with applications to 'or' and to the Jespersen/Ducrot/Horn facts on negation in scalar predicate contexts) and 'conventional implicature' ('but', 'even'), as well as 'presupposition' ('King-of-X'-sentences, 'stop' and 'also'). A key notion is 'relevance', explicated as a measure of epistemic context-change potential and related to information in the traditional, stochastic way. Another is the notion of 'negotiation'—i.e. of a social situation in which persons with locally incompatible preferences with respect to an issue attempt to influence each other. Assumptions guaranteeing compositionality (additivity) of relevance are seen to militate for dichotomous issues.

I. Introduction

'Information' is a partial synonym of 'meaning', and there is little of either without reasoning. Within a deductive framework with classical closure operation $\mathrm{Cn}(\cdot)$ let a theory T represent an epistemic state. Classical theory change being monotonic, one might identify the meaning of a sentence E in context T with the set-difference $\mathrm{Cn}(T, E) - T$.

Already for sentential languages, and disregarding obstacles to computing closure, this is not a felicitous picture of human beliefs; nor, hence, of meaning. 1. Logically independent sentences A, B may intuitively stand

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in inferential relations. Indeed, if Hume was right, all empirical knowledge is of this contingent nature. 2. Epistemic state-change is highly non-monotonic. Beliefs can be given up; tea with Harper's Diesel Oil added is no longer tasty.

The oldest though far from ontologically leanest formalism for inductive, non-monotonic reasoning is the probability calculus (PrC). Its axioms, extending classical logic, constrain belief to be coherent. Incoherence means: being disposed, in unwitting practice, to consider favourable or fair a system of bets in which one must lose come what may (Ramsey 1926).

Now, imputing to life-sized agents as epistemic states point-valued probabilities, i.e. unique conditional probability functions $P(\cdot|\cdot)$ is implausible. And even if we recognize PrC as imposing but 'roomy' (Jeffrey 1965) constraints, we still face NP-hard computation. Should this deter us from using probability theory in the analysis of natural language meaning and prima facie meaning-conditioned acceptability intuitions? No.

1. Probability is well investigated and motivated; a proper extension of classical logic; and hence a natural benchmark for competence models of defeasible reasoning. At the very least it could be scout to leaner formalisms; a standard mathematical tactic.[1]

2. Probability trades with cardinal utility, i.e. a quantitative representation of preference. Indeed it offers the one principled link, so far, between normative accounts of rational belief and conduct under conditions of uncertainty where real stakes are at issue. Moreover, a fair bit of non-monotonic inference, i.e. jumping to conclusions, can be recovered through probabilistic updating gated by utility-dependent decision-thresholds. On such a framework for statistical decisionmaking, 'Signal Detection Theory' (SDT) and the developed world's industrial production of middle-sized dry goods have been running profitably since the 1940s.

3. With Ramsey (1926) we can explicate belief and meaning in terms not of 'holding true' and concomitant assent or dissent, but of *dispositions to conduct.* This is, essentially, the Maxim of C.S. Peirce's Pragmatism. Example: if you think rain more likely than dryness, don't dislike carrying an umbrella on a dry day more than being wet and are equally happy dry with or without umbrella, then take the umbrella along. You will then act in a way 'extensionally' indistinguishable from the way you would act if you were sure it was going to rain. Pragmatist construal makes probabilistic belief states more plausible than will the assumption of introspectible accountability and explicit imputability required by forensic

[1] See Barwise (this volume) for the return of classical logic in a state-subspace setting.

discourse about belief—a rather special language game that should not determine the class of useful theories of meaning.

4. Probability functions can thus be treated as personal (Ramsey, 1926). For linguistic applications here considered this means: their ostensible imputation to one or more of actual or virtual discourse participants is being imputed to competent Speakers.

5. There is a base in personal probability even for a boolean semantic component or interpretive projection, and its extensions to semantics for predicate logic. Cf. Field's (1977) semantics for classical logic. This base is naturally at home in a 'cognitivist' setting. Hence, even taking a conservative line on algebraic semantics, we need not, in principle, ever refer to extramental *sive* extrasocial truth-conditions to account for native speaker intuitions on acceptability and paraphrase.

6. Probability, also with decision-theory built around it, has nice mathematical structure.

7. Computational load, both low and high in the complexity hierarchy, is a problem in many walks of artificial and other intelligence. Checking a truth-table of 20 atomic constants is a long-term prospect; so is generalized anaphora resolution, NP-hard by an argument of Ristad (1993).

8. Though it is widely held that Kahneman and Tversky (cf. Kahneman et al. 1982) showed probability not to be a serious candidate even for a competence model, the evidence has not gone unchallenged. Consider e.g. the 'taxi-cab' problem, for which Birnbaum's (1982) re-analysis showed the data to be as predicted by an SDT approach. Speculations on what people cannot unconsciously do should therefore be checked against the psychophysical SDT literature.[2]

I shall be attending mostly to phenomena which in recent years have mainly been addressed under the heading of 'pragmatics'. Yet I think there is now nothing to be gained—and much to be lost—by treating 'pragmatics' as a label for a class of meaning-related phenomena which are somewhow secondary to or parasitic on 'semantics' proper. If we followed the late 1970's slogan 'Pragmatics = Meaning − Truth-Conditions' (Gazdar 1979), then the central features which distinguish what is now known under the label 'Dynamic Semantics' (Kamp 1981, Heim 1982, Groenendijk and Stokhof 1991) from, say, classical Montague Semantics,

[2]Note for readers familiar with the experimental literature: The finding that people tend to ignore base-rates can be rephrased: they tend only to attend to relevance (of observations) as defined in Section III below, and ignore prior odds to the extent of setting them evens.

would be part of pragmatics. If we say: semantics is what is in the mental lexicon, then 'also', 'but' and 'even' are the province of semantics, *in toto*.

In Section IV I hope to show—in line with a general hypothesis first adopted by Oswald Ducrot (1973)—that the theoretical constructs useful for describing such apparently extra-lexical phenomena as e.g. particularized implicature are the same as are being used to describe core lexical properties. Accordingly we might as well let *semantics*, as an activity, mean what it presumably meant for Bréal, coiner of the name: the description of meaning. And that, most ecumenically, means: the specification of constraints imposed by utterances on possible contexts of use. I propose to use the label *pragmatics* for a particular approach to meaning in natural language and scientific discourse (cf. Skyrms 1984), namely the one associated with the pragmatism of Alexander Bain, founding editor of the journal *Mind*, and of C.S. Peirce, who developed it under the trade name 'pragmaticism'. The tools and some still under-appreciated applications of this pragmatic approach are, again, in large measure due to F.P. Ramsey (1926).

II. Information and Relevance

In a probabilistic setting over finite 'sample spaces' Ω, i.e. event or proposition fields of sets on a carrier set Ω, whose points w are worlds, models, or maximal consistent sets of sentences, probability weights/masses are assigned to points, normalized to distribute a fixed unit mass. Palpably, the empty set must receive zero mass $[P(\phi) = 0]$, the universal set unit mass; $[P(\Omega) = 1]$, the mass of $A \cup B$ is the sum of their masses minus that of $A \cap B$ (not to be counted twice!) $[P(A \cup B) = P(A) + P(B) - P(A \cap B)]$. These are the axioms of finitely additive probability, in sensori-motor imagery. We can also derive them from rational action: e.g. coherently fair bets (Ramsey 1926).[3]

[3] If your beliefs are not 'coherent', i.e. violate the laws of probability, you can be sold a Dutch Book—a system of bets in which you must lose come what may. If you fail to be 'strictly coherent' (Kemeny 1955, Lehman 1955 and Shimony 1955 proved), i.e. if you assign zero probability to non-empty sets of worlds you consider possible, you can be sold a Book in which you cannot win but may possibly lose. I assume strict coherence (Carnap: 'regularity') of probability functions only, and almost trivially so, with respect to given small discourse contexts. I do not assume it with respect to every larger finite context and associated finite set of models or worlds. (It leads to inconsistency for infinite sets of worlds.) Thus, discourse beliefs may assign probability 1 to propositions which, in real-world (expert, ontic, ...) terms would be considered contingent. Hence they would assign probability zero to their non-empty complements. Beliefs may thus be strictly coherent *locally*, though not strictly coherent under extensions of the universe of models or possible worlds. (This is much like relativizing

Conditioning on a proposition E amounts to transformation of Ω by set intersection with E, where all mass previously assigned to $\Omega - E$ is redistributed evenly among points in E. Hence $P(A|E) = P(AE)/P(E)$ [for $P(E) > 0; AE =_{df} A \cap E$] is a standard definition of conditional probability.

For simplicity let Ω be finite. Carnap and Bar-Hillel (1952) [CBH] consider two explicata of *amount of information* (phenomenologically: unexpectedness):

DEFINITION: $\text{cont}(E) =_{df} P(\bar{E}) = 1 - P(E) = (\text{card}\{w : w \in \bar{E}\})/(\text{card}\{w : w \in E \cup \bar{E}\})$ [the last '=' being valid only for $P(\cdot)$ assigning equal probability mass to all $w \in \Omega$]

DEFINITION: $\text{inf}(E) =_{df} \log_2[1/(1-\text{cont}(E)] = -\log_2[P(E)]$

Inf is conveniently additive when A and B are stochastically independent, i.e. if $P(A|B) = P(A)$, equivalently $P(B|A) = P(B)$, then $\text{inf}(AB) = \text{inf}(A) + \text{inf}(B)$. If Q_i is a generic element of a partition, then $\sum_i P(Q_i)\text{inf}(Q_i)$ measures the average expected information gain from an answer to the question: Which element of the partition is the actual world in?[4]

The relation to entailment-based informativeness, prominent in seriously formal explications of Gricean conversational implicature (Gazdar 1979; Soames 1982) is: If $A \models B$ then $\text{inf}(A) \geq \text{inf}(B)$; and $\text{inf}(A) > \text{inf}(B)$ if in addition $B \not\models A$. The converse is invalid.

Inf or cont as such stronger notions have not, so far, found explicit well-informed and consequential use in linguistic pragmatics.[5] However, the license they offer to compare informativeness even of $\models$-incomparable propositions recalls one aspect of a notion proposed by Sperber and Wilson (1986) [SW] which I'll label relevance$_{SW}$.

SW maintain that utterances U carry an ostensive presumption of optimal relevance. This practically implies, for one: if U has several alternative interpretations $\{E_i\}$, interpret as that E^* which can be deemed most relevant in the context; if these interpretations are ampliative, make requisite assumptions. I take the explanatory value of this principle for granted when it is stated with reference to the intuitive explicandum.

necessity.) When I speak of 'the tautology' or 'the empty proposition' the default interpretation is: with respect to the idealized, maximal universe of worlds. This will be pertinent in the section on presupposition.

[4]With an intuitively different kind of sample space this is Shannon's entropy as applied to signal transmission.

[5]Mandelbrot (1961), reported in Miller and Chomsky (1963), who derived the distributional facts of 'Zipf's Law' from statistical a priori truths unrelated to 'least effort', did not run under that label.

However, SW have not offered—indeed declined to offer—an *explication* of the intuitive notion 'relevant'. Relevance$_{SW}$ of an E is large to the extent that its *contextual effects* are, and small to the extent that E in context is hard to *process*. Both notions remain informal, and contextual effects are heterogeneous. Still, SW's most formally committed and elaborately discussed kind of effect has a correlate in simple monotonic theory change.

Call E for the nonce 'non-degenerately K-informative' iff $\mathrm{Cn}(K, E)$ is consistent and $\mathrm{Cn}(K, E) - K$ non-empty. Call E and K 'each-way informative' iff, in addition, $\mathrm{Cn}(K, E) - E$ is non-empty. Modulo proscription of derivations by connective introduction rules (which are of no present concern), and keeping processing effort constant, each-way informative E and K would be relevant$_{SW}$ to the extent that the set-differences were large.[6] Without further constraints this logic appears to leave $\{E, K, \overline{EK}\}$ consistent; remedy, $\wedge$-introduction, in effect makes any logically independent K and E relevant$_{SW}$ (to some non-nil extent).

The stochastic extension of $\mathrm{Cn}(K, E) - K$, granted the wherewithal for ascent to the Lindenbaum algebra of our propositional language, is measured by CBH's (1952) amount of conditional information of E given K:

DEFINITION: $\mathrm{inf}(E|K) =_{df} -\log_2[\mathrm{p}(E|K)]$.
FACT: $\mathrm{inf}(E|K) = \log_2[1/\mathrm{p}(E|K)] = \log_2[\mathrm{p}(K)/\mathrm{p}(EK)] = \log_2[\mathrm{p}(K)] - \log_2[\mathrm{p}(EK)] = \mathrm{inf}(EK) - \mathrm{inf}(K)$.

If the stochastic extension $\mathrm{EFF}_1(E, K)$ of each-way informativess were to explicate extent of contextual effect we could now, in turn, explicate such effect, for comparison's sake:

$$\mathrm{EFF}_1(E, K) =_{df} \mathrm{inf}(E|K) + \mathrm{inf}(K|E) = 2\mathrm{inf}(EK) - \mathrm{inf}(K) - \mathrm{inf}(E).$$[7]

[6] Other criteria of relevance informally noted though not explored do include an explanandum for the notion I'll favour below.

