The Unaccusative Alternation: Deriving the Change-of-State Constraint

Abstract The paper investigates the sources of the change-of-state (COS) constraint imposed on the universal causative-unaccusative alternation .The discussion consists of two parts: first, the study presents cross-linguistic empirical evidence that the generalization which captures a subset of non-alternating verbs extends beyond the scope of verbs of surface contact, i.e, beyond Fillmore's (1970) *hit*-verbs. The generalization which captures this set is the absence of COS interpretation in the internal argument. Two novel diagnostics for identifying COS are then developed. The question why such a pre-condition for alternating verbs should exist in the first place has not yet received a satisfactory answer in the literature. The second part aims to eliminate this stipulation, proposing instead a theoretical derivation of the constraint. The intuitive terms of *state* and *change-of-state* are defined formally: a state of an object is derivable from a scalar structure. It is a point in n-dimensional space of its relevant (scalar) measurements. The paper argues that the interaction of the said scalar structure with a (counterfactual) model of causation yields the COS constraint. Hence, a scalar analysis of unaccusatives predicts the distribution of alternating and non-alternating verbs.

Keywords Causative · Unaccusative · Scalarity ·States · Change-of-State ·Causation

1 Introduction

It is commonly assumed that the subject of the transitive participating in the unaccusative alternation (henceforth 'the alternation') is interpreted as causally responsible for the occurrence of the event; the sentence *the sun melted the ice* is understood to mean *the sun caused the ice to melt*. The transitive subject position may be occupied by agents, natural forces or instruments (Levin & Rappaport-Hovav 1995; Van Valin & Wilkins 1996; Reinhart 2002).

(1)   a.   The painter / the brush / autumn reddened the leaves. (Reinhart 2002)

         b.   The leaves reddened.

         c.   Walter / the heat / the candle melted the ice.

         d.   The ice melted.

Furthermore, transitive verbs whose external argument is exclusively agentive do not exhibit the alternation. The External Argument Restriction (EAR) is demonstrated in (2):

(2)   a.   John / *the straw /* his thirst drank the lemonade.

         b.   *The lemonade drank.

         c.   Mary /* the brush / *the renovations painted the house.

         d.   *The house painted.

In light of the above, the thematic role of the external argument of the transitive member is often taken to be causative and underspecified, labeled effector (Van Valin & Wilkins 1996), abstract causer/initiator (Ramchand 2008) or cause (Reinhart forthcoming). In order to capture this underspecification, theories supplied abstract linguistic entities which encapsulate realizations of thematic roles; entities such as an underspecified cause role (Levin & Rappaport Hovav 1995, Reinhart 2002), or a "flavor" of voice (V_{cause}, see Folli & Harley 2005; among others).[1]

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[1] The underspecification account, although crosslinguistically accurate, is not perfect. There are cases in which the external argument of alternating verbs disallows agents and instruments (McKoon & Macfarland 2000, Wright 2002, Rappaport Hovav 2014). The finer details of the External Argument Restriction will be irrelevant here because the transitives discussed below allow both agents and causes across the board.

I show that thematic variability, or underspecification, by itself, does not entail the availability of the alternation: many verbs allow freedom in the choice of their external argument but disallow the alternation. A few examples follow (to be extended in section 2):

(3)   a.   The government / the earthquake / the wall isolated the inhabitants.

         b.   *The inhabitants isolated.

         c.   John / the weather conditions / the walls protected the city.

         d.   *The city protected.

         e.   John / the hurricane / the ship crossed the ocean.

         f.   *The ocean crossed.

The examples in (3) show that that an underspecified external thematic role is not sufficient to license the alternation. The question is: what is the constraint that blocks the alternation in the examples in (3) above?

In the paper, I show that regardless of one's views on whether the external argument is added via a causativization operation (Pesetsky 1995; Harley 2008; Ramchand 2008, to name a few), or conversely, is eliminated via a reduction operation (Levin & Rappaport Hovav 1995; Reinhart 2002; Härtl 2003; Horvath & Siloni 2011a, among others), the alternation is constrained by the semantics of the internal argument: a change of state (henceforth COS) interpretation is necessary to manifest the alternation:

(4)   **Main Claim: The COS constraint**

        No COS → No causative-unaccusative alternation.

Variants of such a claim exist since at least Fillmore's (1970) grammar of hitting and breaking (see Beavers 2011, Rappaport Hovav & Levin 2012, Levin & Rappaport Hovav 2014, Spalek 2014, among others). The paper contributes novel data to the body of evidence corroborating the existence of the constraint. Given that there are empirical reasons to adopt (4), the paper then turns to examine the theoretical sources of the constraint: why would the unaccusative alternation b e thus constrained from the outset? Observe that causative constructions are not limited to have a change in an argument in the general case (for example, causing someone to read a book or to say a word). This paper offers a semantic account for the constraint.

The paper is structured as follows: in Section 2, I present data supporting the hypothesis that a COS interpretation necessarily mediates the alternation, followed by an interim theoretical discussion. Since the notion of COS in the literature is often intuitively used and not well-defined, I present in Section 3 a formal definition for COS and explore its relations to Intrinsicity and to scalar structures. Section 4 takes stock of the overall picture which has emerged, discusses implications for representations of the alternation, and delineates topics for future research.

2 The COS constraint

2.1 Setting aside independent restrictions

First and foremost, the availability of the alternation is not reducible to the COS constraint alone. Let us fix COS interpretation as constant, and examine the distribution of the alternation with respect to the External Argument Restriction (EAR, see (2)).

The EAR dictates that the alternation is unavailable if the external argument is strictly agentive, or alternatively, if the external argument does not license causes (see (2)). This restriction is divorced from whether or not the internal argument undergoes COS. Interestingly, there are cases in which verbs show subtle subject-object dependencies: the subjects are strictly agentive for certain choices of objects. In such cases, the alternation vanishes (see Spalek 2014, Levin and Rappaport Hovav 2014):

(5)   a.   I emptied the trash can.   (Agentive, COS)

         b.   *The trash can emptied.

         c.   The alarm emptied the building.   (Nonagentive, COS)

         d.   The building emptied.

