

Only if: If only we understood it

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1 The problem

Only and conditional sentences of the form *if p then q* have been studied extensively. But their joint appearance in (1) is still puzzling (e.g. McCawley 1974, Barker 1993, von Stechow 1997, Dekker 2001):

- (1) a. You only succeed if you work HARD.
 b. Only if you work HARD do you succeed.

Claim: A new solution to the puzzle becomes available if conditionals are analyzed as having existential readings in certain contexts (e.g. under *only*). The analysis also explains why in many instances we feel that the negation of a conditional is equivalent to the negation of its consequent.

1.1 The meaning of *only*

Only, when analyzed as a propositional operator, presupposes its prejacent and negates any not already entailed (NW) alternatives to the prejacent (e.g. Rooth 1985, von Stechow 1997, Fox 2006):

- (2) $[[\text{only}]] (\mathcal{A}_{\langle s,t \rangle}) (p_{\langle s,t \rangle}) = \lambda n: p(n) = 1. \forall q \in \text{NW}(p, \mathcal{A}): q(n) = 0$
 $\text{NW}(p, \mathcal{A}) = \{q \in \mathcal{A}: p \text{ does not entail } q\}$

Given (2), (3) has the interpretation in (4):

- (3) Gisela only went to BERLIN.

- (4) Presupposition:
 Gisela went to Berlin.

Assertion:

It is not the case that Gisela went to Bern.

It is not the case that Gisela went to Vienna.

It is not the case that Gisela went to Vaduz.

It is not the case that Gisela went to Bern and Berlin.

Etc.

We can set aside the debate about whether an *only* sentence really just presupposes its prejacent or whether it asserts it in a pragmatically backgrounded or “assertorically inert” way (e.g. Atlas 1993, Herburger 2000, Horn 2002).

1.2 The meaning of bare conditionals

Bare conditionals are widely thought to have universal force (e.g. Lewis 1918, Sommers 1984):

- (5) Universal Conditional:
If p q is true iff all relevant *p*-cases are *q*-cases.

This view is independent of whether:

- *if* is seen as a mere device to mark a restrictor of a tacit universal modal operator (Lewis/Kratzer analysis, e.g. Kratzer 1986)
- *if* is treated as a genuine two-place operator (e.g. Gillies’s 2010 iffiness)
- conditional antecedents quantify over all antecedent worlds (strict conditional, Lewis 1918)
- the relevant cases are the *p*-cases that are only minimally different from world of evaluation (variably strict conditional, Lewis 1973)
- cases are possible worlds, situations, events or something else

Under (5), (6) has the meaning in (7):

- (6) If you work hard you succeed.
- (7) $[\forall x: R(x) \wedge \text{you-work-hard}(x)] \text{you-succeed}(x)$
 ‘All relevant cases where you work hard are cases where you succeed.’

The semantics of *only* in (2) and the universal account of *if p q* in (5) seem well-motivated.

Problem: Given (2) and (5), (1a,b) should be true as soon as not *all* failures to work hard result in success. This is too weak: (1a,b) are felt to be false as soon as one instance of working just a little or of not working at all leads to success.

- (8) ONLY [If you work HARD do you succeed]

- (9) Presupposition:
 If you work hard you succeed.

Assertion:

It is **not** the case that in **all** cases where you work a little you succeed.

It is **not** the case that in **all** cases where you work when you feel like it you succeed.

It is **not** the case that in **all** cases where you do not work at all you succeed.

Etc.

[Since ‘all’ is downward entailing in its restriction, *work a little*, *work when you feel like it*, denote stronger alternatives to *work hard*. *Not work at all* denotes a non-weaker alternative.]

3 The *only if* puzzle and CEM

The reason that on (5) we don’t derive the exclusionary force of the *only if* conditional is that (10a) is not equivalent to (10b) (but only to (10c)). If, however, the negation of a conditional were actually equivalent to the negation of its consequent the exclusionary force of *only if* would follow (Barker 1993):

- (10) a. $\neg [\forall x: p\text{'-case}(x)] \rightarrow q\text{'-case}(x)$
 b. $[\forall x: p\text{'-case}(x)] \rightarrow \neg q\text{'-case}(x)$
 c. $[\exists x: p\text{'-case}(x)] \rightarrow \neg q\text{'-case}(x)$

3.1 CEM 1: Stalnaker (1968, 1981)

- (11) Stalnaker conditional:
 Conditional antecedents denote singular definite descriptions. They pick out the single closest possible world in which the antecedent is true. (Stalnaker 1968, 1981).