[7] Where the 2 of $2\mathrm{inf}(EK)$ tells us that $\mathrm{EFF}_1(E, K)$ is always non-negative. EFF_1 is not, of course, what I think Sperber and Wilson appear to have proposed: an increasing function of the cardinality $\mathrm{card}((\mathrm{Cn}(K, E) - K) \cup (\mathrm{Cn}(K, E) - E))$ of a set of sentences of *lingua mentalis*. Rather it is something I have constructed as a closest counterpart of their notion in a theoretical setting that harbours a notion of relevance which looks like meeting Carnap's (1950) general desiderata for the explication of pre-theoretical notions: closeness to intuition, formal intelligibility, empirical fruitfulness, and (last and least) simplicity. Relevance$_{SW}$ does not meet any of these desiderata well. (As editorial comment p. 736 of *Behavioural and Brain Sciences* 10 (1987) put it, presumably regarding the first and third : '[A]re we, like St. Exupéry's star-counting businessman, just indiscriminate implication-collectors, restrained only by our limited resources?')

By contrast, in a quantitative or qualitative stochastic setting, *relevance* is a very different and specific relation between two propositions. E is *relevant* to H iff learning its truth in a state where its truth was not assumed would affect the probability assigned to H. It is *positively* relevant to the (quantitative) extent that it raises it, *negatively* to the extent that it lowers it. Thus relevance is a properly *disjunctive* notion: of positive and of negative relevance. I shall reserve for this generic notion the index-free label, under which it is familiar e.g. from Keynes (1921), Carnap (1950) and Jeffrey (1965); and more generally in the current literature on stochastics.

Relevance comes into its own when the context involves uncertainty about the resolution of an *issue*, a partition of the space of possibilities into two or more *hypotheses* to which interests attach. If our paradigmatic discourse situation is not one of simple 'information transfer' but of explicit or tacit *debate*, then some such hypothesis will be the speaker's argumentative *goal*.

This idea informs the approach to 'conversational' and 'conventional' implicature of Ducrot (1973) and his student Anscombre (1973) [AD]. AD explained implicatural phenomena through rankings of propositions by what they called *valeur argumentative* w.r.t. an ostensible ulterior conclusion H. Often H would be explicitly given by linguistic context. Thus in AD's favourite example format some sentence 'E' is uttered in support of some immediately prior H. My pulp fictional example, for a task—disambiguation—little discussed by AD or H.P. Grice (1967):

> [H] *You will now give me your wallet.*
> ['E'] *If not, I'll let you have it.*
> [There is a bag of trash/garbage in common view. Speaker is also seen to be holding a gun.]

What interpretation, as speakers of British English, are we and Addressee (A) to give ['E']? That Speaker will let A hang on to the wallet if A doesn't hand it over? That she will present him with a disvaluable commodity bundle, the garbage? Or that she will kill him? Most likely the last, the strongest argument in favour of acting in accordance with [H].[8]

It has drawn useful heuristic attention to the relevance of the pre-theoretical explicandum for a wide range of 'particularized' conversational implicature phenomena. But it has never been argued to outperform, even at an informal level of application, Ducrot's (1973) pertinent notion of 'argumentative value', which yields to coherent explication.

[8] Here we are lucky: no appeal to processing effort seems required. Perhaps we'll be lucky most of the time. My hope is that we shall need it only as a tie-breaker, if ever. — 'Let him have it' brought a British juvenile to the gallows when the jury bought

Often enough such an H is not given, or not to be trusted as being the real, perhaps ulterior goal. And then A, or any hearer, must 'abduce' a hypothesis H^* such that the relevance of (let us simplify: unambiguous) E to H^* is maximal among the alternatives H_i in the taken-for-granted context K. Call this (part of) figuring out the speaker's intentions, or real intentions.

On this view, speakers S do not engage in idle gossip, do not proselytize for the sake of it, but speak to a *point*: the adoption by the interlocutor A of a proposition H as a constraint on A's conduct or, indeed, as a *constraint on S and A's joint future*—technically, a 'jointly randomized strategy'.

Interpersonal pragmatics on this view is interpersonal decision theory. Leaving aside the rational reconstruction of pure convention (Lewis 1969) that might well underlie stable aspects of social institutions, including any sort of language game, we cannot in general presume that social interactions have the structure of a 'team game' (of 'perfect cooperation') where all agents have identical or at least compatible *prima facie* preferences.

Whenever there is debate—whether or not you should give me your wallet; which is the most suitable meeting place; the tastiest animal to eat; which of H and $\bar{H}$ is true—proponent and sceptic have locally incompatible preferences regarding H for as long as H is an issue between them. Such agents are autonomous in the vulgar—that is: pre-Kantian—sense of asking

Why ∗∗ should I (do or believe that)?

And the answer will be: Because there are incentives in the form of sanctions, rewards, and—as a special case for the proximally pure, epistemic case—evidence (Merin 1994).

This lends the paradigmatic social situation the structure of a *bargaining game* [BG], proposed by Harsanyi (1977) as a widely applicable model of social interaction.[9] For our purposes 'paradigmatic' means: having a theory that has a model in the kind of linguistic phenomena we want to explain. No more; no less. This empirical issue is, I believe, independent of the issue of whether or not there must be, underneath, a Lewis-construable convention.

Types of bargaining games are manifold, tokens notoriously 'brittle'. So chances are that only very robust features, shared by the whole class

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the prosecution's story that it was uttered as an incitement to murder, rather than as a plea to hand over the weapon to the policeman subsequently killed with it.

[9] Against the backdrop of which other kinds of interaction—check: 'love', 'urbanity'—gain their distinction.

of bargaining games, can have predictive import for the structure of linguistic meaning. And I think: they actually do.

Even for degenerate, 'ultimatum' BGs [example: law-abiding customer vs. fixed-price store], if Pro makes a claim, Pro won't object to Con conceding more (a windfall), but will mind getting less. Con won't mind giving away less than conceded, but will mind giving away more. Put bluntly: claims are such as to engender intuitions glossable 'at least'; concession dually, 'at most'. We shall see that this very robust feature of all bargaining games already affords a lot of linguistically useful structure (Sec. IV).

Speaker's utility attaching to an imperative/jussive E is, prima facie, the utility attaching to the prospect of its realization. What, then, is it for indicative/declarative E? Prima facie, E's relevance to an ulterior epistemic or deontic constraint. We can explicate relevance as a special case of utility, i.e. a real-valued representation of preferences, long as we are careful about degenerate cases where some measures of relevance go to infinity. And the explicans turns out to be a measure of epistemic state change potential (see Sec. III).

So we are back with Peirce's and Ramsey's notion of belief as a disposition to conduct; and with interpersonal efforts to transform those dispositions. This helps to embed into the best-developed theory of rational conduct available today AD's approach to natural language.[10] AD shied away from stochastic interpretation, eschewed formalization, and viewed argumentation as something *sui generis* rather than as a special case of a bargaining situation.[11] In consequence, I believe, they were unable to compete in predictive commitment with the most rigorous 1970's work on, say, generalized conversational implicature (Gazdar 1979, Soames 1982; predicated on Horn 1972). But their insights are the principal linguistic inspiration behind what follows.

III. Decision-Theoretic Semantics (DTS)

What are the implications of judging more relevant one rather than the other of two ideologies of communication: the (Neo-)Gricean view of optimal information transfer, apparently shared by SW; and the partisan, persuasion-oriented view?—Well, one might answer, relevant to what?

Well-rounded philosophical discourse on information would note that 'figuring out real intentions' already presumes scepticism, and (Austin

[10] All in French; but read Horn (1989) and König (1991) via the indexes for useful glimpses.

[11] They also distinguished their argumentative from a logico-semantic domain in ways that underplayed their argumentative hand, as König (1991:194n5) demonstrates.

1946) cause for it. The objective of optimal information transmission doesn't. But philosophy, let alone aesthetics or ethics, needn't be decisively consequential for explanation of robust linguistic intuitions. Much as one may consider one super-objective—i.e. *ideology*—more enlightening than another about what goes on introspectibly, that other may be the one by which the poorly introspectible linguistic intuitions of present interest are predominantly conditioned.

I should like to treat the largely stochastic and preference-related constraints to be discussed as *embedding conditions*—a term by which Brian Ellis (1979) characterized normative rationality constraints—but here within a *descriptive* semantics of discourse. 'Embedding condition' is my preferred synonym for what Chomsky called, with regard to syntax, 'competence'. That is, we idealize a naive theory of linguistic or other conduct, even beyond our finite capacities, and without prejudice to finer, procedural and—where these are unaddressed, as in in Section VI—subpropositional descriptions. These, I believe, will nevertheless turn out to satisfy the pragmatic constraints proposed to the extent of being adequate to the linguistic facts.

Empirical commitments sharpen up with a formal definition of relevance. Epistemic updating that, by most accounts, is Ramsey-coherent proceeds by conditioning in accordance with Bayes' formula. Put in 'odds' form, where $\mathrm{Odds}(A) =_{df} P(A)/1 - P(A)$:

$$P(H|E)/P(\bar{H}|E) = [P(H)/P(\bar{H})]\cdot[P(E|H)/P(E|\bar{H})]$$

Posterior odds (on the left) equal *prior odds* times the *likelihood ratio* of H on E. For cognitive convenience (Peirce 1878), take logarithms to any fixed base; say, 2 for common measure:

$$\log[\mathrm{Odds}(H|E)] = \log[\mathrm{Odds}(H)] + \log[P(E|H)/P(E|\bar{H})]$$

The last summand measures the epistemic context change potential of E with respect to H under $P(\cdot)$.

> DEFINITION: The *relevance* $\mathrm{r}_H(E)$ of proposition E to proposition H in an epistemic context represented by conditional probability function $P(\cdot|\cdot)$ is given by $\mathrm{r}_H(E) =_{df} \log[P(E|H)/P(E|\bar{H})]$.

This is the log-likelihood-ratio for simple H.

> DEFINITION: Call E *positively relevant* to H iff $\mathrm{r}_H(E) > 0$, *negatively* iff $\mathrm{r}_H(E) < 0$, else *irrelevant* to H.[12]

[12] Let us also adopt Carnap's convention that, whatever our particular measure of relevance, relevance of E be zero when it contradicts immutable background belief.

If $E \vdash H \quad (\bar{H})$, then $r_H(E) = \infty\,(-\infty)$.[13]

Briefly, then: a proposition E is irrelevant to an *issue* iff its truth or falsity would not affect the degree of belief in either of the issue's possible outcomes. (No issue, no relevance!) $\mathrm{r}_H(E)$ is a function of the change in the probability of H that would be occasioned by assigning probability 1, i.e. epistemic certainty to E.[14]

Here is a more general view of the approach. $P(\cdot|\cdot)$ represents a (continuous) *commitment state*: a partial function

$P(\cdot|\cdot) : Prop \times Prop \rightarrow [0,1]$

mapping pairs of propositions to a real number. It is what Ramsey (1929) called a *probability theory*, as distinct from a theory defined by closure under classical consequence.

Changing the state $P(\cdot) = P(\cdot|\Phi \vee \bar{\Phi})$ to $P'(\cdot) =_{df} P(\cdot|E)$ by *conditioning* on E will increase / decrease / leave unaltered the probability of $X \in Dom(P(\cdot))$. E is then positively / negatively / not at all *relevant* to X in the context represented by $P(\cdot)$. Thus we can say: A proposition E acts as a partial function

$$f_E : \mathcal{P} \rightarrow \mathcal{P}$$

on a space $\mathcal{P}$ of probability functions. Its fixed points are states $P(\cdot) = P(\cdot|E)$, i.e. where E is *presupposed* (see Section VI). And it is undefined where $P(\cdot) = P(\cdot|\bar{E})$, i.e. where $\bar{E}$ is presupposed. Finally, we can define $BF(j) = \{X : P(\cdot) = P(\cdot|X)\}$ as the 'full belief' set at j, represented by a 'theory' closed under meet and classical consequence, and immutable by conditioning.[15]

This property is automatically satisfied by the classical definition of independence, $P(AB) = P(A)P(B)$, where division by zero is not an issue.

[13] $\mathrm{r}_H(E)$ is a continuous monotone increasing function of other measures of relevance, e.g. $P(HE) - P(H)P(E)$, $P(H|E) - P(H)$, $P(H|E) - P(H|\bar{E})$, $P(H|E)/P(H)$. All purely ordinal claims thus remain true for them. $\mathrm{r}_{(\cdot)}(\cdot)$ is additive under certain conditions (see below under CIP) and values all cases of entailment alike. I.J. Good (1950, 1983), chief explorer of $\mathrm{r}_{(\cdot)}(\cdot)$, calls it 'weight of evidence' and notates $W(H : E)$; Peirce spoke of 'weight of argument'. I follow Keynes, Carnap and Jeffrey also for reasons of science policy: 'relevance' has been a widely invoked term in language analysis ever since Grice (1967) brought it to linguists' attention, and should retain an explication that is both useful and consonant with general scientific usage.