In light of the above, a naïve application of the EAR leads to the wrong results, since *empty* licenses underspecified subjects but does not necessarily alternate (see (5b)). A traditional approach avoids the problem by assuming polysemy: it enumerates *empty₁* and *empty₂* which correspond to different sets of thematic roles and consequently different behaviors are expected (Dowty 1979, Reinhart 2002; to appear). A different approach evaluates the relevant restriction after the theme argument is merged (see Rappaport Hovav & Levin 2012 for the Proper Containment Condition). The exact nature of the EAR, the level in which it applies, and the dependencies incurred by the choice of the internal argument are topics well beyond the scope of this paper. It must be stressed here that whichever avenue one pursues in accounting for the ungrammaticality of (5b), it has no bearings on the COS constraint. The constraint, as formulated above, only argues that a lack of COS interpretation bars the alternation. COS interpretation is a necessary, but not a sufficient, condition for the alternation.

Is it enough that both the COS constraint and the EAR are obeyed in order to account for the distribution of alternating verbs? In this regard, a representative pattern must be examined. COS verbs such as *destroy* are non-alternating causatives in English (Alexiadou et al 2006, Rappaport Hovav 2014). Because they allow underspecified subjects, they do not violate the EAR and are expected to show the alternation. Thus, their behavior in English poses a potential problem for the hypothesis advanced here.

(6)   a.   The vandals / the storm / the intense heat destroyed the crops. (Rappaport Hovav 2014)

        b.   *The crops destroyed.

It is true that verbs of destruction reveal a non-alternating paradigm within English. However, from a cross-linguistic perspective, the absence of unaccusative *destroy* in English is an idiosyncratic gap. Hebrew, Arabic, French, Greek, Czech and Hungarian all show unaccusative alternates of *destroy* (thanks to Julia Horvath for the Hungarian data and to Lior Laks for the Arabic data):

(7)   a.   *ha-yevulim nehersu.*[2]   (Hebrew)

               the crops   destroyed

        b.   *inhadam   il-be:t.*   (Arabic)

               destroyed the-house

        c.   *Petit à petit, la montagne s'est détruite   laissant place à une plaine.*   (French)

               gradually,   the mountain SE.BE destroyed leaving place   to a   plain

        d.   *To paketo katastrafike   apo mono tu.*   (Greek, Alexiaodou et al 2015)

               the package destroyed.NACT by   self   his

        e.   *Všechny hračky se zničily.*   (Czech, Hron 2012)

               All   toys   SE destroyed

        f.   *A   termes el-puszt-ult.*   (Hungarian)

               The crops   PERF-destroy-UNACC.PAST

Language-specific gaps stem from two possible sources: (i) the lexicalization of the relevant verb is such that the verb has only a single diathesis, or (ii), the verb had both diatheses; one of which disappeared in an earlier stage of development of the language. Either way, the gaps are not attested crosslinguistically for obvious reasons. In the former case, a lexicalization pattern of a given language need not represent a general state of affairs. In the latter case, the gap is a historical accident. Therefore, unlike agentive verbs which systematically lack unaccusative alternates across languages, verbs of destruction do not behave on a par (see (7) above) and consequently do not constitute counterevidence to the claim made in (4).

Having set aside independent factors such as the EAR, subject-object interdependencies and language-specific gaps, we are prepared to investigate the research question: what is the connection

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[2] The verbs in (7) are often ambiguous between a passive and an unaccusative. They may be disambiguated by context and by diagnostics such as "by itself", see section 3.1 for further discussion.

between COS interpretation and the availability of the alternation itself? In section 3, I offer a semantic solution.

This rest of the empirical section is divided into two principal parts. The first part presents empirical evidence reinforcing the claim that lack of a COS interpretation blocks the alternation (section 2.2); diagnostics for identification of COS are also provided (section 2.3). I address only verbs which I found to have consistent distributional behavior in Hebrew, English, French and Russian. The second part of the section discusses the theoretical implications of the evidence (section 2.4).

2.2 Evidence for COS involvement in the alternation

2.2.1 Non-alternating transitives

Many transitives do not exclusively select agents as external arguments, allowing for a variety of thematic choices: agents, causes, instruments and sometimes eventualities. At the same time they do not show a corresponding intransitive.

I present below such transitives falling into four classes whose common semantic denominator is that their direct object is interpreted as not undergoing COS, and that their subjects allow at least agents and causes. The evidence supports the hypothesis that a lack of COS entails a lack of alternation (since the lack of alternation cannot be attributed to the External Argument Restriction). At the moment, it suffices to compare the interpretation of the objects in these sets of verbs to the objects of the verbs traditionally referred to in linguistic literature as change-of-state verbs (e.g. *break*, *melt* or *open*); COS semantics will be defined rigorously in section 3. An excursion into the semantics of the cause role also follows in sections 2.4 and 3.

This first large class of *verbs of positioning with respect to stationary objects* consists of many smaller subclasses. A list of representative verbs is found below:

(8)   **Stationary object verbs:**

verbs of crossing*: cross, traverse, reach, enter…*

verbs of surface contact: *touch, hit, support, strike, carry…[3]*

verbs of attack and defend: *attack, defend, protect, secure…*

others: *encircle, frame, surround, isolate…*

The lack of alternation is attested crosslinguistically. Some examples in English have already been provided in (3). Below are other selected examples from English, Hebrew and French:

(9)   a.   The armies / the water / the walls surrounded the city.

        b.   *The city surrounded.

        c.   John / the disease attacked David.

        d.   *David attacked. (intended: he became attacked)

        e.   John / the storm / the arrow struck the bird.

        f.   *The bird struck. (intended: it became struck)

(10)   a.   ha-cva'ot / ha-mayim / ha-xomot hekifu et ha-ir.   (Hebrew)

                the-armies/ the water / the walls surrounded the-city

                'The armies / the water / the walls surrounded the city.'

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[3] The observation that verbs of surface contact do not alternate dates back to Fillmore (1970). Here I exclude strictly agentive verbs, in order to control for the EAR (see (2)).

b.   *ha-ir nikfa/hitnakfa.[4]

the-city surrounded

c.   Dan takaf   / ha-maxala takfa   et David.

Dan attacked / the-disease attacked (FEM)   David.

'Dan / the disease attacked David'

d.   *David nitkaf/hittakef

David attacked

e.   dan / ha-sufa   / ha-xec   paga/pag?a   ba-cipor.

dan / the storm / the arrow struck.MASC/struck.FEM in-the-bird

'Dan / the storm / the arrow struck the bird.'

f.   *ha-cipor nifge?a/hitpag?a[5]

the-bird attacked

(11)   a.   les armées / l'eau   / les murs a(ont)   entouré   la ville.   (French)

The armies / the water / the walls has (PL)   surrounded the city

'The armies / the water / the walls surrounded the city.'

b.   *la ville s'est entourée.[6]

the city se is surrounded.

c.   Jean / la maladie a   attaqué David.