Given (11), (12a) and (12b) are equivalent. The Conditional Excluded Middle (CEM) in (12d) follows from this equivalence and (12c):

- (12) a. $\neg [\iota x: p\text{-case}(x)] \rightarrow q\text{-case}(x)$
 b. $[\iota x: p\text{-case}(x)] \rightarrow \neg q\text{-case}(x)$
 c. $[\iota x: p\text{-case}(x)] \rightarrow q\text{-case}(x) \vee \neg [\iota x: p\text{-case}(x)] \rightarrow q\text{-case}(x)$ Excluded Middle
 d. $[\iota x: p\text{-case}(x)] \rightarrow q\text{-case}(x) \vee [\iota x: p\text{-case}(x)] \rightarrow \neg q\text{-case}(x)$ CEM

Since the Stalnaker conditional validates CEM, it is better able to capture the exclusionary force of *only if* than the universal conditional in (5):

- (13) Assertion:
 In **the** closest world where you work a little you do **not** succeed.
 In **the** closest world where you work when you feel like it you do **not** succeed.
 In **the** closest world where you do work at all you do **not** succeed.
 Etc.

But, one standard objection (Lewis 1973) is that there is not always a single closest world in which the antecedent is true (Uniqueness Assumption), cf. (14). Nor is there always a set containing the closest worlds where the antecedent is true for any antecedent and world of evaluation (Limit Assumption). This motivates the variable strict conditional (Lewis 1973):

- (14) a. If Bizet and Verdi had been compatriots, Bizet would have been Italian.
 b. If Bizet and Verdi had been compatriots, Verdi would have been French.

- (15) If this line were over one inch long...

3.2 CEM 2 and *only if*: von Fintel (1997)

To use CEM and at the same time keep a variably strict analysis, von Fintel (1997) proposes that conditional antecedents denote generic operators. Unlike universal quantifiers, generic ones show homogenous behavior under negation (cf. Fodor 1970, Löbner 1983) (*Dogs don't like thunder*). A generic version of (5) thus gives us CEM, which in turns helps capture the exclusionary force of *only if* conditionals:

- (16) a. $\neg[\text{GEN } x: p\text{-case}(x)] \rightarrow q\text{-case}(x)$
b. $[\text{GEN } x: p\text{-case}(x)] \rightarrow \neg q\text{-case}(x)$

3.3 Challenges for a CEM account of *only if* conditionals

- CEM is controversial and though it seems to hold often, it does not hold always: (17a) is judged false when contemplating a coin about to be flipped, but so is (17b), where the same consequent is negated, contra CEM (e.g. Leslie 2009).

- (17) a. This fair coin will come up heads if flipped. F
b. This fair coin will not come up heads/will come up tails if flipped. F

[Possible solution: (17a) and (17b) are not both false but indeterminate and to be accounted for in terms of supervaluations (Klinedinst 2010; Stalnaker 1981)]

- Generic quantification may be too weak (Cohen 2004):
If some non-generic cases of goofing off lead to success, is (1) not false?
- Overly strong presupposition (McCawley 1974):
The analysis predicts that (1a,b) presuppose their prejacent, where the prejacent has, crucially, (quasi)-universal force. However, while (1a,b) assert that hard work is a necessary condition for success they do not presuppose that it is a sufficient one. An *only if* conditional does not have quite the same force as a bi-conditional:

- (18) a. You succeed only if you work hard. But sometimes when you work hard you don't succeed. Coherent
b. You succeed if and only if you work hard. #But sometimes when you work hard you don't succeed. Contradictory

4 Existential conditionals under *only*

- (19) Existential conditional:
In certain contexts, *if p q* is true iff some *p*-cases are *q*-cases.