[14] Jeffrey (1965) generalized epistemic changes to those occasioned by shifts of probability short of epistemic certainty. Note that even epistemic certainty can be interpreted in a purely local, contextual manner. Truth-conditional analogy: replace big, realist possible worlds by arbitrary Boolean valuations.

[15] To keep matters simple—and in line with the assumption that linguistics often deals in ostensibilia inadmissible to philosophy of science—I ignore treatments of mutable full belief in contingent matters such as e.g van Fraassen's (1995); which a more

Relevance is intelligibly related to conditional informativeness:

FACT: $\mathrm{r}_H(E) = \inf(E|\bar{H}) - \inf(E|H)$.
COROLLARY: $\mathrm{r}_{\bar{H}}(E) = -\mathrm{r}_H(E)$.

Let us make taken-for-granted background K explicit, and supply a

DEFINITION: $\mathrm{r}_{H|K}(S) =_{df} \log[P(S|HK)/P(S|\bar{H}K)]$ is the relevance of S to H, given K.

Then we have

$\mathrm{r}_{H|K}(E) =_{df} \log[P(E|HK)/P(E|\bar{H}K) =$
$\inf(E|\bar{H}K) - \inf(E|HK)$.

So $\mathrm{r}_{H|K}(E)$ is *decreasing* in $\inf(E|KH)$ and *increasing* in $\inf(E|K\bar{H})$. If E were already taken for granted, its assertion, a primitive notion for now, would be uninformative $[\inf(E|KE) = 0]$. E would also be irrelevant to any H, its epistemic impact having already been absorbed into the probability function. In this special case, relevance—to any proposition—and informativeness coincide. (In general they don't.) Both are 0.[16]

Next consider the interpersonal component of linguistic explanation, as outlined in the paradigmatic response 'Why should I?'

THESIS BG: A dichotomic epistemic issue $\{H, \bar{H}\}$ is modelled by a two-person *bargaining game* (BG) between Pro and Con whose negotiation set is generated by a set Σ of interpretive or expression alternatives linearly ordered by signed *relevance* to H. Pro aims to establish, say, H and Con, $\bar{H}$. This yields *dual preferences* (i.e. inverse preferences) over Σ.[17] If the ordering is not total, hence not linear, we have a game of 'incomplete information'.

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refined account will have to consider, especially so as regards presupposition (Section VI, below). What I pursue here, to naively idealizing descriptive ends, is classical probability. Thus, having $P(A|B)$ undefined for $P(B) = 0$ may be descriptively useful even though Popper/Renyi conditional probabilities not so constrained would be more adequate for certain philosophically interesting applications.

[16]This explains why a notion irrelevance$_{SW}$, insofar as relevance$_{SW}$ incorporates the stochastic extension of 'each-way informativeness', would engage common usage of 'irrelevant' (after all, an important, intrinsically non-directional notion) better than relevance$_{SW}$ that of 'relevant'. Again, I am not advocating this notion for use, but offer it as a potential part-explanation for why proponents of relevance$_{SW}$ might have been led into considering such a notion in the first place.

[17]Think of two *homini oeconomici* faced with a cake on a shelf too high up to be reached without one climbing on the other's shoulders. Who will get how much, if between them they are to get more than nothing?

> DEFINITION: Call H the *discourse topic*. This makes the discourse topic (DT) an entity of type proposition. [In view of the Corollary nothing is lost if we proceed thus instead of calling $\{H, \bar{H}\}$ the DT, as would be consonant with the familiar method of Yes-No-Questions. If more comfortable with $\{H, \bar{H}\}$ treat H as an abbreviation.][18]

I shall assume that we are only dealing with *single issue* contexts, leaving it as an empirical question about the language faculty whether or not such pointedness or tunnel vision is to be definitional of a predictive notion of 'context'.[19] Figuring out the ostensible and/or intended H explicates 'figuring out intentions'.

Recall now that if I claim \$5 from you, I won't mind (be committed to applying sanctions) if you give me \$$n$ where $n \geq 5$. If you concede \$5 to me, you won't mind (be committed to applying sanctions) if I take \$$m$ where $m \leq 5$. The principle also informs properly assertoric discourse.

Call *'upward cone'* for claims (of proposition) Φ the join ${}^{\geq}\Phi$ of propositions at least as relevant as the one induced by lexically explicit Φ. Then the dual *'downward cone'* ${}^{\leq}\Phi$ (join of propositions at most as relevant) represents Con's default expected counterclaim (concession), for which Pro bears no burden of evidence.

IV. 'Conversational Implicature'

In what follows, a Boolean semantics is presupposed. The possibility that it might, in turn, be induced by other semantic substrates in suitable contexts of use (Merin 1992; 1995a) will be ignored. The set of persons to whom probability functions (p-functions) here considered are imputed is left implicit here. The default set (cp. Wilson 1975) will right now include the actual or virtual Addressee; but a representation of ostensible 'common ground', 'common sense' or, as Aristotle called the latter, *endoxa*, will be closer to what is needed.[20] Only *qualitative*, and rarely stronger than ordinal, relations among probabilities will be directly appealed to. Read p-function symbols as shorthand for sets of p-functions satisfying stated constraints.

A. 'Scalar Conversational Implicature' [SCI]

Thesis BG explains immediately the *defeasibility differential* between the 'upperbounding' (Horn 1972) implicature/default and speaker Pro's

[18] DT is here a trans-personal, polarity-independent notion.

[19] For parochial linguistic rather than philosophical or cognitive engineering purposes that might militate towards considering multiple objectives.

[20] Cf. Merin 1996, Ch.2 for some of the complexities.

'lowerbounded' claim/assertion: virtual or actual Con's 'at most' is *not Pro's responsibility to back*. And rationality of Con makes the Scalar implicature a computational *default*, and indeed by *quasi-juridical* default. Net meaning is the rationally expected-to-be conceded claim; the intersection of 'assertion' and 'implicature'.

A1. Particularized SCI

Q: *Do you speak Portuguese*? A: My husband does [$= F$].

Scalar Implicature: Speaker A (= Wife) doesn't. [$= \bar{E}$]

is an example due to Hirschberg (1985), who explains: The context of potential Portuguese-speakers is the $\subseteq$-poset of alternatives $Pow\{husband, wife, child\} - \phi$. A generalization of Gricean 'Quantity' implicates $\bar{E}'$ for all such E' with subject denotata $s \not\leq_{Poset} \{husband\}$.

But what is the 'way of being given' of this context-set? The subset-structure is not pertinent. Nor is the poset-rule independently motivated. And so it won't explain (where $\surd$ means O.K.)

A: $\surd$\{*My brother/mother/servant//Kim/Kim Bloggs*\} *does*

A: *\{*Kim Basinger/The president of Brazil/Bill Clinton*\} *does*. [G]

Let $Q =$ Boss Inc., $A = W$ (Wife) at her job interview. Ask: a. Why should Q ask? and b. W answer as above? Because: (a) Q wants utility-relevant information ('Should we hire W?' [$= \{H, \bar{H}\}$?]) and (b) W wants to be hired [H]. H is the *discourse topic*. Suppose W doesn't speak Portuguese, but can call upon someone who does, virtually gratis. Typically such a person will be kin or agnate; else a friend (Kim); or an acquaintance (Kim Bloggs). But presumably *not* Kim Basinger. Hence the *.

Moreover, $\mathrm{r}_H(E) > \mathrm{r}_H(F) > 0$, surely. Treat E and F as potential claims. Recall that claims (demands) in bargaining are always 'at least'. And that the strongest compatible response (meanest concession) amounts to 'at most' that. So $\bar{E}$ is critical, sceptical[21] Boss' counterclaim, made and conceded *by default*.[22]. Indeed,

FACT: $\mathrm{r}_{\bar{H}}(\bar{E}) > 0$ iff $\mathrm{r}_H(\bar{E}) < 0$ iff $\mathrm{r}_H(E) > 0$.

That's why smart W gives an indirect, (call it) *'second-best'* answer. Surely also $\mathrm{r}_H(F) > \mathrm{r}_H(G) = 0$. Thus, W will never implicate that the President of Brazil can't speak Portuguese. And note again: presumably E, F, G are logically independent.

[21]'Persuade us!'

[22]Ede Zimmermann of Stuttgart University reminded me that here W clearly knows whether or not E. Where such an assumption is not met, $\bar{E}$ will not be implicated by default. Cp. also Soames (1982)

A2. 'Generalized Conversational Implicature':

Entailment-based informativeness has done rather well with 'strong' Scalar implicature from *or* construed as lattice join ($\vee$) to local, defeasible strengthening with intuitions appropriate to XOR (∇) (cf. Soames 1982). To make relevance predict we need a further definition.

DEFINITION: A and B are *independent conditionally* on H and $\bar{H}$ with respect to $P(\cdot)$ $[(A \perp B | \pm H)]_p] \Leftrightarrow P(AB|H) = P(A|H)P(B|H) \wedge P(AB|\bar{H}) = P(A|\bar{H})P(B|\bar{H})$.

Intuitively, $(A \perp B | \pm H)$ when knowing whether H or $\bar{H}$ accounts fully for any interactions between A and B. It yields additivity, i.e. compositionality of relevance:

FACT: If $[(A \perp B | \pm H)]_p]$, then $\mathrm{r}_H(AB) = \mathrm{r}_H(A) + \mathrm{r}_H(B)$.[23]

Intuitions on relevance often rest on warrant for a stochastic conditional independence presumption (CIP) that reduces computational load and the need for appeal to world knowledge.

[CIP] Conditional Independence Presumption: $(X \perp Y | \pm H)$ where X, Y are denotata of sister nodes in coordinate constructions X' CONJ Y'.

CIP, widely adopted in AI applications for cumulation of evidence, enters the following

THEOREM: If $(A \perp B | \pm H)$ and $\infty > \mathrm{r}_H(A)$, $\mathrm{r}_H(B) > 0$ then
(**a**) $\mathrm{r}_H(AB) > max[\mathrm{r}_H(A), \mathrm{r}_H(B)] > \mathrm{r}_H(A \vee B) > 0, \mathrm{r}_H(A \nabla B)$, whereas
(**b**) $\not\models \mathrm{r}_H(A \nabla B) \geq 0; \not\models \mathrm{r}_H(A \nabla B) < 0; \not\models \mathrm{r}_H(A \vee B) < \mathrm{r}_H(A), \mathrm{r}_H(B))$.

By (a), CIP rules out 'paradoxes of relevance': counterintuitive negative relevance of conjunctions or even disjunctions of positively relevant atoms. Conjoined with Thesis BG it explains 'strong' Scalar implicature for $\vee$. A reasonable candidate for a default context set *ceteris paribus* should be the Lindenbaum algebra over $\{A, B\}$. Its atoms represented by $AB, \bar{A}B, A\bar{B}, \bar{A}\bar{B}$ finest-partition the space of possibilities. Suppose A and B positively relevant to H, preferred by Pro. Under incomplete information (nothing e.g. is presumed known about the comparative relevance

[23] Without any independence assumptions we have as a
FACT: $\mathrm{r}_H(AB) = \mathrm{r}_H(A) + \mathrm{r}_{H|A}(B)$.
The epistemic dynamics here parallels analyses context-change familiar from the literature on dynamic approaches to discourse.

of $A\bar{B}, \bar{A}B$) Con's natural default counterclaim to Pro's $A \vee B$ is $\bar{A} \vee \bar{B}$; their meet is $A \nabla B$.

Thus, *reduced* expected (positive, evidential, partisan) *relevance* of a claim has *increased* (non-partisan) semantic *informativeness* as a byproduct since $A \nabla B \models A \vee B$ while $A \vee B \not\models A \nabla B$. (Echoes of Adam Smith's Invisible Hand ideology there!) Various epistemic conventions for the default to bite are conceivable: e.g. that Pro should know that AB if AB holds (Soames 1982).

Relevance predicts better than Neo-Gricean informativeness on some hard distributional facts. Recall that 'pragmatic/quantitative scales', of which (*and, or*) is a putative instance, are linguistically given to us most tangibly by their diagnostics (Horn 1972). On adopting now the following

> HYPOTHESIS: Expression schema X *if not indeed* Y is acceptable iff for any context of use c determined by an issue $\{H, \bar{H}\}$, probability measure $\mathrm{p}(\cdot)$ inducing a relevance function $\mathrm{r}_H(\cdot)$ and propositions X, Y satisfying CIP and finitude of relevance, either **(i)** $\models_c 0 < \mathrm{r}_H(X) < \mathrm{r}_H(Y)$ or **(ii)** $\models_c 0 < \mathrm{r}_{\bar{H}}(X) < \mathrm{r}_{\bar{H}}(Y)$.

we can derive

> FACT: **A or B, if not indeed A*. Proof: By Theorem (b), Hypothesis (i) is not generally satisfied. Nor (ii) w.r.t. $\bar{H}$.
> FACT: $\surd$*A (or B), if not indeed A and B*. Proof: By Theorem (a), Hypothesis (i) is generally satisfied. Analogously (ii), w.r.t. $\bar{H}$.