Jean / the disease has attacked David

'Jean / the disease attacked David'

d.   *David s'est attaqué[6]

David se is attacked.

e.   Jean / la tempête / la flèche a frappé   l'oiseau.

Jean / the storm / the arrow has struck the-bird

'Jean / the storm / the arrow struck the bird.'

f.   *L'oiseau s'est frappé.[6]

The bird se is struck

At this stage, it must be mentioned that for *surround*, a COS implicature is derivable for some speakers. Consider the sentence *the water surrounded the city*. A scenario in which the state of the city has changed is conceivable (say, the city may be flooded or become inaccessible). However, this interpretation is a defeasible implicature: another scenario can be constructed in which a lowland city is unperturbed as it is prepared for repeated floods. Moreover, a different choice of objects, as in *the water surrounded the small stone*, favors a lack of COS interpretation. These judgments show us that in order to speak meaningfully

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[4] Unaccusatives in Hebrew appear canonically in two binyanim: *nif'al* and *hitpa'el*, thus they have two possible morphological realizations.

[5] A passive reading exists: *ha-cipor nifge?a al-yedey ha-xec* 'the bird was struck by the arrow'. See section 3.1 for more information about disambiguating passives and unaccusatives.

[6] A reflexive, but not unaccusative, reading is possible: *la ville s'est entourée d'un rempart* 'the city has surrounded itself with a rampart'. The same hold true for (11d,f).

and in a falfisiable fashion about COS, we must commit ourselves to a truth-conditional analysis of COS, which is done in section 3 below. I return to the *surround* example in section 3.4.2.

In light of the above, examples (9)-(11) above show that, crosslinguistically, transitives denoting an event in which a stationary direct object undergoes no obligatory change in its properties or state, do not exhibit the alternation.[7]

Another set of transitives that denote no COS in their direct object is the class of *verbs of description*. Similarly to the group of stationary object verbs, their external argument is not exclusively an agent:

(12)   **verbs of description***: describe, represent, demonstrate, illustrate, spell out, mark, indicate…*

The lack of alternation is attested crosslinguistically. Examples from English, Hebrew and French follow:

(13)   a.   John / the war / the unjust taxes represented our weakness.

        b.   *Our weakness represented.

        c.   John / the war / the declining sales demonstrated the problem.

        d.   *The problem demonstrated.

        e.   John / the forest clearing / the map indicated the spot.

        f.   *The spot indicated.

(14)   a.   Dina / ha-milxama/ ha-misim ha-lo codkim yicga/yicgu   et xulšatenu.

              Dina/the-war   /the-taxes the-not unjust represented.FEM/represented.PL weakness-ours

              'Dina / the war / the unjust taxes represented our weakness.'

        b.   * xulšatenu nicga/hityacga.

              Weakness-ours represented

        c.   Dina / ha-milxama / ha-mexirot ha-conxot hidgima/hidgimu   et ha-be'aya.

              Dina / the-war / the-sales the-declining represented.FEM/represented.PL the-problem

              'Dina / the war / the declining sales demonstrated the problem.'

        d.   *ha-be'aya nidgema/hitdagma.

              The-problem demonstrated

        e.   dan / karaxat ha-ya'ar / ha-mapa ciyen(a) et ha-nekuda.

              Dan / clearing-PSS the-forest / the map indicated the-spot

              John / the forest clearing / the map indicated the spot.

        f.   *ha-nekuda nicyena/hictayena.

              The-spot indicated

(15)   a.   Jean /la guerre /les taxes injustes a(ont) représenté notre faiblesse.

              Jean /the war /the taxes unjust has (PL) represented our weakness

              'Jean / the war / the unjust taxes represented our weakness.'

        b.   *Notre faiblesse s'est représentée.

              Our weakness se is represented

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[7] The examples throughout this section are all transitives, as evidenced by the possibility of passivization: *the city was surrounded by walls, he was attacked by the disease*, *the bird was struck by the arrow*, etc.

    c.   Jean / la guerre / la baisse des ventes a(ont) démontré   le problème

            Jean / the war / the decline of sales has(PL) demonstrated the problem

            'John / the war / the declining sales demonstrated the problem.'

    d.   *Le problème s'est démontré.

            The-problem se is demonstrated

    e.   Jean / la clairière de la forêt / la carte   a   indiqué le point.

            Dan / the clearing of the forest / the map has indicated the-spot

            John / the forest clearing / the map indicated the spot.

    f.   *Le point s'est indiqué.

            The-spot se is indicated

Concluding, the examples above show that crosslinguistically, transitive verbs of description whose direct object undergoes no obligatory change in its properties or state, do not exhibit the alternation.

Similarly to the two previous sets of transitives, *verbs of guarantee and violation* denote no COS in their direct object.

(16)   **Verbs of guarantee and violation:** *guarantee, justify, warrant, ensure, encourage, discourage, challenge, confirm, corroborate, disprove, refute, violate, contradict…*

The lack of alternation is attested crosslinguistically. I continue to provide examples from English, Hebrew and French.

(17)   a.   John / the river / the infrastructure guaranteed fresh water.

        b.   *Fresh water guaranteed.

        c.   John / the river / the infrastructure encouraged rapid growth.

        d.   *Rapid growth encouraged.

        e.   John / the discoveries / the video contradicted the claim.

        f.   *The claim contradicted.

(18)   a.   dan / ha-nahar / ha-taštit   hivti'ax/hivtixa   mayim triyim.

            Dan / the-river / the-infrastructure guaranteed.MASC/guaranteed.FEM water fresh(PL)

            'John / the river / the infrastructure guaranteed fresh water.'

        b.   *mayim triyim nivtexu/hitbatxu.

            water fresh(PL) guaranteed

        c.   dan / ha-nahar / ha-taštit   oded/odeda   gidul mahir.

            dan / the-river / the-infrastructure   encouraged.MASC/encouraged.FEM growth fast

            'John / the river / the infrastructure encouraged rapid growth.'

        d.   *gidul mahir ne'odad/hi'toded.

            growth fast encouraged

        e.   dan / ha-tagli'ot /   ha-video satar/satru   et ha-ta'ana.

            Dan / the-discoveries / the-video contradicted.MASC/contradicted.PL the-claim

            'John / the discoveries / the video contradicted the claim.'

f.   *ha-ta'ana nistera[8] / histatera.

the-claim contradicted

(19) a.   Jean / le fleuve / de l'infrastructure a garanti   d'eau douce.