One such context is under *only*. This explains:

4.1 Exclusionary force of *only if*

The exclusionary force of *only if* conditionals now follows without having to posit CEM (cf. also von Fintel 1997 on existential prejacent, a possibility he contemplates but ultimately rejects):

- (20) Assertion:
It is **not** the case that in **some (any)** cases where you work a little you succeed.
It is **not** the case that in **some (any)** cases where you work when you feel like it you succeed.
It is **not** the case that in **some (any)** cases where you do not work at all you succeed.
Etc.

4.2 Existential presuppositions of *only if* sentences

(19) correctly predicts that (1a,b) presupposes that *some* cases of hard work lead to success and that they do not presuppose that *all* do (cf. McCawley 1974); though (1a,b) cannot be felicitously used to promise that hard work will guarantee success, they can be used to encourage someone to work hard.

(21) is misleading because it presupposes that *some* instances where you drink kale juice you live to be 120:

- (21) Only if you drink kale juice do you live to be 120.

5 Additional support for the existential conditional

5.1 Weak conditionals

Not all bare conditionals have universal force. The ‘weak’ conditional in (22) can be true as soon as the speaker puts just some of her quarters in the meter (e.g. Schubert and Pelletier 1989). While this may be due to heavy contextual restriction on a universal quantifier (Barker 1997, Schein 2003), on the simplest account, it follows from existential quantification:

- (22) If I have a quarter, I’ll put it in the meter.

- (23) $[\exists n: [\exists x: \text{Quarter}(x)] \text{Have-}I(x, n)] \text{Put-}I\text{-it-in-the-meter}(n)$

5.2 Bare plurals under *only*

Like conditionals, bare plurals receive existential interpretations under *only*, even when they combine with individual level predicates, which normally force generic or quasi-universal readings (e.g. McCawley 1974, von Fintel 1997). (24a) rules out that children eat arugula and does not presuppose that adults in general eat arugula, only that some do.

- (24) a. Only ADULTS eat arugula.
b. Only MEN find Formula 1 races interesting.

- **Existential generic bare plurals**

Just as conditionals in isolation can have existential force (weak conditional), so can generic bare plurals (Cohen 2004, cf. also von Fintel 1997):

- (25) A: Birds lay eggs.
B: Mammals lay eggs too.

6 Negative contexts

6.1 Scope of decreasing quantifiers

- (26) a. Every student will succeed if he works hard.
b. No student will succeed if he goofs off. (Higginbotham 1986)

If in (26a) can be reasonably translated as a material conditional, but not *if* in (26b) (Higginbotham 1986); (26b) should then mean that for no one is goofing off a sufficient condition for success or, equivalently, that everyone goofs off and fails:

- (27) a. $\forall x (\text{Student}(x) \rightarrow (\text{Work-hard}(x) \rightarrow \text{Succeed}(x)))$ cf. (26a)
b. $\neg \exists x (\text{Student}(x) \wedge (\text{Goof-off}(x) \rightarrow \text{Succeed}(x))) \Leftrightarrow$ cf. (26b)
 $\forall x (\text{Student}(x) \rightarrow \neg(\neg \text{Goof-off}(x) \vee \text{Succeed}(x))) \Leftrightarrow$
 $\forall x (\text{Student}(x) \rightarrow (\text{Goof-off}(x) \wedge \neg \text{Succeed}(x)))$

I discuss three solutions that have been given for this problem before proposing a fourth, the existential conditional:

Solution 1: *if* = ‘and’ here: *If* in (26b) is not the material conditional ‘ $\rightarrow$ ’, but conjunction ‘ $\wedge$ ’ (Higginbotham 1986, cf. also Dekker 2001’s dualization operator).

- (28) $\neg \exists x (\text{Student}(x) \wedge \text{Goof-off}(x) \wedge \text{Succeed}(x))$

Conceptually, this raises an issue of compositionality (Higginbotham 1986) (though I see in principle nothing wrong with saying that *if* is ambiguous as long as there is some rationale for when each reading appears.)