With or without a lexicalization constraint (Horn, Gazdar), Neo-Gricean informativeness would mispredict for one or the other option. *Without* one, it predicts acceptability of the first, since disjuncts entail disjunctions without being entailed by them. *With* such a constraint, $\{A, A\, and\, B\}$ does not induce a 'quantitative scale' (there is no item contrasting with *and*). Thus, *Horn-diagnostics* appear to diagnose *relevance-based* rather than informativeness-based scales, under the above definitions.[24]

[24]However, one may suspect that *A or B*, by implicating ignorance of whether A, would explain the * by redundancy of *if not indeed A*, which opens the possibility of A. To look for arbitration consider a language that distinguishes between inclusive and exclusive disjunction by lexico-syntactic means: German. Whereas Latin *vel* and *aut*, as Gerald Gazdar and Geoffrey Pullum noted in the 1970's, are both non-specific, German will force inclusive disjunction by *oder auch* (lit.: 'or also'), and exclusive disjunction by *oder aber* (lit.: 'or but'; trsl. 'or else'). And we do have $\surd$*A oder aber B, wenn nicht A oder auch B*, but **A oder auch B, wenn nicht A oder aber B*. This is again predicted by the Theorem (a different sub-theorem of it!) when $A \nabla B$

A3. Negation of Scalable Attributes

Horn investigated pairs of intuitively 'positive' and 'negative' ordered subsets of lexical fields (e.g. {*boiling, hot, warm*} vs. {*cool, cold, freezing*}; etc.). Decision-Theoretic Semantics will recover his 1972 and Ducrot's (1973) observation[25] that negations of strong (weak) positives are, respectively, weak (strong) negatives; and so on. But it need not merely observe the phenomenon stipulatively, as did Ducrot within an informally relevance-based setting; nor assume, with Horn (1972) that lexical meanings are generally of the form 'at least' and, for marked cases, 'at most'; together with unspecified mechanisms for picking the right one.

Horn had assumed that an attribute space consisted of two disjoint inclusion chains of basic predicates. These 'positive' and 'negative' 'scales' were ordered by predicate inclusion, as indicated by 'at least' and, occasionally, 'at most'. The assumption, though unkind to common sense, had a real predictive payoff. In stipulating ordering by entailment (set-inclusion) it yielded, by contraposition (cf. also Fauconnier 1975), the observed facts, including Jespersen's observation that e.g. *not 5 pounds* means, usually, 'less than 5 pounds'.[26]

We assume instead, more plausibly, that attribute spaces given by a lexical paradigm are *partitions* into attributes of similar grain (induced

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is granted non-zero signed relevance, just as 'tepid'—see the next section—is granted warmth by *This beer is tepid if not downright warm* in Horn's famous example pair, the other half of which, *This coffee is tepid if not downright cold*, grants it coolness. The 'ignorance' thesis likewise predicts the *, since the suspender opens a possibility (just one being true) which *oder auch* already countenances. But note that the crucial ignorance-implicature in the original English example $\neg K_s \neg A$ (unlike its sister $\neg K_s A$) as explicated by Gazdar (1979) relies on Manner, i.e. relative expression length. If, in line with Grice's own late doubts, one tries to do without Manner (cp. also Mandelbrot 1961), one should prefer my preferred explanation. If not, then not on grounds local to the argument.

[25] See Horn's 1989 book for easy access to this work and a later essay on neg-raising.

[26] Horn's (1972) assumption on lexical representation of scalables has been criticised by Carston (1988:174f.) who favours, with paradigmatic reference to numerals, a single linguistic meaning or sense (neither 'at least' nor 'at most' nor 'exactly') such that the proposition, i.e. truth-conditional content, actually expressed (Carston: 'explicature') is contextually determined. This plausible contention, and others concurring, did not engender explications of such linguistically autonomous senses and contextual mechanisms so as to yield the Jespersen/Horn/Ducrot facts. Horn's theory—something his 1992 reply refrains from stating that baldly—was the only approach to these very non-peripheral intuitions that did explain them.

pointwise by partitions of propositions).[27] Ordering—by relevance—is induced by the independently motivated virtual bargaining pragmatics.

Recall from Section III the definition of 'upward cone' ${}^{\geq}\Phi$. Call *'unmarked scalar complement'* the complement ${}^{<}\Phi$ of ${}^{\geq}\Phi$ and construe as the denial of a claim deemed excessive. Call *'marked scalar complement'* the dual ${}^{>}\Phi$ of ${}^{<}\Phi$ and construe as the rejection of a concession deemed insufficient; thus inheriting concession's phenomenologically marked status.[28] Horn's observation is then captured in the following

> THEOREM: If X and Y are elements of a partition of the space of propositions (thus inducing a partition of an attribute space) and $\mathrm{r}_H(Y) > \mathrm{r}_H(X) > 0$, then $\mathrm{r}_{\bar{H}}({}^{<}X) > \mathrm{r}_{\bar{H}}({}^{<}Y) > 0$.

V. 'Conventional Implicature'

Traditional accounts of degree particle *even* (e.g. Karttunen and Peters 1979;) note that *Kim even talks* [abstractly: $even(\alpha, \beta)$ where α is focus of *even*] indicates highest 'surprise/improbability' of *Kim talks* [$= E := (\alpha, \beta)$]; the comparison class being propositions (α', β) with $\alpha' \neq \alpha$ (e.g. *Kim walks*).

Anscombre (1973) proposed superior argumentative value (AV) of E over E' w.r.t. some H. Explicate by relevance $\mathrm{r}_H(E)$. Then, for given H and a set $\{E_i\} = \{(\alpha_i, \beta)\}$ of expression alternatives, $\mathrm{r}_H(E) = \max_i[\mathrm{r}_H(E_i)]$ iff $\mathrm{r}_H(E) = \max_i[\inf(E_i|\bar{H}) - \inf(E_i|H)]$. In simplified words: the E_i most (positively) relevant to H is that whose truth would be the most surprising if $\bar{H}$ rather than H were accepted. And of course, there is no point arguing for an H already accepted.

Whether or not one takes AV to be primary or derived: intuitions are squared and an issue between Anscombre (1973), Kay (1990)–*contra* surprise—and Francescotti (1995)—*pro*—is accountably resolved.

Note: $\mathrm{r}_{H|K}(E) > \mathrm{r}_{H|K}(F)$ does not imply $E, K \models F$ for $K \not\models E \rightarrow F$. Unlike 'contextual entailment' from E to E', by which Kay (1990) offers to explicate superior 'informativeness', his explanatory ordering relation.

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[27] Plausibility is not so much a matter of introspection on meaning—after all, very little is known about the form of entries in the mental lexicon. Rather, if basic attribute spaces were structured as (sets of) inclusion chains they could not be partitions if either chain had $n > 1$ elements. And then they would be ill-suited for computing expected values of actions conditioned by propositions they induce, since one could not define a probability distribution over them. I consider this to be a truly pragmatic constraint that has linguistics shaking hands with philosophy and the design sciences.

[28] Why marked? 1. 'Don't pick a fight you know you're gonna lose' (Sen. Sam Goldwater). 2. Note also the double anaphoricity: to a concession responding, in turn, to a putative claim. There is no need to invoke Ducrot's and Horn's still formally unexplicated 'metalinguistic negation' here.

But 'entailment' is surely a misnomer (for relevance, it would appear) in view of

> Author: The hero of my novel sleeps with M******. [a 1990s media star]
> Editor: So what. The hero of our Greek dust-gatherer[29] even sleeps with his own mother.

DTS yields an account of conjunction *but* and its interaction with *even* that recovers observations and informal explanatory claims of Anscombre and Ducrot (1983), along with the much more occult interaction with *also*. Consider as a

> HYPOTHESIS: A *but* B is felicitous only if there is an epistemically accessible proposition H—a discourse topic—such that $\mathrm{r}_H(A) > 0$ and $\mathrm{r}_H(B), \mathrm{r}_H(AB) < 0$, relative to probability function(s) $P(\cdot)$ representing Addressee's and/or third parties' epistemic state, as ostensibly imputed by Speaker.

Consider this hypothesis now in conjunction with a further

> HYPOTHESIS: A CONJ *even(B)* [:= (α_1, β) CONJ $even(\alpha_2, \beta)$] with VP-focus is felicitous only if there is a discourse topic H such that $\mathrm{r}_H(B) > \mathrm{r}_H(A) > 0$.

And suppose, as we did, that, for any given reading, H must be unique. This implies

> PREDICTION: **Kim splurbs but Kim even glurbs* for any English substitution instances of *splurbs* and *glurbs*; explicating AD's claim and explanation.[30]

A-unexpectedness of B is not necessary for $\mathrm{r}_H(A) > 0$ and $\mathrm{r}_H(B), \mathrm{r}_H(AB) < 0$. Example:

> *Kim is a doctor but she lives in Mozambique*;
> [H = Kim is rich.]

What suffices is that A and B be, let us call it, H-contrary, i.e. that $-\mathrm{sgn}(\mathrm{r}_H(A)) = \mathrm{sgn}(\mathrm{r}_H(B)) = \mathrm{sgn}(\mathrm{r}_H(AB)) \neq 0$. But note the following

[29] My *lingua franca* suggestion for a synonym of the very idiomatic 'white elephant'.

[30] A referee noted that the badness of the example might be due to violation of a requirement for pronominalization, fielding as an apparent counterexample *Mary tried as hard as she could but {she/?Mary} even couldn't lift the newspaper.* Looking at *Kim splurbs but she even glurbs* I still feel that it sounds rather better with *but then* in place of *but*: compare e.g. *Kim walks but {then/*ϕ} she even talks.* So I think the intensionality of *try as hard as one can* followed by *cannot* introduces complications which a formal account of expectation projection might sort out in the end. See also Merin (1996) on *but then*.

THEOREM: If $(A \perp B| \pm H)$ then $P(B|A) < P(B)$ iff $\mathrm{sgn}(\mathrm{r}_H(A)) = -\mathrm{sgn}(\mathrm{r}_H(B)) \neq 0$.

In all but superficial respects it was established by Reichenbach (1956) in an intuitively rather different context: a discussion of causal relations, where a propositional variable with values in $\{H, \bar{H}\}$ represents a common cause of A and B and thus accounts fully for any stochastic dependence between them.

A salient special case of this is the (default case) of A *but* B, namely where $H = \bar{B}$ and where B is, therefore, by our Hypothesis, ostended as being unexpected given A, in terms of Addressee's and/or Common Sense's probability. An instance is the stock example

Kim is poor but honest.

This default case avoids introducing new atoms H into the propositional universe of discourse and it yields all basic empirical properties of 'but' by purely qualitative reasoning, as demonstrated by the following

THEOREM: If $\mathrm{r}_H(A) > 0$ and $H = \bar{B}$ and $P(AB) > 0$ then (i) $\mathrm{r}_H(B) < 0$; (ii) $\mathrm{p}(B|A) < \mathrm{p}(B)$; (iii) $\mathrm{r}_H(AB) = \mathrm{r}_H(A) + \mathrm{r}_H(B)$; (iv) $\mathrm{r}_{\bar{H}}(B), \mathrm{r}_{\bar{H}}(AB) > \mathrm{r}_H(A)$.

The relevance-based analysis accounts, amongst other things, for the following apparent language universal (Merin 1995), an asymmetry between 'particular'-denoting NPs and 'universal'-denoting VPs: While

Kim$_i$ walks but Kim$_i$ talks

is fine for suitable contexts (Shall we hire Kim as a confidential messenger?), we have

**Kim walks but Sandy walks*
Kim walks but Sandy {*also walks* / *walks too*}

for all contexts. On present evidence, any language having equivalents of 'but' and 'also' obeys the pattern, first noted for English, and classified as brute syntactic fact, by Zellig Harris (1964).

The apparent asymmetry of subject (particular) and predicate (universal) calls for an explanation.[31] Let $P(\cdot)$ be defined on a monadic first order quasi-English fragment.

[NNIR] DEFINITIONAL FACT: If $P(\cdot)$ satisfies non-negative instantial relevance [NNIR] (Carnap) then Qb cannot be Qa-unexpected. By contrast, NNIR does not rule out Pc being Qc-unexpected nor, say, Qd-unexpected.

[31] Cf. Merin 1996: Ch. 5 for a fuller version.

Yet, as we saw above, A-unexpectedness of B is not generally necessary for acceptability of 'A but B'.[32] But recall also that the special case $H = \bar{B}$ of H-contrariness (making B A-unexpected) is a prime candidate for an interpretive default. Let us embed this fact into a more general setting and adopt as a

> [DSP] HYPOTHESIS: Every natural language L obeys a Default Satisfiability Principle [DSP]: Let L have a default condition Γ on preferred interpretation of a class $\Sigma \subseteq L$ of expressions. Let $\sigma \in \Sigma$. If σ satisfies Γ for no context of nondegenerately empirical use (e.g. H: $0 \neq \mathrm{r}_H(\sigma) \neq \pm\infty$), then σ is unacceptable [write: $^*\sigma$].