Jean / the river / the infrastructure has guaranteed water fresh

'Jean / the river / the infrastructure guaranteed fresh water.'

b.   *De l'eau douce s'est garantie.

water fresh se is guaranteed

c.   Jean / le fleuve / de l'infrastructure a   encouragé   croissance rapide.

Jean / the river / the infrastructure has encouraged   growth   rapid

'John / the river / the infrastructure encouraged rapid growth.'

d.   *croissance rapide s'est encouragée.

growth rapid se is encouraged

e.   Jean / les découvertes / la vidéo a(ont)   contredit   l'allégation.

Dan / the discoveries / the video has(PL) contradicted the claim

'John / the discoveries / the video contradicted the claim.'

f.   * l'allégation s'est contredite.

the-claim se is contradicted

Recapitulating, the data presented in (17)-(19) patterns with the previous sets of transitives lacking COS interpretation in their direct object.

Similarly to the three previous sets of transitives, I present below verbs which I have not classified in a specific semantic group, sharing with the verbs discussed previously the characteristics of non-agentive uses as well as a lack of COS in their direct object. The same pattern is observed for these verbs, as in (21)-(23):

(20)   **Other non-COS verbs:** *demand, require, regulate, risk, endanger, commemorate…*

(21) a.   John / the task / the machine required our collaboration.

b.   *Our collaboration required.

c.   The passenger / the sally / the damaged wheels risked the airplane.

d.   *The airplane risked.

e.   John / the celebrations / the plaque commemorated the battle.

f.   *The battle commemorated.

(22) a.   dan / ha-mesima / ha-mexona daraš/ darša   et šituf   ha-pe'ula šelanu.

Dan / the-task /   the-machine required.MASC/required.FEM share-POSS the-action ours

'Dan / the task / the machine required our collaboration.'

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[8] A passive reading exists: *ha-ta'ana nistera (al yadey ha-ed)* 'the claim was contradicted (by the witness)'. The verb *nistar* is incompatible with 'by-itself' modification: **ha-ta'ana nistera me-acma* 'the claim contradicted by itself' (for more information about the 'by-itself' test and forms ambiguous between passives and unaccusatives, see section 3.1).

b. *šituf ha-pe'ula šelanu nidraš/hitdareš.[9]

share-POSS the-action ours required

c. ha-nosa'at / ha-gixa / ha-galgalim ha-pgui'm sikna/siknu et ha-matos.

the-passenger / the-sally /the-wheels the-damaged risked.FEM/risked.PL the-airplane

'The passenger / the sally / the damaged wheels risked the airplane.'

d. *ha-matos niskan/histaken.

the-airplane risked

e. dan / ha-xagigot / ha-šelet hinci'ax/hincixu et ha-krav.

Dan / the-celebrations / the-plaque commemorated.MASC/PLU the-battle

'Dan / the celebrations / the plaque commemorated the battle.'

f. *ha-krav nincax/hitnace'ax.

the-battle commemorated

(23) a. Jean / la tâche / la machine a exigé notre collaboration.

Jean / the task / the-machine required our collaboration

'Dan / the task / the machine required our collaboration.'

b. *Notre collaboration s'est exigée.

our collaboration required

c. Le passager / la sortie / les roues endommagées a(ont) risqué l'avion.

the-passenger / the-sally /the-wheels damaged has (PL) risked the-airplane

'The passenger / the sally / the damaged wheels risked the airplane.'

d. *L'avion s'est risqué.

the airplane risked

e. Jean / les célébrations / la plaque a (ont) commémoré la bataille.

Jean / the celebrations / the plaque has (PL) commemorated the battle

'Jean / the celebrations / the plaque commemorated the battle.'

f. *La bataille s'est commémorée.

The battle commemorated

Recapitulating, I have presented a considerable number of non-alternating transitive verbs (listed in (24), whose external role is underspecified) which share a semantic determinant: their direct object does not undergo COS.

(24) **non-alternating transitives**: *cross, traverse, reach, touch, hit, support, strike, carry, attack, defend, protect, secure, encircle, frame, surround, isolate, describe, represent, demonstrate, illustrate, spell out, mark, indicate, guarantee, justify, warrant, ensure, encourage, discourage, challenge, confirm, corroborate, disprove, refute, violate, contradict, demand, require, regulate, risk, endanger, commemorate…*

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[9] *nidraš* has a passive reading only, and is incompatible with 'by-itself' modification: **šituf ha-pe'ula šelanu nidraš me-acmo* 'our collaboration required by itself' (for more information about the 'by-itself' test and disambiguating passives from unaccusatives, see section 3.1).

At this point, the reader may ask whether there could be another independent common denominator to all these sets which is not a lack of COS in the direct object: perhaps an aspectual facet? Indeed, there is some correlation with stativity. In their non-agentive uses, many verbs may have a stative interpretation: *the walls protected the city, the river guaranteed fresh water* or *the map indicated the spot.* However, this tendency cannot define the set of non-alternating transitives, since other members of the set do allow eventive interpretation in their non-agentive uses: *the hurricane crossed the Atlantic Ocean, the stone hit the window*, *the stream carried the detritus*, *the smoke entered the room* and so forth. It emerges that the restriction involved here does not depend on the compositional aspectual behavior of the entire predicate – the properties of the internal argument are sufficient to predict the pattern. The generalization here brings to mind Jaeggli's (1986) affectedness constraint:

(25)   Affectedness Constraint (Jaeggli (1986))

        If a complement of x is unaffected, it is impossible to eliminate the external theta role.

Originally, the constraint was formulated to capture the set of verbs disallowing NP-preposing in passive nominals. It is often also associated with the study of middles (Roberts 1987; Fellbaum & Zribi-Hertz 1989; Fagan 1992; Hoekstra & Roberts 1993, among others). According to Jaeggli, a relation between an affected complement and its predicate is always 'well defined', by virtue of being independent of the relation holding between the predicate and its external argument. By his account, such a 'well-defined' relation is absent when unaffected objects are involved. Unfortunately, it is not formally clear what 'well-defined relation' here means. In section 3 I show exactly what the nature of this relation is, and why it motivates the witnessed behavior.