Empirically, (29a) and (29b) are not really equivalent (Leslie 2009): (29a) is falsified by Meadow, who will get a good grade no matter what because her mafioso father pressures the teacher. But if Meadow actually happens to work hard (maybe to spite Dad) she does not falsify (29b):

- (29) a. No student will succeed if he or she goofs off. F
b. No student will succeed and goof off. T

Solution 2: Restrictor theory: Uniformly translate the *if*-clause as a restrictor, a la Lewis/Kratzer for adverbs and modals (von Fintel 1998):

- (30) a. Every student who works hard will succeed. cf. (26a)
 b. No student who goofs off will succeed. cf. (26b)

But, a hard-working Meadow falsifies (29a)—she will succeed even if she does nothing at all—but she will not falsify (30b) because she does not actually goof off (Higginbotham 2003, von Fintel and Iatridou 2002, Leslie 2009). (A possible solution to save the restrictor theory is pointed out by Leslie (2009): modalize the restriction, cf. Klinedinst (2010)).

Solution 3: CEM: Conditionals under negative quantifiers are explained if we posit (presuppose) CEM (and decomposition of the negative quantifiers). This is noted in Higginbotham (2003) and advocated in von Fintel and Iatridou (2002):

- (31) [No x : Student(x)] [All w : Goof-off(x , in w)] Succeed (x , in w) $\Leftrightarrow$
 [All x : Student(x)] $\neg$ [All w : Goof-off(x , in w)] Succeed (x , in w) $\Leftrightarrow$
 [All x : Student(x)] [All w : Goof-off(x , in w)] $\neg$ Succeed (x , in w) (via CEM)

Solution 4: Existential conditionals: Conditionals under negative quantifiers, like conditionals under *only*, have existential force. (This is effectively a modalized version of the ‘and’ theory presented as solution 1.)

- (32) a. [Every x : Student(x)] [$\forall w$: Work-hard(x, w)] Succeed(x, w) = (26a)
 b. [No x : Student(x)] [$\exists w$: Goof-off(x, w)] Succeed(x, w) = (26b)

[Additional examples:

- (33) Most patients will improve if they take this medication.
 [Most x : Patients(x)] [$\forall w$: Take-med(x, w)] Will-improve(x, w)
- (34) Few/no patients will improve if they continue to smoke.
 [Few/no x : Patients(x)] [$\exists w$: Continue-smoke(x, w)] Improve(x, w)
- (35) Few/no patients will improve if they take this medication.
 [Few/no x : Patients(x)] [$?w$: Take-*this*-medication(x, w)] Improve(x, w)]

6.3 Conditionals under *doubt*

- (36) I doubt that John will succeed if he goofs off. (von Fintel and Iatridou 2002)

(36) expresses doubt that goofing off and success are compatible. This follows if conditionals under *doubt* are existential.

6.4 Conditionals under negation

- (37) a. It's not the case that John will succeed if he goofs off.
 b. I don't think that John will succeed if he goofs off.
 c. John won't succeed if he goofs off.

If conditionals under negation also have existential readings, this explains the intuition that the negation of a conditional often feels equivalent to the negation of its consequent: The existential conditional derives the effect of CEM without positing CEM from a basic logical equivalence:

$$(38) \quad \neg[\exists w: \text{Goof-off}(j, w)] \text{ Succeed}(j, w) \Leftrightarrow [\forall w: \text{Goof-off}(j, w)] \neg \text{Succeed}(j, w)$$

Speculation: Instances where a conditional under a negation is not equivalent to the negation of its consequent tend to arise where the conditional repeats a previous, strong conditional, preserving its strength:

- (39) A: If a fair coin is flipped it will land heads. F
 B: If a fair coin is flipped it will NOT land heads. T
 C: If a fair coin is flipped it will not necessarily land heads. T

(39A) is false because odds are that half of the fair coins will land tails if flipped. (39B) is true if it mimics the universal reading of (39A) and (39C), cf. (41a). In contrast, (40) uttered in isolation is false because then it has existential reading, cf. (41B):

- (40) If a fair coin is flipped it will not land heads. F
- (41) a. $\neg[\forall w: [\exists x: \text{Fair-coin}(x)] \text{ Flipped}(x, w)] \text{ Land-heads}(x, w)$ T
 b. $\neg[\exists w: [\exists x: \text{Fair-coin}(x)] \text{ Flipped}(x, w)] \text{ Land-heads}(x, w)$ F

7 Analysis

7.1 If-clauses as plural definite descriptions (Schein 2003)

If-clauses are plural definite descriptions of possible events. Overt adverbs of quantification are interpreted *in-situ* as taking scope over the consequent (Schein 2003, cf. Schlenker 2004).