This hypothesis is not as ad hoc as one might think in view of its sudden introduction. Suppose an instance of such a default condition Γ is the Conditional Independence Presumption [CIP]. Given CIP, additivity of r is also a default presumption by the above proposition. And this predicts *'A and A' for any aspectually stative sentence A. I believe this prediction is correct and non-peripheral enough to give DSP some credibility. Returning to 'but' we now have as a

> COROLLARY: Given DSP, CIP (which, recall, is also instantiated by our special case), if the probability underlying r obeys NNIR, then *'Qa but Qb'.

NNIR, for the linguistically pertinent p-function, can be motivated as other than a brute, if behaviourally or evolutionarily plausible fact. Argumentation involving H-contraries uses Universal Probabilistic Instantiation [UIP]. To see its workings recall again the earlier example

> *Kim is a doctor but she lives in Mozambique*

where, as before, it is background knowledge that Mozambique has a very low Gross National Product (as the United Nations statistics say). The argument runs essentially as follows:

> $\forall x[doctor(x) \rightarrow P(rich(x)) = \alpha\ (1 > \alpha \gg 0.5)]$
> $doctor(Kim)\ \models\ P(rich(Kim)) = \alpha$;
> and similarly for the second conjunct.

[32] Consider as another example, [A] *Wilkins is a man of principle, but* [B] *he is now Chancellor of Crowford*. No aspersions need be cast on Crowford, nor Wilkins. Simply imagine a context where we are discussing the moral decline of Batbridge and suppose that A *but* B presents A as an argument *for* some contextual proposition H (e.g. 'Wilkins can stop the rot at Batbridge') and B *against*; with B ostensibly carrying the day.

We now need—I'll give it in appropriately specialized terms—a standard technical

> DEFINITION: A probability function $P(\cdot)$ on sentences is symmetric with respect to a sequence Qa_i of sentences (Q a fixed predicate) iff its value is invariant under all finite permutations of the set of individual constants a_i.

Probability creates an intensional context, as is readily apparent on realizing that epistemic necessity may be interpreted as subjective probability 1. We now have a linguistically useful

> FACT (Skyrms 1980): Validity of UIP requires that no p-relevant information be conveyed by the individual constant. Names must be treated as properly arbitrary and thus $P(\cdot)$ must be symmetric.

Its usefulness rests on something I shall adopt as an empirical hypothesis

> [ED] HYPOTHESIS: Natural language semantics satisfies an Embeddability Desideratum [ED]. Models or Discourse Representation Structures (Kamp 1981) generated by a small universe of individuals or their discourse referents should be embeddable in larger models of arbitrary finite cardinality.

This hypothesis, in turn, lends linguistic import to the following

> THEOREM (Savage-Kemeny-Gaifman-Humburg): A symmetric probability function $P(\cdot)$ on finite models m extends to symmetric $P'(\cdot)$ on extensions m' of arbitrary finite size only if $P(\cdot)$ satisfies NNIR.[33]

And thus we have as a

> COROLLARY: ED and validity of UIP imply NNIR.

One might think the appeal to deep results to be a case of theoretical overkill. And one would, indeed, do well to think so if one is ready to accept the following thesis, rarely professed though frequently implicit in casual pragmatico-semantic argumentation: The structure of natural languages and attached bits of mind is very much simpler than that of, say, the hydrogen bond.

If we do proceed with the stochastic approach, we must ask next what explains the healing power of 'also'. This takes us into a phenomenon traditionally treated in its own right.

[33] *Proofs*: Gaifman (1971), Humburg (1971).

VI. Presupposition, Accomodation, and Update Regimes in Dynamic Semantics

In this section I shall consider some notions of presupposition designed, for one, to integrate some of the eponymous phenomena into the present framework. I should like to treat them, again, as embedding conditions. Thus I hardly go into the 'projection problem'[34], except with respect to negation and, in a peripheral and specialized way, coordination with *and* and *but*; and more peripherally yet with respect to *if*. Nor do I do justice to sub-sentential discourse anaphora when, for instance, dealing with King-of-X sentences.

Current formal accounts of presupposition—considered at least mediately as a property of sentences by way of a property of utterances—follow Stalnaker's (1974) insight that one ought to start one's account with a notion of *being presupposed in a context*.[35] Subject to the usual rider that we are dealing with *ostensibilia* throughout and identifying context with some sort of ostensible common ground, being thus presupposed means being uncontroversial in virtue of being entailed by the context.

If the context, an epistemic state, is, again in line with semantic practice, representable by a set of possible worlds, it is natural to consider now a stochastic extension—indeed, for the case of entailment a mere paraphrase—of this notion. We identify epistemic states with probability measures and adopt as a

> DEFINITION: Proposition A is presupposed in epistemic state (context) $P(\cdot)$
> iff $\forall X[P(X) = P(X|A)]$.[36]

This definition feeds into a pair of pairs of notions in search of phenomena—notions of *sentence-presupposition* and *utterance-presupposition*, prima facie and in some respects alternative to current

[34] The recursive determination of presuppositions of logically complex sentences on the basis of those, ceteris paribus and apparently, attaching to atomic constituents.

[35] Actually, Stalnaker starts with the notion 'being presupposed by a person' (in a context). However, the literature, no doubt primed by indexical semantics, has few terminological problems with treating persons as metonymic for contexts ostensibly taken for granted by them.

[36] I chose this version for intuitability and safety. $P(X|A)$ is undefined on the classical definition of conditional probability whenever $P(A) = 0$. On the standard Kolmogorov definition of independence, the definiens becomes $\forall X[P(AX) = P(A)P(X)]$. In this case the contradictory proposition would, like the tautological one, Ω, be presupposed in any context. As our definition stands, the definiens will be undefined for $A = \phi$ and we shall be saved from a commitment whose bark (see the next footnote but two) would, however, be worse than its bite.

explications (Heim 1983) as a condition on definedness of updates of (deductive, i.e. non-stochastic) theories.

The present framework offers two main ways in which, using semi-theoretic terminology, *presupposition failure* can occur and two corresponding notions of expression presupposition. Each of them has a contextual ('utterance' = <sentence, context>) and a transcontextual, 'sentence' version. The former is addressed by reading definitions *with* the material in square brackets. I shall let co-text decide which notion I am talking about whenever I do not specify: the default is the stronger notion, unless the weaker is needed to preserve consistency. And for the first notion the weaker will, it seems, in general be called for.

(1) Felicitous utterance of a sentence S requires that a proposition Θ be presupposed in the context. Let us call the corresponding would-be notion of sentence or utterance presuposition *strong presupposition*. More formally:

> DEFINITION: Sentence S *strongly presupposes* (presupposes$_s$) proposition Θ [in context j] iff its truth-conditional denotatum[37] $[\![S]\!]$ is (a) irrelevant to all propositions H in all epistemic states [accessible from j by conditionalization] where Θ is not contextually presupposed, and (b) relevant to at least one proposition H' in an epistemic state [accessible from j by conditionalization] where Θ is contextually presupposed. [Clause (a) has a formal rendering $\forall H, i : \neg(P_i(\Theta) = 1) \rightarrow \neg(P_i(SH) \neq P_i(S)P_i(H))$.][38] Equivalently it reads, contraposed, $\forall H, i : P_i(SH) \neq P_i(S)P_i(H) \rightarrow P_i(\Theta) = 1$.] Clause (b) amounts to $\phi \neq [\![S]\!] \neq \Omega$.

Clause (b) of the definiens, in ruling out the trivial cases $S = \Omega$ and $S = \phi$ avoids the consequence that any arbitrary Θ is presupposed by any tautology or contradiction S'; these being, by definition irrelevant to any proposition.[39] The material conditional of clause (a), in the contraposed

[37] This always means: denotation at a point of reference that evaluates its 'meaning' (Montague) or 'character' (David Kaplan), and whose correlation with epistemic states I shall leave underspecified for now, except to say that we do want enough transcontextual stability to distinguish $\{S : P(S) = 1\}$ from the (universal) tautology.

[38] Recall: $\neq$ is the join of $>$ and $<$.

[39] Relevance in the way here defined might be a footnote to Wittgenstein's (1922) musings at 4.461 ff., to the effect that tautology and contradiction are alike in *saying* nothing. For sure, *ex falso quodlibet sequitur*—but in this degenerate case entailment is not the limiting case of (what Carnap would have called) 'extreme relevance'. Nor, dually, when the tautology is entailed by any proposition.

version, will be true if its consequent is, which will be the case if $P(\Theta) = 1$ or if its antecedent is false, which will be the case when $S = \Omega$ or $S = \phi$ or $P_i(\cdot)$ is not, after all, a probability measure (i.e. incoherent or otherwise undefined). (For the context-relative case Ω is, of course, the universal proposition with respect to each probability measure $P_i(\cdot)$ of each state i quantified over.)

Under a dynamic, epistemic, personalist perspective $P(\Theta) = 1$ means that Θ is presupposed, i.e. that it has already been conditioned on. So if our S is contingent ($\Omega \neq S \neq \phi$) as required by clause (b), then the antecedent must be false; and this is the interpretation. When $P_i(\cdot)$ *is* a probability measure and S is uttered relevantly, Θ must already be conditioned on by the context. Thus $P(\Theta|S) = 1 = P(\Theta|\bar{S})$. This is analogous to the notoriously inadequate notion of naive semantic presupposition ($S \models \Theta$; $\bar{S} \models \Theta$), where '$\models$' is defined in terms of plain transcontextual truth, and Θ turns out to be the tautological proposition.[40] But recall that under our construal, probability 1 is a case of discourse-local, epistemic necessity, and attaches to what in the given context of felicitous use is *treated as* unquestionable. Thus one might read Ω as an indexed Ω_i when it means $\epsilon X[P_i(X) = 1]$ (any proposition having an ostensible common prior of 1 at i), and index-free when it means $\epsilon X[\forall i[P_i(X) = 1]]$.

This definition unsurprisingly preserves a classical feature of the explicandum, presupposition:

THEOREM: S presupposes$_s$ Θ iff $\bar{S}$ does.

Before looking for empirical applications, consider the second intuitive notion of presupposition failure and its complement: (2) Felicitous utterance of a sentence S requires that a proposition $\bar{\Theta}$ not be presupposed in the context. Let us call the corresponding would-be notion *weak presupposition.*

DEFINITION: Sentence S *weakly presupposes* (presupposes$_w$) proposition Θ [in context j] iff its truth-conditional denotatum $[\![S]\!]$ is (a) irrelevant to all propositions H in all epistemic states [accessible from j by conditionalization] where $\bar{\Theta}$ is contextually presupposed, and (b) relevant to at least one proposition H' in an epistemic state [accessible from j by conditionalization] where $\bar{\Theta}$ is not contextually presupposed. [Clause (a) has a formal rendering
$\forall H, i : \neg(P_i(\Theta) > 1) \;\rightarrow\; \neg(P_i(SH) \neq P_i(S)P_i(H))$.]

[40]Presupposes$_s$ is even more directly the analogue of Karttunen's retracted 1971 construal of presupposition (cf. Gazdar 1979), $(\Diamond S \vee \Diamond \bar{S}) \vdash \Theta$, which entails $\Theta = \Omega$. The same considerations as follow now apply.

Equivalently it reads, contraposed,
$\forall H, i : P_i(SH) \neq P_i(S)P_i(H) \;\rightarrow\; P_i(\Theta) > 0$.]
Clause (b) again amounts to $\phi \neq [\![S]\!] \neq \Omega$.[41]

THEOREM: S presupposes$_w$ Θ iff $\bar{S}$ does.

Being strongly presupposed entails being weakly presupposed, but not vice versa. A more pertinent way of stating the connection between 'weak' and 'strong' is a kinematic and ultimately dynamic one: accomodation (Lewis 1979). If presupposition$_w$ fails, *there is no possibility of accomodation* to satisfy presupposition$_s$ of the same proposition..

I shall begin empirical discussion with the 'weak' notion, not least because it bears on the most famous example in the presuppositional literature. To approach it I shall introduce a pair of auxiliary notions, one of which is just non-degenerate unilateral entailment of one *proposition* (not primarily a sentence or an utterance) by another, relative to context.

DEFINITION: S *a-poses* Θ at i iff (i) $S \models_i \Theta$, $\Theta \not\models S$, and (ii) $S \not\models_i \bar{\Theta}$, $\Theta \not\models_i \bar{S}$.
[I.e. iff at i S (i) unilaterally and (ii) non-degenerately entails Θ].[42]

Next (dropping indices henceforth) derive from this another

DEFINITION: S *b-poses* Θ iff $\bar{S}$ *a-poses* Θ.[43]

We then adopt as a further

DEFINITION: S *poses* Θ iff S a-poses or b-poses Θ.

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[41]Presupposes$_w$ is related to presupposes$_s$ as $(\Diamond S \wedge \Diamond \bar{S}) \vdash \Theta$ is to $(\Diamond S \vee \Diamond \bar{S}) \vdash \Theta$.