2.2.2 Non-Alternating unaccusatives

A mirror-image to non-alternating transitives, non-alternating unaccusatives also exist. As expected under my hypothesis, they are characterized by a lack of COS. The first class in this set is *verbs of existence* (see Levin & Rappaport-Hovav 1995:148-151 for unaccusativity diagnostics). Below is a table of crosslinguistic verbs of existence (in table (i) below), as well as select examples in English (in (23)) demonstrating that these verbs do not have transitive alternates:

Table (i): Verbs of existence cross-linguistically

	English	Hebrew	Spanish	Italian	French	Russian
(a)	exist	kayam	Existir	esistere	exister	sushhestvovat'
(b)	dwell live reside	šaha gar hitgorer	Vivir	vivere abitare	vivre habiter	zhit' prozhivat' obitat'
(c)	live	xay	Vivir	vivere	vivre	zhit'
(d)	wait	xika himtin	Esperar	attendere	attendre	zhdat' ozhidat'
(e)	survive	sarad	sobrevivir	sopravvivere	survivre	vyzhit' ucelet'

(26)   a.   The solution exists.

        b.   *John exists the solution.

        c.   John waited (for an hour).

        d.   *Mary / the rain waited John (for an hour).

        e.   The archaeological findings survived.

        f.   *Luck survived the archaeological findings.

Thus, the behavior of existence verbs corroborates that claim that only COS verbs may participate in the alternation.[10]

A second class of unaccusatives which do not denote COS are *verbs of measurement*. Verbs such as *cost, weigh, last* and *measure* do not show causative alternates and do not passivize. Below are examples from English (the same holds in Hebrew and French):

(27)   a.   The present cost ten dollars.[11]

           b.   *John / *the expenses / *the wrapping cost the present ten dollars.

           c.   The box weighed five kilograms.

           d.   *John / *the mass / *the machine weighed the box five kilograms.

           e.   The movie lasted two hours.

           f.   *John / *the screening / *the TV lasted the movie two hours.

The examples above show that measure verbs pattern with existence verbs with respect to the (un)availability of the causative.

A third class of non-alternating unaccusative is the one of *spatial configuration verbs (*in a "simple location" sense). Verbs such as *sit, stand* and *lie* have a range of meanings associated with them. Languages diverge with respect to the morphological realizations of those different meanings. What will be relevant here is the meaning of 'simple position', in which the unaccusative verb is predicated of inanimates and describes their location (e.g. *The statue stood in the corner*, see Hoekstra & Mulder 1990; Levin & Rappaport-Hovav 1995). Under that interpretation, verbs of spatial configuration pattern with verbs of existence and verbs of measurement: they do not have COS interpretation and lack causative alternates. What makes the class unique is the availability of agentive transitives (beyond the scope of the paper) which pattern neither morphologically nor thematically with canonical causatives (for a full discussion, see Levin & Rappaport-Hovav 1995:128-130). Below are examples from English (adapted from L&RH 1995:129, the same data are repeated in Hebrew and French):

(28)   a.   The statue stood in the corner.

           b.   John / *gravity / *the lever stood the statue in the corner.

           c.   The books sat on the table.

            d.   John / *gravity / *the box (*sat)/set the books on the table.

           e.   The dress lay on the bed.

           f.   John / *gravity / *the hanger (*lay)/laid the dress on the bed.

The examples above show that spatial configuration verbs in a simple position sense pattern with measure verbs and existence verbs with respect to the availability of the causative. Concluding, non-alternating unaccusatives (existence verbs, measure verbs and spatial configuration verbs) reinforce the hypothesis that a lack of COS blocks the alternation.

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[10] It seems that at least some of these verbs are dyadic and include a spatio-temporal argument (e.g. *live*, see also Levin & Rappaport-Hovav 1995). The assumption that some dyadic verbs do not alternate for independent reasons does not detract from the line of inquiry that for each of the instances where no change of state is involved, there is consistent lack of alternation (other dyadic unaccusatives in Hebrew, such as *barax* 'escape', or *hitxolel* 'occur', *do* show causative alternates). I motivate the presence of the spatio-temporal PP in section 3.4.

[11] Measure phrases (MP) are not referential arguments. They cannot be used with quantifiers or with pronouns: *the present costs (*every/any) ten dollars/(*it)*. MP also cannot be extracted from wh-islands (see Rizzi 1990). Further evidence for unaccusativity of measure verbs (apart from lack of passives) is left for future research.

2.2.3 *Fill* verbs

A third phenomenon providing relevant evidence is the situation where both alternates exist, but only under certain entailments. Verbs such as *fill, cover* or *obstruct*, in their transitive use, show two readings: an eventive reading, where the direct object undergoes COS, and a stative reading, where it does not. The intransitive counterpart of these verbs allows only a COS interpretation, thus lacking the stative reading, as shown in (29) below. Note that both transitive readings are causatives. That is, the water caused the pool to fill (eventive) or to be full (stative).

(29)   a.   The water filled the pool. (water level increased / is constant)

           b.   The pool filled (with water). (water level increased / * is constant)

           c.   The sand filled the hole. (the quantity of sand increased / is constant)

           d.   The hole filled (with sand). (the quantity of sand increased / *is constant)

           e.   *ha-šeleg   kisa et   ha-arec*. (Hebrew)

                  the-snow covered the-earth

                  The snow covered the earth. (snow level increased / is constant)

           f.   *ha-arec hitkasta   be-seleg*.

                  the-earth covered (intr) in-snow

                  The earth covered with snow. (snow level increased /*is constant)

The examples in (29) provide additional indication that the alternation requires COS of the direct object. Otherwise, the unavailability of the intransitive stative reading is unexpected.

2.2.4 *Bloom* verbs

Additional reinforcement is provided by the intransitive mirror image of *fill* verbs, namely, verbs which show two intransitive uses. There is only a single transitive use: the one corresponding to a COS interpretation in the direct object.

       Verbs such as *bloom, blossom, rot*, *erode* and *decay* have been labeled as verbs of internal COS. A subset of internal COS verbs, such as *bloom, sprout, flower* or *grow* also has a mode-of-being sense which describes a certain state of existence (Levin 1993:250-251). The transitive (where it exists) corresponds only to the COS reading (see also McKoon & Macfarland 2000, Wright 2002, Rappaport Hovav 2014):

(30)   a. The cactus blossomed (for two days). (the cactus changed / was in blossom)

           b. Bright sun blossomed the cactus. (the cactus changed / *was in blossom)

           c. The corn grew in the fields. (the corn changed / was ripe)

           d. The hot sun grew the corn in the fields (the corn changed /*was ripe)

In each of the intransitive sentences in (30), the subject may be interpreted as being a certain state for the lifespan of the verb - an interpretation which is blocked in the transitive alternate.