- (42) If you work hard you usually succeed.

- (43) $[\iota X: \forall e (X(e) \Leftrightarrow \text{you-work-hard}(e))]$ (a)
 $[\text{Most } e': X(e')] \exists X': \exists e'' [X'(e'') \wedge \forall e'(X'(e'') \rightarrow R(e'', e'))]$ (b)
 $[\forall e''': X'(e''')] \text{you-succeed}(e''')$ (c)

'The events where you work hard are such that (a)
 for most among them there are related events (b)
 all of which are events where you succeed.' (c)

[Following Schein (2003), the quantificational force of the conditional is limited not in the antecedent (cf. Stalnaker/Lewis similarity measure) but by a tacit *ceteris paribus* clause sandwiched between (b) and (c) (Herburger and Mauck, *ms.*). I abstract away from this here.]

On this account *if* has meaning (cf. also Gillies 2010):

$$(44) \quad [[if]] = \lambda f_{\langle e,t \rangle} . \lambda g_{\langle E,t \rangle} . [\iota E: \forall e (E(e) \leftrightarrow f(e)=1)] g(E)=1$$

7.2 Tacit adverb = an ambiguous silent *ever*?

- The difference between a conditional with universal force and one with existential force resides in a tacit adverb taking scope over the consequent. On the universal, unembedded reading *If you work hard you succeed* has a universal adverb (45). When embedded under *only*, negative quantifiers, *doubt* and in weak conditionals it has an existential adverb (46) (except for mimicking):

$$(45) \quad [\iota X: \forall e (E(e) \leftrightarrow \text{you-work-hard}(e))] \quad (a)$$

$$\rightarrow [\forall e': E(e')] \exists E': \exists e'' [E'(e'') \wedge \forall e'(E'(e') \rightarrow R(e'', e'))] \quad (b)$$

$$[\forall e''': E'(e''')] \text{you-succeed}(e''') \quad (c)$$

$$(46) \quad [\iota X: \forall e (E(e) \leftrightarrow \text{you-work-hard}(e))] \quad (a)$$

$$\rightarrow [\exists e': E(e')] \exists X': \exists e'' [E'(e'') \wedge \forall e'(E'(e') \rightarrow R(e'', e'))] \quad (b)$$

$$[\forall e''': E'(e''')] \text{you-succeed}(e''') \quad (c)$$

- Leaving aside weak conditionals, the reading of the tacit adverb is generally the one that is strongest in a particular context: existential in negative, universal otherwise.
- Leaving aside weak conditionals, the ambiguity of the tacit adverb recalls the ambiguity of *ever* (and possibly *any*) which can be argued to have (limited) universal readings and existential readings, which arise in DE contexts, where the expressions behave like NPIs:

- (47) a. **Ever** the optimist, he said that everything would work out just fine.
b. I will stay here **forever**.

- (48) a. I don't think I have **ever** seen as pretty a hibiscus plant as this one.
b. Don't **ever** try this at home!

- In *only if* conditionals the quantificational force of the conditional is not necessarily existential but is that of the overt adverb: (49) rules out that there are any levels of work but hard work that always, often or usually lead to success:

- (49) Only if you work HARD do you always/often/usually succeed.

- (50) ONLY [$\iota X: \forall e (E(e) \leftrightarrow \text{you-work-hard}(e))$] (a)
 $\rightarrow$ [All/Many/Most $e': E(e')$] $\exists E': \exists e'' [E'(e'') \wedge \forall e' (E'(e') \rightarrow R(e'', e'))]$ (b)
 $[\forall e'': E'(e'')] \text{you-succeed}(e'')$ (c)

Tacit existential adverb in *only if* conditional is a default.