[42]For $X \models Y$ read $P(Y|X) = 1$. Thus S *a-poses* Θ at j iff $P_j(\Theta), P_j(S|\Theta) < P_j(\Theta|S) = 1$. Note that everyday usage is quite happy to identify 'presupposing' (of a proposition by a proposition, utterance or sentence) with a-posing. E.g., *That Kim is a bachelor presupposes that Kim is* $\{$*male/*$^{?}$ *unmarried/* a bachelor*$\}$. The faint $^{?}$ might be an reflection of mental-lexical semantic ordering constraints also evidenced by syntactic ordering differentials of adjectives (e.g. *heavy blue* vs. *blue heavy*). Some of the relevance constraints established below would seem to rule out arbitrary disjunctions being thus presupposed.

[43]Extensionally speaking, these two notions are not novel: S a-poses Θ iff S is *extremely positive* for Θ in the sense of Carnap (1950:Ch.6) [i.e S is positively relevant and no proposition entailing S is negatively relevant]; and S b-poses Θ iff S is *completely negative* for Θ [i.e. S is negatively relevant and no proposition entailed by S is positively relevant]. This statement of equivalence assumes, again, that entailment is relative to taken-for-granted background assumptions and that the probability measure is regular.

Here are examples. Suppose, as did Gazdar (1979) for X = Buganda, that we are not wholly certain on whether or not there is a King-of-X. It would seem that X = Bhutan is a reasonable assignment these days.[44] Then

(A) *The king of Bhutan is bald*

a-poses (indeed in any context i)

(Θ) *There exists a king of Bhutan*

whereas, with negation interpreted as Boolean propositional complementation,

(B) *The king of Bhutan is not bald*

b-poses Θ. The connection between 'posit' and 'presupposition$_w$' is given by the next

FACT: Sentence S presupposes$_w$ proposition Θ if its truth-conditional denotatum $[\![S]\!]$ poses Θ.[45]

Both S and $\bar{S}$ are irrelevant to any H in any context i such that $P_i(\cdot) = P_i(\cdot|\bar{\Theta})$. Thus, in our example, if $\bar{\Theta}$ is contextually presupposed, i.e. if it should be certain that there exists no king of Bhutan ($P(\Theta) = 0$) then clearly $P(A) = 0$, hence A is irrelevant (in our stochastic sense) to any H. Likewise, since $B = \bar{A}$, we shall then have $P(B) = 1 - P(A) = 1$, and thus B will also be irrelevant to any H.[46] That is, *The King of Bhutan is bald* (S) may be held true when it is certain (i.e common ground) that there is a king of Bhutan, and may be relevant to all sorts of propositions H; and cannot be held true when it is certain that there is no King of Bhutan. By contrast, *The King of Bhutan is not bald* may be held true and relevant

[44]Informants tend to tell me they are about 90 percent sure there is one. Legal advisors to the publishers please note: Any king of Bhutan will be a good Buddhist and thereby above taking offense at succeeding the French monarch in this paradigm example of analytic philosophy.

[45]Weak presupposing is therefore a rather technical notion. For take any logically independent (and thus contingent) A, B. Then A a-poses $A \vee B$ and b-poses $A \rightarrow B$. More constructively: if context selects a suitable B then, for given A, the b-posit is the residuation of B by A and accomodating it ensures that A is extremely relevant to B. Setting $H = B$ might be one heuristic for figuring out what an interlocutor is getting at. Abduction is, after all, a notionally violent businesss.

[46]One might ask: how can a certainty be irrelevant to everything? The answer is that all its relevance has already been spent. This is, of course, to make an assumption that is, in principle, of the same kind as the one of logical omniscience, which underlies intuitive interpretations of standard epistemic modal logic. When it comes to introspecting on relevance one must make allowance for the fact that it is at best an *embedding condition* on representations; and such allowance is useful for explaining linguistic phenomena where slowness of human minds and finitude of lifespan are likely parts of an explanation.

to some H if it is certain that there is a king of Bhutan ($P(\Theta) = 1$), and must be held true (on the propositional negation reading) but also irrelevant to any H if it is certain there is no king of Bhutan.

One advantage of the approach to presupposition via stochastic relevance is that presupposition failure—with respect to weak presupposition—need not entice one into commitments to absence of truth-valuedness (or dynamic 'error state' correlates thereof) to make sense of a feeling of oddity that might have played a part in motivating Frege's (1892) claim of a truth value gap and Strawson's (1950) attack on Russell (1905) demurral. If S is irrelevant to all H, then it lacks a property which one might consider no less important than truth-valuedness. Thus we can reasonably go on with Russell to call (A) false and (B) true in an epistemic state where we are certain there is no king of Bhutan; hence disagree with Strawson's claim that no proposition is expressed; and yet agree, though under Wittgenstein's 1922 interpretation, that nothing is *said.*

Note that weak presupposition failure has a natural reflex: whereas

> (C) *The king of Bhutan is not bald—(because/since) there isn't one*

is smart-alecky and *nastily* echoic, viz. sarcastic,[47]

> (D) *The king of Bhutan can't be bald—{because/since} there isn't one*

is non-pathological. As a negated version of something akin to Veltman's (1991) 'might'-operator—a 'test' that leaves the current state unchanged if its argument proposition is a possibility there—*can't* diagnoses impossibility (probability 0) of A holding (almost literally!) *ever since* $\bar{\Theta}$ ostensibly became a contextual presupposition.[48]

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[47]Indicative of a breach of social contract, viz. civil procedure.

[48]Formally: no updates by conditioning on A—or by its generalization, probability kinematics (Jeffrey 1965), revising probability for A—is possible subsequent to conditioning on $\bar{\Theta}$, an update which (ostensibly) occured prior to the current state. The discourse-connective interpretation of 'since' preserves the structure of its temporal semantics, as explicated by (Kamp 1968): *(ever) since A (was the case), B (has been the case)* glosses $S(A, B)$ true iff $\exists t[t < t_* \wedge A(t) \wedge \forall t'[(t < t' < t_*) \rightarrow B(t')]]$ where propositions A, B are properties of moments of time ($A(t)$ iff A is true at t), $<$ is linear temporal order, and t_* represents the present (time) point. The one structural difference required in view of the re-interpretation $A(t) \mapsto P_t(A) = 1$ is a weakening or elision of the rightmost inequality. — Note also that the acceptability differential is not explained by Heim's (1983) 'local accomodation' solution to presupposition cancellation.

But now consider the situation when weak presupposition does not fail, but strong presupposition is not satisfied either. If a proposition S poses another Θ then, by definition, Θ is not presupposed by the current context. (Recall the footnote on presupposing$_w$ being a very technical notion.) When the existence of a king of Bhutan is posed, we are uncertain about the existence of a king of Bhutan. Then either of S and $\bar{S}$ may conceivably turn out to be true or false and, in principle, have as little or as much relevance to some arbitrary proposition H, say,

(H) *There is a good market for pate-polish in Bhutan*

as any other epistemically contingent proposition might have.[49]

In this case we have the option of *accomodating* (Lewis 1979) the presupposition (proximally: accomodating a speaker who utters a sentence carrying such a presupposition). Having the option means: what the speaker says is not necessarily irrelevant if such accomodation does not take place. Things are different with strong presupposing: there failure to accomodate spells universal irrelevance. In either case accomodating the presupposition means that it springs, as Lewis put it, into existence: to make sense—or, as we shall see, more sense—of what someone is saying when that utterance wants a presupposition which is not actually a presupposition of the current, ideally mutual context. How do we accomodate it? The natural proposal in the present framework is: by agreeing tacitly to condition on it, i.e. by transforming the epistemic state from $P(\cdot)$ to $P'(\cdot) =_{df} P(\cdot|\Theta)$.

Are there any constraints on what can, or can readily, be accomodated? Clearly, if $P(\Theta) = 1$ it cannot be accomodated because it need not be. And if $P(\Theta) = 0$ it cannot be accomodated ever by conditioning.[50] Are there further constraints stateable in our stochastico-semantic terms?

Kripke (n.d.) and Soames (1989) note that Stalnaker (1974) and Lewis (1979) assume that accomodable propositions should be *uncontroversial.* (And indeed: why accomodate a speaker if the proposition treated by him as presupposed *is* controversial?) The root of this intuition will presumably be that once accomodated they become presuppositions, which, by

[49]For readers new to the subject: do not confuse the speaker's claim (which implicitly entrains a claim to have evidence adequate to make the claim a certainty) with the current state of the common ground reflected in the probability function. An assertion is a claim for an update by conditioning.

[50]This is a potentially useful property of stochastic representations. We can distinguish between orderly accomodation by conditioning (I do not here consider generalizations thereof), which by most accounts is coherent in the sense of being Dutch-Book-proof, and disorderly accomodation which would involve an arbitrary exchange of one's epistemic state function for another. (But see van Fraassen 1995.)

Stalnaker's intuition are 'common (back)ground'. And 'common ground', in legal parlance, means uncontroversiality. Given the above definition of context-presupposition and the remarks on accomodability, 'uncontroversial' cannot mean 'common ground' in the sense of something already presupposed. So what does it mean?

Let me suggest that uncontroversiality is here defined with respect to the *issue* at hand, i.e. the *discourse topic*, H. This H will thus typically be a proposition—a constraint on conduct or on dispositions to conduct such as belief—which the utterance is to be an argument for or against.[51] Recall that in the above example H concerned prospects for sales of pate-polish.[52] Using our favourite relevance measure for uniformity, recall the

DEFINITION: $\mathrm{r}_{H|\Theta}(S) =_{df} \log[P(S|H\Theta)/P(S|\bar{H}\Theta)]$ is the relevance of S to H, given Θ.

Add to this a further

DEFINITION: Proposition A is uncontroversial in context i iff it is stochastically independent of the discourse topic H of context i $[(A \perp H)_i]$, i.e. iff $P_i(AH) = P_i(A)P_i(H)$.[53]

Save for degenerate propositions ϕ and Ω this makes uncontroversiality firmly relative to the issue at hand. We now have as a

THEOREM: If S a-poses Θ and $(\Theta \perp H)$ then $\mathrm{r}_{H|\Theta}(S) = \mathrm{r}_H(S)$.[54]

More interestingly, we obtain (where $|\cdot|$ is the absolute value function, $|a| =_{df} a \cdot \mathrm{sgn}(a)$),

THEOREM: If S b-poses Θ and $(\Theta \perp H)$ then $\mathrm{sgn}(\mathrm{r}_{H|\Theta}(S)) = \mathrm{sgn}(\mathrm{r}_H(S))$ and, if $\mathrm{r}_H(S) \neq 0$, then $|\mathrm{r}_{H|\Theta}(S)| > |\mathrm{r}_H(S)|$.

I.e., accomodating a b-posit Θ of one's utterance S which is uncontroversial with respect to the issue $\{H, \bar{H}\}$ at hand makes positively relevant S yet more positively relevant and negatively relevant S yet more negatively relevant. If S was irrelevant to H already before accomodation it stays irrelevant.

[51] Kripke (n.d.:14) thinks that 'questions' or 'topics', too, might be part of what he calls the 'active context'.

[52] And never mind the full detail of causal chains presumed in assessing (causal) relevance of S to H. Treat the value of our measure as a sufficient statistic of that—which indeed it is, in the sense statisticians use the notion.

[53] This definition does not already include the abovementioned constraints on accomodability that rule out presuppositions and contradictions as accomodables.

[54] When S neither entails H nor $\bar{H}$ but Θ is positively relevant to H, then $\mathrm{r}_{H|\Theta}$(S) ¡ $\mathrm{r}_H(S)$, and dually when Θ is negatively relevant to H. Accomodation in such cases already spends some of the force of S.

'Accomodation' corresponds to what Heim (1983) called 'global accomodation'. Non-accomodation covers the case which Heim, considering negated King-of-X sentences (B), dealt with by stipulating 'local accomodation' to avoid undefinedness of updates under conditions warranting cancellation, i.e. (and presumably: taken for granted) falsity of existence (Θ). The present account is not forced to take such measures; hence I speak of 'local' accomodation only in a pre-technical, handwaving sense when describing suspension. Note, however, that Heim's 'stipulation' of a preference for global over local accomodation would be explained by relevance optimization and the uncontroversiality assumption on accomodables. Indeed, in the case of a context which bars ('global') accomodation of the existence assumption—the case which prompted Heim's introduction of 'local' accomodation—the relevance of (B) without accomodation is zero. This would explain its infelicity, or that of (C) as a straightforward, non-sarcastic contribution; and the need for modal circumlocution as in (D).