2.2.5 Interim Summary

I hypothesized that the common denominator for all the sets of verbs which disallow the alternation is a lack of a COS interpretation for the internal argument. The verb sets are:

    (i)   Causative verbs that lack an unaccusative alternate. These transitives are not exclusively agentive. They share the characteristic of having an object which lacks a COS reading (section 2.2.1).

    (ii) Unaccusative verbs that lack a causative alternate. These unaccusatives share the characteristic of a subject which lacks COS reading (section 2.2.2).

(iii) Alternating verbs in which the causative has two readings but the unaccusative shows only the COS reading (section 2.2.3).

(iv) Alternating verbs in which the unaccusative has two readings but the causative shows only the COS reading (section 2.2.4).

Thus, the alternation obeys the following generalization, ((4) repeated):

(31) **The COS constraint:**

No COS → No causative-unaccusative alternation.

Before discussing the theoretical significance of my findings, I conclude the empirical section by providing a few diagnostics detecting a COS interpretation or its absence.

2.3 Diagnostics for detecting COS

Although my analysis of COS (to be presented in section 3) differs from the traditional approach, it is fruitful to observe some canonical entailments in order to better understand the nature of the phenomenon. If so, COS was traditionally formulated as entailing a result state ψ, which obtains for participant x as a result of predicate φ being true (dating back to Wright 1968; Lakoff 1970; Dowty 1979). Hence, if *φ, but not ψ* is a contradiction, COS has occurred (for instance, by employing past participles, e.g. #*John cleaned the house but it is not cleaned*). Beavers (2011) proposes a general test which abstracts away from concrete ψs: if *but nothing is different about x* is a contradiction, then a COS in some property of x took place. For instance (examples taken from Beavers 2011):

(32) a. John just painted the bedroom, #but nothing is different about it.

      b. John just carved the wood into a toy, #but nothing is different about it.

What is it about the word *different* used here that licenses COS? Beavers (2011) answers that "Intuitively, *something is different about X* only picks out properties that can be observed by looking at X itself". Therefore, *different* in this context means that two observable states of the object in time are unequal. As such, it suffices to speak of different states (or different observations) of the object, not necessarily of result states. To further advance this observation, recall that there are (atelic) COS verbs which do not entail result states (e.g. *widen, cool…*). The end state is not the semantic determinant involved in the test.

2.3.1 Successive object modifications test

I wish to add two of my own tests to the family of *φ, but not ψ* COS entailment tests. Keeping in mind that COS may minimally be achieved by requiring two different states in time, let us assume that an object is in a certain original state at a given time t_1. The object transitioned later to a different state at t_2. Therefore, as of time t_2, another hypothetical change of the object from the original state to the newer state is contradictory, because the object is no longer in its original state. To flesh it out, consider a context where John wishes to perform a certain action on an object. To his annoyance, Mary has preceded him and performed the same action (expressed by the same verb) on the same object. Although Mary just did it, John is determined to carry out his plan nonetheless. Now, if the object has a certain state with respect to this verb which has changed, John's actions would lead to a contradiction.[12] By contrast, if the object has no state with respect to the verb, or a state which has not changed, John's actions are licit. Consider the following examples:

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[12] If one accommodates the context described above, then it follows that there is a presupposition of a counter-directional change which reverts the object to its original state, under the condition that the change is reversible. For instance, for *John opened the door (too) right after Mary had done it* to be acceptable, it follows that the door reverted from an open state to a closed state, after Mary opened it and before John opened it again (see Fabricius-Hansen 2001; Horvath & Siloni 2011a).

(33)   Non COS verbs

        a. John crossed the road (too) right after Mary had done it / right after it had been crossed.

        b. John touched Ed's cheek (too) right after Mary had done it.

        c. John described the sea (too) right after Mary had done it.

        d. John guaranteed the wares (too) right after Mary had done it.

        e. The French army surrounded the city right after the British one had done it.

        f. John demanded the (too) right after Mary had done it.

        g. John supported the old woman (too) right after Mary had done it.

        h. John contradicted Ed (too) right after Mary had done it.

(34)   COS verbs

        a. *John broke the window (too) right after Mary had done it / right after it had been broken.

        b. *John emptied the pool (too) right after Mary had done it.

        c. *John killed the woman (too) right after Mary had done it.

        d. *John opened the door (too) right after Mary had done it.

        e. *John froze the water (too) right after Mary had done it.

        f. *John melted the ice (too) right after Mary had done it.[13]

        g. *John heated the soup (too) right after Mary had done did it.

        h. *John moved the stone (too) right after Mary had done it.

The reader is welcome to verify that all non-alternating transitives in section 2.3.1 (from which the examples in (33) are taken) are noncontradictory in the test's environment. As such, the test reinforces the intuition that these verbs do not denote COS. By contrast, the examples in (34), alternating verbs, are contradictory; corroborating the claim that they involve COS. The test does not discriminate alternating verbs from non-alternating ones. Rather, it allows distinguishing COS verbs, alternating and non-alternating alike, from non-COS verbs, which are uniformly non-alternating, according to the constraint.

      Lastly, the test does not detect COS in periodic verbs, which allow the original and last states to be identical: *rotate, turn, spin (*i.e. the last orientation may be the original one, although it changes in course of the event). Their detection failure is fully expected due to the rationale of the test: it is based on the assumption that the desired state is different from the original one. However, the next test is suited for periodic verbs.

2.3.2 Simultaneous object modifications test

Similarly to the previous test, let us assume an object is in a certain state at time t_1. Two independent, simultaneous actions denoted by a given verb are performed on this object; each is directed at transitioning the object to some new state independently of the other action. If the result is contradictory, it means that the object has two distinguishable states at the same time. Hence, the presence of states is detected by the

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[13] (34f), (34g) and (34h) denote atelic COS verbs. They are acceptable only under the reading in which John continues the action on the object from the state where Mary left off; i.e. from a changed state (but possibly a non-final state, since the verb is atelic). In (34f), John melts the parts of ice which have not yet been melted, in (34g), John heats the soup from an intermediate temperature, in (34h) John moves the stone from its intermediate location. In each of these sentences, a reading where John operates on the original state of the object (e.g. location/temperature) is contradictory. (e.g. *#John moved the stone from the mountaintop (too) right after Mary had done it*). Here, change-of-location verbs pattern together with canonical COS verbs (see also footnote 18).

test. Consider a context where John and Mary are competitors and they are given a task to perform a certain action on the same object at the same time. Mary has managed to fully accomplish the task by herself, while John was not as successful. Now, if the result is contradictory, it means that each person transits the object to a distinct state (i.e. Mary, but not John, reached the result state), hence the test detects the presence of states. Alternatively, if the object has no state with respect to the verb, or has a state which has not changed, competitive simultaneous actions are licit. Consider the examples below:

(35)   Non COS verbs

a. They crossed the road at the same time; John crossed it only halfway when Mary finished...

b. John and Mary caressed David's cheek at the same time; John barely touched it when Mary finished…

c. They secured the castle at the same time; John was only halfway securing it when Mary finished...

d. They described the book; John was only halfway describing it when Mary finished…

e. They demanded the sugar; John was only halfway demanding it when Mary finished…

Compare with COS-verbs below, which are ungrammatical in the test's environment. Recall that the context is that John and Mary are competitors; their actions are simultaneous and take the same time on the same object. Mary has managed to fully accomplish the task by herself (each example below has a slightly different continuation, depending upon the less-than-maximal degree value obtained by John).