- Other cases where conditionals with overt adverbs of quantification appear under negative quantifiers, *doubt* and *not* show similar behavior:

- (51) No student always/often/usually gets an A if he or she studies very little.
(52) I doubt that Meadow always/often/usually gets a D if she studies very little.
(53) a. It is not the case that Meadow always/often/usually gets a D if she studies very little.
b. Meadow does not always/often/usually get a D if she studies very little.

7.3 Existential consequents AND definite antecedents: Too much?

To the extent that plural definite descriptions show homogeneity under negation (Löbner 1985 cf. *The children are not asleep*) on a Schein-type analysis of conditionals the negation of a conditional is equivalent to the negation of what follows the definite description (see also Schlenker 2003). Do we by adopting such an account of *if* therefore not derive CEM and already solve the problem of *only if*, conditionals in DE contexts? Not really. Whether we derive CEM-like effect or not depends on the force of the tacit adverb:

- CEM-like effect derives exactly when the tacit adverb is existential; (40) has the interpretation in (54). In the CEM-violating (39B) the tacit adverb is universal (mimicking a universal adverb in a previous sentence), as in (55):

- (54) [$\iota X: \forall e X(e) \leftrightarrow \text{you-work-hard}(e)$] (a)
 $\neg [\exists e': X(e')] \exists X': \exists e'' [X'(e'') \wedge \forall e' (X'(e') \rightarrow R(e'', e'))]$ (b)
 $[\forall e'': X'(e'')] \text{you-succeed}(e'')$ (c)
(55) [$\iota X: \forall e X(e) \leftrightarrow \text{you-work-hard}(e)$] (a)
 $\neg [\forall e': X(e')] \exists X': \exists e'' [X'(e'') \wedge \forall e' (X'(e') \rightarrow R(e'', e'))]$ (b)
 $[\forall e'': X'(e'')] \text{you-succeed}(e'')$ (c)

- The weak presuppositions of *only if* conditionals show that we need existential quantification. The examples in (1) presuppose that *some* instances of hard work lead to success not that all do.
- No negation needs to be ‘lowered’ to derive CEM effect, which follows already from existential quantification, regardless of whether negation takes scope over definite description or under it. Since no lowering is needed, no lexical decomposition of *doubt* and *no* is required.

7.4 Afterthought: The relation between antecedent and consequent events

When temporal order does not matter *only if* q p is equivalent to *if* p q . This is why we are instructed to translate both with ' $p \rightarrow q$ ' when all we have is propositional logic:

- (56) a. If Socrates is a man he is mortal.
b. Only if he is mortal is Socrates a man.

But as soon as temporal order matters, the equivalence fails (McCawley 1983):

- (57) a. If you heat butter, it melts.
b. Only if butter melts do you heat it.

Generally, the (*only*) *if* antecedent clauses describe matters that are temporally/causally prior to those described by the consequent clauses. This suggests that the relation R in the logical forms above is often understood to be 'Follow' (Schein 2003).

Conclusion:

- *If* has meaning: It is a plural definite description operator (Schein 2003).
- Quantification is over possible situations or events (e.g. Lycan 2001, Schein 2003)
- Adverbs of quantification (overt or tacit) are interpreted as taking scope over the consequent (Schein 2003, cf. also Gillies 2010)
- My proposal: The tacit adverb is ambiguous (similar to *ever*):
A tacit adverb in the consequent can be universal: universal force of conditionals
A tacit adverb in the consequent can be existential: existential force of conditionals
- The tacit adverb is existential when a conditional appears in a DE context: under *only*, under *doubt*, under negation (except denial negation) and under negative quantifiers. Setting apart weak conditionals, the tacit adverb behaves like a low-scalar NPI.
- CEM need not be posited as a principle or presupposed (von Fintel and Iatridou 2002), nor should it be validated by the semantics of conditionals. Where it seems to hold this follows from the logic of existential quantification under negation:
 $\neg \exists x F(x) \Leftrightarrow \forall x \neg F(x)$

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