If H is at issue, the independence assumption corresponds just to the presumption that Θ is uncontroversial. However, the uncontroversiality assumption for accomodables as explicated here (but how else could one explicate it?) is rather strong.[55]

Consider the related case[56] of

S := *The fishermen of Morris Island have stopped smoking*

and suppose

H := *We can sell lots of cigarettes to the fishermen of Morris Island.*

If the 'suspender-clause' diagnostic is anything to go by (compare *Kim* {*has/?hasn't*} *stopped smoking, if indeed she ever did*) this has

[55]Kripke remarks that a French monarchist might belligerently say to a republican: 'No matter what you say, I met the King of France last week'. And there the existence of a King of France is neither uncontroversial nor expected to be so. Kripke is agnostic on the counterexemplary force of the example to the empirical claim of uncontroversiality, noting that a number of things might be said to domesticate it. Let me try this one: set S = *I met the king of France*; H = *There is a king of France and he walks*; Θ = *There is a king of France*. Then $\mathrm{r}_H(\Theta) > 0$. Since S a-poses Θ, the result noted in the previous footnote would entail a reduction in the relevance of S if Θ was to be accomodated. So the relevance-preserving prediction is that it is not accomodated but purely and simply asserted. And I believe this squares with metapragmatic intuitions, along with those about a naive opponent's reluctance to accomodate something relevant to the proponent's cause. Dually ($\mathrm{r}_H(\Theta) < 0$) there is much scope for *esprit de finesse* and for a semantics for 'even though'.

[56]I owe this example in all but naming to Peter Krause of Stuttgart University

$\Theta :=$ *The fishermen of Morris Island have been smoking*

as a weak presupposition whose ('global') accomodation can be blocked by a ('locally' accomodating) *if indeed*-suspender.[57] Presumably Θ is not independent of H: smoking in the past presages continued smoking and hence, presumably, good sales prospects. So we cannot assume—if we want to retain the strong uncontroversiality thesis—that it is accomodated in a way that can be blocked by the suspender clause. Moreover we can readily establish by construction of countermodels (here for our particular case) the following

> PROPOSITION: If S bp Θ and $-\infty < \mathrm{r}_H(S) < 0$ and $\mathrm{r}_H(\Theta) > 0$ and no further assumptions are being made, then $\nvdash \mathrm{r}_{H|\Theta}(S) \leq 0$, $\nvdash \mathrm{r}_{H|\Theta}(S) \leq \mathrm{r}_H(S)$, $\nvdash \mathrm{r}_{H|\Theta}(S) \geq \mathrm{r}_H(S)$, $\nvdash \mathrm{r}_{H|\Theta}(S) \neq \mathrm{r}_H(S)$.

Hence the Theorem provides no general explanation of phenomena of which the negated King-of-X-sentences are a prime instance.

Nor should one be crude enough to overlook the role discourse anaphora and perhaps the syntactic position of the negation morpheme play in favouring what Russell explicated as the (now so-called) 'narrow scope'—but really: the accomodated or anaphoric (van der Sandt 1989)—reading. So, pretty as the result may be, I should not credit it with great causal or procedural importance in turning a putatively basic 'wide scope' reading[58] for negation into a 'narrow scope' (i.e. accomodated) one. What it

[57] Section IV on implicature showed felicity of suspenders to be intimately linked to argumentative directionality. This is no less true for presupposition. If we abstract from such notions, and thus from a semantics for 'indeed', suspenders are conditional protases. Taking on board Adams' (1965) thesis $P(B \textit{ if } A) = P(B|A)$, we have, classically, $0 < P(A) < 1$ unless $P(B \textit{ if } A)$ is, respectively, undefined or equal to $P(B)$. So expressive prolixity would ensue if A had been ('globally') accomodated. If prolixity is proscribed by what Grice dubbed a 'Manner' maxim, A cannot be accomodated nor, hence, can a strong presupposition A be satisfied. (But I would prefer to do without that maxim wherever it does not reduce to proscription of zero relevance. Perhaps Bolinger's 'different form—different meaning' would do as well.) Neither can it fail as a weak presupposition, in view of the definedness requirement $0 < P(A)$, an assumption also noted in other words by Karttunen and Peters (1979). If conditionals were represented simply by material implication, updating with *If there is a King of Bhutan, he isn't bald* would have the same effect as updating with the 'wide-scope' negation reading of sentence (B). But of course this argument does not address the subsentential level of representation where individual-designating discourse referents make their appearance and descriptive impact. Hence I am not about to re(-)solve the 'projection problem' for conditionals here. Suspenders are introduced naively and as diagnostics only.

[58] Or, if that can be explicated in terms of higher order epistemic modality over accomodation and non-accomodation, scope-unspecified reading.

does show at the very least is that the wide-scope-negation (Heim: 'locally' accomodated) reading—hard to get at the best of times—would under prototypical independence conditions of accomodability lead to a reduction in relevance.[59]

One can even say something more upbeat. We might suppose, substantially in line with observations by Stalnaker (1974), that very often a weak presupposition Θ is being *presented* by the speaker as being uncontroversial, no matter what an objective assessment of the situation might tell us. Interpret uncontroversiality now not, as it were, by a 'backward' glance at what has been established, but with a 'forward' glance at the speaker's proximally ulterior objective; and in our technical sense. For our example, the speaker may pretend or even believe that past smoking in itself is irrelevant for present sales prospects. That it should be so is implausible, given what *we* believe about the addictive powers of cigarettes, and implausible granted a real-world-considering inductive regime of positive instantial relevance. Still, there is nothing incoherent about this assumption. And I guess one meets it quite often.

Further modest support for the independence default comes from considering the case where a speaker could not possibly pretend to irrelevance, namely when very plainly $\Theta \models H$.

PROPOSITION: If S ps H and $\Theta \models H$ then $\mathrm{r}_{H|\Theta}(S) = 0$.

The prediction would be that under antecedent conditions Θ will not be treated as context-presupposed or imputable as offered for accomodation by a speaker aiming to engage H by assertion of S.

Note in summary that accomodation presumed optional has an argumentative or, rhetorical motivation to turn weak presupposition into strong; or rather: to militate against suspension of accomodation. Accomodation to a posit, under prototypical conditions, increases relevance (or at least does not decrease it). By contrast, the earlier example of scalar implicature resulted in a decrease. It is an empirical question whether a conventional, hypothetical imperative 'Be Relevant!' or 'Be Informative!' is our predictor. The two notions do not invariably coincide, as the

[59] I have not taken into account the role a concomitant increase of (prior) probability would play for intuitions. And I think it need not be taken into account if we assume that someone making an assertion of S is thereby ostending the availability of sufficient backing to force (if need be) conditioning of the joint epistemic commitment state on S—however improbable S may have become as a result of updating with a Θ that enhances its relevance to H.

example with disjunction showed,[60] and as was seen on explicating informativeness in the measure-theoretic sense of Carnap and Bar-Hillel. When we now consider accomodation in terms of a contextually given set of epistemically possible worlds, considerations of relevance offer one way to account for particular contextual choices—a way that also articulates presuppositional phenomena formally with those of rhetoric.

Consider next, in more leisurely fashion, 'also'; and, eventually, strong presupposition. Traditionally, $also(b, B)$ as e.g. in

Kim a l s o talks

—where the first argument of $also(x, y)$ is the focus—presupposes that some individual a other than b (Kim) has the property B. Kripke (n.d.) criticised this view[61]: with a counterexample

Kim and Sandy will come. The boss will also come,

(here adapted from the original conditional version). This presents a context for $also(b, B)$ in which $\exists x[Come(x) \wedge x \neq \text{theboss}]$ is satisfied even when, contrary to linguistic intuition, Kim *is* the boss.

The presupposition in context, says Kripke, is that b (the boss) is not identical with any one of a certain set $\{a_i\}$ of individuals (here: {Kim, Sandy}). This set is such that, for utterance of $also(b, B)$ to be 'appropriate', it must be non-empty and, say for a singleton, Ba is an anaphorically salient part of the context. More generally[62] we can distil from this a semi-theoretical

OBSERVATION: Let $also\{B, b\} = \{also(b, B), also(B, b)\}$. Then $also\{b, B\}$ conventionally implicates that there are contextually presupposed $\{Aa_i : i = 1, \ldots\}$ such that $A \subseteq B$ or else $\{b\} \subseteq \{a_i : i = 1, \ldots\}$, and presupposes, in any context satisfying the conventional implicature, that $A \subseteq B \Rightarrow \{b\} \not\subseteq \{a_i : i = 1, \ldots\}$; the converse also obtaining for $also(b, B)$,

[60] Put starkly: if the criterion of success is partisan maximization of evidential relevance *it can pay to be underspecified* independently of processing considerations.

[61] Arguing with respect to the particle 'too', which differ from 'also' in ways I shall here neglect.

[62] Much of this can be extracted from Kripke or earlier literature cited there. Let me however offer some partly new examples:
Kim and Lee are runners and Sandy is a l s o an athlete
??*Kim and Lee are athletes and Sandy is a l s o a runner*
8 is divisible by 4 and 10 is a l s o divisible by 2
??*6 is divisible by 2 and 8 is a l s o divisible by 4*
*4 is divisible by 2 and {10/*15} is also divisible b y 5.*

i.e. where the focus of 'also' is the singular term (individual-denoting NP) b.[63]

The conventional implicature (CI) part addresses anaphoricity; the 'presupposition' generalizes what Kripke contends it is;[64] and we shall see shortly that there are indeed also reasons within a DTS for separating out the components.

The CI (Aa_i) is preserved under negation as in

Kim didn't also come or under one possible reading of
Kim didn't come too,

and is suspendible:

Kim didn't a l s o come, if indeed anyone did.[65]

It thus fulfils the diagnostic criteria for weak presupposition:

OBSERVATION: $also\{b, B\}$ presupposes$_w$ that there are contextually presupposed $\{Aa_i : i = 1, \ldots\}$ such that $A \subseteq B$ or else $\{b\} \subseteq \{a_i : i = 1, \ldots\}$.[66]

The 'presupposition' (as labelled by Kripke) appears more recalcitrant to suspension:[67]

Kim a l s o came, if (?indeed) anyone did

The only reading I can obtain here is that either nobody came or at least two people did, one of them being Kim. This speaks for retention of non-identity. Suppose now we ensure someone did come and negate:

The boss came. (But) Kim didn't a l s o come,
a. *??if (*indeed) Kim is not the boss*
b. *%unless Kim is the boss*

---

[63]Predicates to be read extensionally as sets. Generalization: to relations and sets of sequences (n-tuples), as presumably in [Alpha]: *I'll have a beer.* — [Beta]: *I'll have a lemonade,* < pause > *too.* Or is this a case of inference from $A \subset C$ and $B \subset C$ where $C =$ *have something to drink*?

[64]'The presupposition ... is that neither [Kim] nor [Sandy] is the boss.' 'This presupposition cannot be assigned to the consequent without knowing the antecedent.' (pp.10,9) Kripke's notion is thereby, if anything, an instance of utterance presupposition. The abstraction offered here is a contender for sentence presupposition.

[65]Cancellation is subject to the familiar stricture: *Kim didn't a l s o come—nobody (else) did* is sarcastic; *Kim can't a l s o have come, since nobody (else) did*, civil.

[66]Higher-order probabilities or modal iterations might be called for to state this in a formally satisfactory way.

[67]To the point of defying identity of indiscernibles: *Every property the boss has, Kim has too.*

The (b.)-version casts doubt on insuspendible preservation of the putative strong presupposition under negation; at least when we admit 'unless' as a suspender.[68] Yet, when we compare the last example with

> *The boss came. (But) Kim didn't come, unless Kim is the boss*,

the placeholder '%'-rating should turn into a '?'- or '??'-rating. If so there is an empirical base to the

> OBSERVATION: $also\{b, B\}$ presupposes$_s$ in any context satisfying the weak presupposition, that $A \subseteq B \Rightarrow \{b\} \not\subseteq \{a_i : i = 1, \ldots\}$ [etc. as above].

Consider now the following

> HYPOTHESIS: If in a given context S would be irrelevant to all H, then S is not felicitously assertable in that context.[69]

The Hypothesis and the Observation concerning the CI (weak presupposition) jointly entail, by definition of contextual presupposition, the following

> FACT: Felicity of $also\{b, B\}$ at j implies $P^j(Bb|Aa_i) = P^j(Bb)$ $(i = 1, \ldots)$ for Aa_i meeting the constraint.

I.e. Bb is *stochastically independent* of its contextually presupposed 'anaphoric' antecedent. Updating by conditioning on Aa_i must have taken place (given some non-degeneracy conditions I'll address under 'salience' below). But this has for a

> COROLLARY: For any context j meeting the above requirements, if $A \subseteq B$ and $\{b\} \subseteq \{a_i : i = 1, \ldots\}$, then Bb is irrelevant to all H in j.

This Corollary has, by definition of strong presupposition, a further immediate

> COROLLARY: Satisfaction (by anaphoricity or accomodation) of the (lexical-conventional) weak presupposition of sentence $also\{b, B\}$ entails that $also\{b, B\}$ carries the (noted) strong presupposition.[70]

[68]But note: **The king of Bhutan is not bald, unless there isn't one.*

[69]Empirically we should thus have to countenance epistemic states in which people do not recognize every tautology for what it is; and states where they might even act as if they or their interlocutor had forgotten that either it rains or it doesn't. Note also: felicitous assertability would thus imply, in the weak case, a potential for 'admittance' (Karttunen 1974) by the context; and, in the strong case, 'admittance'.

[70]Note: the two are different propositions in this case.