(36)   COS verbs

a. *They opened the door at the same time; John opened it only halfway when Mary finished... / * was only halfway opening it...

b. *They froze the water; John froze only half of it when Mary finished...

c. * They heated the soup; John heated it only two degrees when Mary finished …[14]

d. * They moved the stone; John moved it only two meters when Mary finished …

e. *They spun the top; John spun it only half circle when Mary finished …

Once more, the reader is welcome to verify that non-alternating transitives in section 2.2.1 (from which the examples in (35) are taken) are felicitous in the test's environment. As such, the test reinforces the intuition that these verbs do not denote COS. By contrast, the examples in (36), alternating verbs, are unacceptable, corroborating the claim that they involve COS. However, this test is less general than the previous one, because it requires that the object be able to transit to at least two different states (gradable verbs); if John and Mary operate on the same object but their actions may only lead to the one common (final) state, the test is inapplicable as we cannot create a potential contradiction. Hence, the simultaneous object modifications diagnostic is not suited to test predicates with binary states such *kill* or *break* (e.g. *John killed David to a lesser degree than Mary*. Levin & Rappaport-Hovav 2010 call these two-point scales); for these verbs, the successive object modifications test still applies. The simultaneous modification test however is able to cover periodic verbs (see (36e)).

A possible objection arises regarding *roll*-verbs: Schäfer (2012) argues that *roll* verbs do not express COS in their basic use. According to Schäfer, cause subjects (e.g. *the wind* in (37) below) are licensed in the presence of a COS interpretation. Since *roll* allegedly does not denote COS in its basic use, (37a) is ungrammatical. Once a directional PP is added, COS interpretation arises and cause subjects are thus licensed ((37b), example taken from Schäfer 2012):

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[14] I assume a contextually specified result state/degree for open-scale atelic verbs. Let us say, in (36c), John and Mary had to bring the soup to 50 degrees; which Mary did by herself. It cannot be that John brought it to 40 degrees at the same time. In (36d), John and Mary had to move the stone 10 meters, which Mary did by herself. It cannot be that John moved it 2 meters at the same time.

(37)   a. *The wind rolled the ball.

        b. The wind rolled the ball across the goal line.

Thus, examples such as (37a) apparently challenge my claim that these are COS verbs. However, upon closer scrutiny, it turns out that causative uses of *roll* verbs naturally appear without a directional PP, hence it does not follow that they lack COS in the absence of the PP. Below are examples from naturally occurring data for *move*, *roll*, *swing*, *spin* and *rotate* (google):

(38)   a. The breeze moved the branches of the trees.

        b. The blast rolled the truck several times.

        c. If the wind swung the door very hard, chances are you may also have loosened nuts on the door hinge.

        d. We observed, as the wind spun the pinwheels we made.

        e. Sometimes the wind rotated the antenna slightly, throwing off the signal and making the picture fuzzy or blurred.

In light of the above, the claim that *roll* verbs express COS of their objects (e.g, a change of location) in their basic use is maintained, in line with the results of the simultaneous object modification test.

        Summarizing, I presented two tools to distinguish between COS and non-COS sets of verbs: the successive and simultaneous object modifications tests demonstrate the different truth conditions of these sets. As such, there are good reasons to believe that the COS / non-COS distinctions are linguistically relevant. Observe that the relevant distribution does not correspond to the telic/atelic distinction (i.e. both telic *break* and atelic *cool* are COS verbs).

        The data I have provided so far were not couched in terms of any theoretical framework. Let me now elaborate on the consequences of my findings on existing theoretical frameworks.

2.4 Theoretical Implications

An important correlation has been noted between the thematic distribution of the external argument and the transitive-unaccusative alternation: when the alternation is manifested, the external argument enjoys a wide thematic range (agents, natural forces, instruments, and sometimes eventualities), but when the thematic choice of external arguments is limited to agents, the alternation vanishes. This observation provided motivation for researchers to posit semantic inventories which differentiate between agents and (underspecified) causes. For instance, Reinhart (2002; forthcoming) introduces [+c] and [+c +m] theta clusters representing causes and agents, respectively, whereas Pylkkänen (2008), Folli & Harley (2005) and Embick (2004), among others, distinguish between v_{do} (or v_{agent}) and v_{cause} heads.

        This distinction, by itself, is not enough to predict the alternation. As previously shown (section 2.2.1), the subjects of many transitives show thematic underspecification, allowing for at least agents and causes, yet they do not alternate. Hence, theories must introduce a semantic inventory and appropriate rules which will predict the available syntactic realizations.

        In principle, there is a possibility to assume that the subject of a non-alternating transitive does not correspond to a cause role (or its linguistic equivalent in various theories), but to some new linguistic entity which differs from both causes and agents. Namely, to argue that for these verbs, the subject is not interpreted as causing the event. I will not adopt this view because there is no independent empirical evidence that the underspecified role of the non-alternating verbs and that of the alternating verbs differ.

        It is a better theoretical practice to treat the subjects in both alternating and non-alternating transitives as causes. There are good reasons to believe that the subjects of both sets do share causal semantics which entail their external merging: a counterfactual analysis of causation (see also Lewis 1973, Dowty 1979) can account for these verbs. The truth conditional analysis of causation as a counterfactual relation follows in section 3.3. As an interim discussion, let us elaborate on the causative interpretation of some non-alternating transitives discussed above (section 2.2.1).