The putatively strong presuppositional constraint is derived from anaphoricity explicated as already-taken-for-grantedness and the weakest of relevance desiderata.[71] That is: requiring relevance implies the 'otherness' constraint, which is stipulated by the traditional accounts. A small result, perhaps: but a result. It will also hold for the example type *Kim and Sandy will come. The boss will also come.* That $\exists x[Come(x) \wedge x \neq \text{theboss}]$ is satisfied even when Kim is the boss does not require a modification to predict that Kim cannot be read to be the boss. Given the Hypothesis we thus derive as a further

> PREDICTION: For any context j meeting the above requirements, if $A \subseteq B$ and $\{b\} \subseteq \{a_i : i = 1, \ldots\}$, then $also\{b, B\}$ is not felicitously assertable in j.

This derivation of the non-inclusion 'presupposition' also explains why it is insuspendible under negation. Intuitively, *Kim didn't* *a l s o* *come*, under the reading synonymous with *Kim* *d i d n' t* *come too* says, inter alia, *Kim didn't come.* Notate this $\bar{B}b$. Taking for granted Aa = *The boss came* and setting $A = B$ (both A, B stand for *came*) we would have $\bar{B}b = \bar{A}b$. However, the CI's equality or inclusion constraint obeyed is $A \subseteq B$, not $A \subseteq \bar{B}$. For, given that 'come' rather than 'didn't come' is the syntactically coded focus of 'also', anaphoric linkage holds between morpho-syntactically positive predicates.[72] The relevance constraint then again predicts $a \neq b$, since equality (or set-inclusion) among (sets of) individuals designated would give $\bar{B}b$ probability 0. With the putative suspender clause added (assuming 'unless' entails 'if not')[73], the assertion amounts to or entails a conditional $(a \neq b) \rightarrow \bar{A}b$. Contraposed this reads $Ab \rightarrow (a = b)$. If Kim did, after all come, Kim is or (better!) must be the boss. But this contradicts the relevance constraint, i.e. the strong presupposition. And note, indeed, that *The boss came. (But) If Kim* *a l s o* *came, Kim {is/must be} the boss* sounds pretty incoherent, and worse so the longer one tries to intuit an interpretation for it.

The non-identity or non-inclusion presupposition as stated, i.e. conditional on satisfaction of the CI, is an instance of strong sentence presupposition. The objections against the naive logical or Karttunen's earliest and disavowed notion of transcontextual sentence presupposition (as I know

[71] Cp. Kripke (n.d.:26, abbreviated) on [A few Rs Qd and b did too]: 'If [b] were among the [R]s, mentioning that he [Qd] would be superfluous.'

[72] The constraint obeyed would be $A \subseteq \bar{B}$ (special case: $A = \bar{B}$) iff the second sentence were *Kim* *a l s o* *didn't come*, synonymous with *Kim didn't come either.*

[73] Cf. Merin (1996a) on 'unless' and 'if not'.

it at second hand) still stand. For notice that the strong sentence presupposition here identified, precisely because it derives from a transcontextual proscription of utter irrelevance and from a lexically conditioned anaphoricity assumption, is of such generality that it is the relevance analogue of logical, tautologous constraints such as non-contradiction. (Note: all contradictions are universally irrelevant.)

Strong utterance presupposition is a notion bordering on triteness: 'utterance' being defined as a context-sentence pair, when a proposition Θ is contextually presupposed in an epistemic context j that is, or is a component of, the context of utterance, it has probability 1 and is ipso facto strongly presupposed by any utterance made in that context. For if one attempted to condition on a proposition E to the effect that $P_j(\Theta) < 1$, the epistemic state would no longer be represented by a probability function. Alternatively, under Carnap's convention, E would be j-irrelevant to any H. What can, however, be usefully said is: Weak sentence presupposition plus accomodation yields strong utterance presupposition. Once a proposition Θ is accomodated in context j, it has unit probability there.

But we have yet to motivate the CI and hence the weak presupposition with a base in lexical semantics. Considering 'also' and 'too' under a diachronic perspective (cp. Merin 1996a on 'but') we find diverse means leading to (nearly) identical ends. On the one hand, *also* < all swa OE 'in every respect so' foreshadows the popular gloss 'parallel'; similarly 'likewise' which, like Ge. *ebenfalls*, takes NP focus only. By contrast, 'too', like Ge. *auch*, derives from a meaning 'add (to)'; as did OE eke, which was gradually replaced by all swa. 'Adding', except in the domain of numbers, demands nonidentity with elements of a given set added to. 'Also' seems to engage the special case (equality) of the antecedent of our presupposed constraint, 'too' the consequent (inequality); similarly for the contraposed equivalent. Common to both varieties, however, is the anaphoric moment ('to', 'so'). This and anaphoric destressing of the non-focus ('scope') then cohere with having updated the epistemic context with the constraint imposed by the utterance referred to. This yields the CI or weak presupposition. And from 'likeness', anaphoricity and relevance yield the nonequality or, more generally, non-membership constraint; i.e. the 'identical ends' imposed by the strong presupposition.

What explains the relaxation in the CI part of $A = B$ to $A \subseteq B$ (Green 1968)? My guess is: symmetry with the subset condition for the singular terms, and a Tversky (1977) non-symmetry in the naive similarity relation.[74] Note that if $A \setminus B \neq \phi$ the constraint will no longer operate; hence conditions of the semantics of 'also' and 'too' will no longer be met.

It remains to explicate salience, a component of anaphoricity and accomodability. Kripke distinguishes an 'active context' from a 'passive context' representing general background knowledge. Use of 'also' requires presence of 'parallel' items (say, a proposition or sentence 'Kim walks') in the active context, with strong constraints on accomodability. The fact that many people besides Kim can be presumed ('passive' context!) to walk is not enough to license 'also'.

A traditional answer to a puzzled interlocutor's 'What is going on here?' in response to a dangling 'also' has been a backward glance at what has been mentioned. But Kripke's own characterization of

> *Tonight many other people are having dinner in New York,*
> *and S a m is having dinner there too*

as being a 'pretty strange performance' already holds the key to another answer. One asks 'Why put things this way?' The answer is: because we might be responding, say, to a worried mother, who asks 'Should Sam really be going out to New York in the evening? Isn't that a dangerous place?'.

In other words, we have an *issue*; and the mother's bias already invites the opposite tack taken by the speaker. Mother had been acting—with regard to the issue—as if she had not conditioned on—and that means: realized the import of—the pertinent and otherwise obvious fact that countless people were happy to dine in the big city. 'Active context' hence is not (just) determined by the backward glance of conversational score kept but rather (or at least as much) by a forward look or sideways glance at the goals participants are still aiming to score. Thus we pass the buck to a notion already saddled with—but also well-equipped to carry—heavy loads: the Discourse Topic. I propose as a (simplified)

> [SAL] HYPOTHESIS: At context j, $also(b, B)$ presupposes Aa for some a and $A \subseteq B$ such that $\exists H[\mathrm{sgn}(\mathrm{r}_H^{j-1}(Aa)) \neq 0 \neq \mathrm{sgn}(\mathrm{r}_H^{j}(Bb))]$ where j is the context derived from context $j-1$ by conditioning on Aa (i.e. $P^j(\cdot) = P^{j-1}(\cdot|Aa)$).[75]

[74] 'Less specific' being more similar to 'more specific' than vice versa. For the special case $A \neq B$ of $A \subseteq B$ we might well think of $A \subseteq B$ as ('globally') accomodated for the benefit of finite minds pressed for time.

[75] Empirical observation: *Aa and also Bb* will exhibit equality, *Aa but also Bb* inequality of sign, with updating taking place, as it were, in mid-sentence.

On the assumption that prior contributions are relevant to an ongoing issue, this, I submit, is what gives us the pertinent aspect of anaphoricity that is not already covered by looking at a 'scoreboard' of propositions taken for granted.[76] If one utters *Kim a l s o lives in New York*, one might, for all we know, take for granted that millions of people live there. (Kripke's observation.) But is the fact that one Mary Doe lives there of ostensible relevance to the issue under debate? Let $H =$ *Do we have sufficiently many friends in N.Y.?* Then prima facie, it is not relevant. On the other hand, if we have just come to agree[77] that she, Mary Doe, lives there, then we have presumably done so for a reason—viz. that Mary Doe happens to be a friend.

The stochastic approach yields not only the salience and otherness constraints emphasized by Kripke. Consider

Sandy walks and Kim a l s o walks

In *Aa and also Ab*, 'also' marks Aa, the anaphoric anchor for $also(b, A)$, as contextually presupposed in the state $P(\cdot)$ evaluating Ab. Thus, by our definition, there follows as a

FACT: Felicity of *Aa and also Ab* implies $P(Ab|Aa) = P(Ab)$.

If not $a \neq b$, then Ab would be $P(\cdot)$-presupposed, hence irrelevant. Next, grant Reichenbach (1956) and Suppes (1970) a

DEFINITIONAL FACT: A has prima-facie causal responsibility[78] for B only if $P(B|A) > P(B)$.

This has an immediate

COROLLARY: If A is contextually presupposed, A lacks prima facie causal responsibility for B.

The corollary and the previous fact lead to the following

PREDICTION: In *Kim fell and she (also) broke her arm* 'also' removes routine intimations of causality (causal implicature).

This prediction is readily confirmed. To fathom the semantics of 'also' further, consider the following

[76] 'Scorekeeping' is apt to be misleading if it amounts only to listing of propositions so far accepted. The real score for an open or hidden persuader is the ostensible common probability of H and, maybe, its distance from an action threshold.

[77] The constraint implicit in relevance of Aa can be made explicit: $\exists j'[P^{j'}(Aa) < 1]$ such that $j' = j - k$ where $m > k \geq 1$ for small integer m.

[78] 'Prima facie' is Suppes' notion, credited to Hintikka. *Secunda facie*, the cause may turn out to be spurious, i.e. a case of spurious stochastic correlation. I doubt that the language faculty deals in second sight.

PROPOSITION: If (i) $P'(\cdot) =_{df} P(\cdot|A)$ and (ii) $0 < P(AB\bar{H})$ and r' induced by $P'(\cdot)$, then $\mathrm{r}'_H(AB) = \mathrm{r}'_H(A) + \mathrm{r}'_H(B)$ (r-additive).[79]

Note a similar decausalizing effect of 'plus' or stressed 'and', near-synonyms to 'and also'.[80] Thus, presuppositional independence induced by 'also' guarantees the very property which makes the characterization of 'also' and 'too' as 'additive' particles (König 1991:Ch.4) so apt.'[81] For note that additivity of relevance is guaranteed for arbitrary A, B, H, which is a condition not easy to meet in general. Note further that the difference between plain *and* and *also* poses a potential problem for the extendibility of any dynamic semantics (e.g. Heim 1982, 1983) which treats simple 'and' in effect by way of sequential updates appropriate by the above evidence for 'and also'.

This evidence for the semantics of 'also' now suggests the following

HYPOTHESIS: 'also' overrides the A-unexpectedness default for 'A but B' by forcing prior conditioning on A.

Additional evidence for this hypothesis is provided by the intuition that *A but also B* intimates or favours an $H \neq \bar{B}$ as the discourse topic. And the intuition that, nevertheless, A and B have inverse signs of relevance with respect to H is fully accounted for by the condition $\exists H[\mathrm{sgn}(\mathrm{r}_H^{j-1}(Aa)) > 0 > \mathrm{sgn}(\mathrm{r}_H^j(Bb))]$ which, given the Proposition, also entails $0 > \mathrm{sgn}(\mathrm{r}_H^j(AaBb))$ for H bound by the same $\exists H$. Intuitions are, as it were, ambicontextual.[82]

VII. A Consequence of CIP: Cognitive Bias Towards Dichotomies

Suppose CIP of Section IV generalized to issue partitions $(H_i : i = 1, \ldots, n)$. Johnson (1986) proved that for $n > 2$, at most one evidential proposition deemed atomic can be relevant to any given H_i if conditional independence of evidential atomic propositions is to be satisfied w.r.t. each element of the issue partition and its complement.

Cognitive engineering cannot always reasonably restrict itself to dichotomies. It will occasionally give up CIP thus generalized. (See also

[79] *Proof*: $P'(A) = 1$, hence $\mathrm{r}'(AB) = \mathrm{r}'(B) = 0 + \mathrm{r}'(B) = \mathrm{r}'(A) + \mathrm{r}'(B)$.

[80] Jeff Kaplan (1984) notes kinship of 'a n d' with 'too'.

[81] This result has implications abovel all for sentence-scope interpretation.

[82] Technical options one might consider for implementing such ambicontextuality are discussed in Skyrms (1983). Feasibility in practice is much improved by limitation to short-term memory, as indeed would be characteristic of the conversational phenomena under discussion here.

above, the 'doctor' example.) But suppose the Maker of cognitive psychology values additivity and freedom from paradoxes of relevance. This will suggest another design option for a 'competence' account: restriction to the case $n = 2$. The adoption of CIP—remember, a defeasible presumption—would thus predict a *cognitive bias towards dichotomizing issues.* Anecdotal evidence speaks for such a bias being evolutionary fact. Of course, more obvious reasons for it can be thought of. That's fine by me. Any independent constraint favouring dichotomy legitimizes descriptive appeal to CIP.

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