In *John/the walls protected the city, John* or *the walls* are interpreted as causally responsible for the protection of the city, because the predicate expresses a counterfactual dependence on them; i.e, if *John* or *the walls* had not played 'their part', *the city* would not have been protected. The other way around is not true: *John* or *the walls* do not counterfactually depend on *the city*. (see also 'maintenance verbs' in Neeleman & van de Koot 2012). The same holds true, for instance, for *John crossed the desert (by walking), the celebrations commemorated the battle* or *the river guaranteed fresh water*. In these sentences, the crossing event counterfactually depends on John's walking, the commemoration event counterfactually depends on the celebrations, and the guaranteeing event counterfactually depends on the river (respectively), but not vice versa (i.e, it is true that if there had been no river, there would have been no guaranteeing event, but it is not true that if there had been no guaranteeing event, there would have been no river).

In light of the above, I leave the causative treatment of the external argument of non-alternating verbs intact. Causation and change of states are two independent notions. They do interact in a specific way which will be explained below. In order to do that, I now turn to developing a rigorous analysis of the COS constraint. What, precisely, is a state of an object? What are its semantic consequences? The next section is dedicated to the task of defining the relevant notions and deriving the corresponding linguistic behavior.

3 What is COS?

3.1 Intrinsicity

The first step toward formally defining states of objects is the intuition that the state of an object is fully determined by the object itself (at a certain time). Namely, the state of an object is a function of what has been labeled as its intrinsic properties. In what follows, I present a theory of Intrinsicity by Lewis (1986), upon which I proceed to define states in section 3.2.

Most approaches agree that the unaccusative verb is predicated of a single individual, its subject.[15] Schematically, the formula of the intransitive sentence is $\lambda x.P(x)$ and the controversial question is what captures the property P: does it include a COS ingredient or its equivalents (e.g. BECOME and/or CAUSE operators, see Dowty 1979;Parsons 1990; Chierchia 2004, or FIENT head, Embick 2004). Let us ignore for the moment the various suggestions as to the precise content of P, and focus on the shared denominator: no other individuals are included in P.

Therefore, the subject, x, has at least one property which must be compatible with the restrictions of the verb, P, since it is true that P(x). For example, for the sentences *the vase broke* and *the soup cooled,* the subjects have the properties of being solid and having temperature, respectively (hence, #*the oil broke* and #*the noise cooled* are infelicitous because their subjects do not have the relevant properties). As such, with respect to the domain of individuals, an unaccusative is predicated of its subject alone. This is the main difference between unaccusatives and passives, as seen below:

(39)   a.   *The window broke by John.

        b.   The window was broken by John.

The example in (39b) is taken to support the claim that the passive existentially closes a distinct external argument, which remains a part of the verb's representation. (39a), on the other hand, does not include a distinct external argument. The "by itself" diagnostic also differentiates between unaccusatives and passives:

(40)   a.   The window broke by itself.

        b.   *The window was broken by itself.

The incompatibility of the passive with "by-itself" modification, (40b), clearly shows it to include a distinct argument in its semantic representation (since "by itself" denies a CAUSE role that is not identical to the

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[15] However, according to Levin & Rappaport-Hovav 1995: the argument participating in the causing event is lexically bound and appears in the semantic representation of an unaccusative verb.

antecedent of "itself". See Levin & Rappaport Hovav 1995, Chierchia 2004, Horvath & Siloni 2013). By contrast, the unaccusative is compatible with "by-itself" modification (40a), and thus does not have a-priori to include an additional distinct argument in its semantic representation. Whether there actually is another argument in the representation is a matter of debate (see Chierchia 2004, Koontz-Garboden 2009 and Beavers & Koontz-Garboden 2012 for arguments in favor of including CAUSE role as a part of the unaccusative structure, and Horvath & Siloni 2011b for the opposite view). A different branch of theories (Alexiadou et al 2006, Pylkkänen 2008 for some languages) argues for the presence of a CAUSE event. I hold here the null hypothesis that there is no other argument in the representation. Below, I also provide new evidence arguing for the lack of an additional argument.

As such, we understand that the subject of the unaccusative verb has an autonomous property (with respect to the eventuality denoted by the verb): it is not evaluated relatively to other individuals. I call it here *intrinsic property* (following Lewis 1986; Lewis & Langton 1998). From a philosophy of the mind viewpoint, Lewis argues that intrinsic properties of objects are purely by virtue of the ways objects are: mass, shape, having five fingers. On the other hand, *relational properties* of objects are the opposite of intrinsic properties: they obligatorily depend on other objects in the world: being a brother, thinking of Paris, being next to John.[16]

(41)   Intrinsicity

a. Intrinsic properties of an object d do not depend on objects other than d. More formally,

b. Being F is an intrinsic property if and only if, necessarily, anything that is F is F in virtue of the way it itself, and nothing wholly distinct from it, is.
(x is wholly distinct from y if and only if x has no common part with y).

If an object has a property intrinsically, then it has it independently of the way the rest of the world is. The rest of the world could disappear, and the object might still have that property. Lewis (following Kim 1982) supplies several philosophical criteria for establishing a property as intrinsic, one of which suffices for linguistic purposes: a property P is intrinsic if it is possible for a lonely object to have it. A lonely object is defined to co-exist only with its proper parts, and no accompanying objects.

Indeed, the verbs of the sentences *the window broke* or *the soup cooled* denote intrinsic properties because they entail that there is a past time in which a lonely window or a lonely soup had the property of being broken (along with its proper parts) or being cool, without any reference to other individuals. By contrast, *the road crossed, *the book read* or *the plank carried* are ungrammatical because *cross, read* and *carry* do not denote intrinsic properties. I suggest they do not give rise to an intransitive verb as this is possible only when the property denoted by the intransitive is intrinsic. The hypothetical intransitive version of *cross, read* or *carry* would entail there being a past time in which a lonely road, a lonely book or a lonely plank had the property of being crossed, being read or being carried, respectively, without any reference to other individuals, which is impossible in the way we perceive the world.

At this point, one understands that the distinction between intrinsic and relational properties is driven by our perception of relations, but not by mathematical necessity.[17] If any property could have been perceived to be intrinsic or to have an intrinsic equivalent, then we would have expected to find for every transitive verb an intransitive alternate which denotes the intrinsic property, contrary to fact. Mathematically speaking, however, it is possible to treat functions with multiple arguments as a composition of functions with lesser arity (by partial function application).

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[16] There are several views regarding the distinction between intrinsic and non-intrinsic properties; here I restrict myself to using relational properties as the negation of intrinsic properties, which I find sufficient to characterize the relevant linguistic phenomena.

[17] A similar argument is found in Levin & Rappaport Hovav 1995:95, regarding internally/externally caused events: "The distinction between internally and externally caused eventualities is a distinction in the way events are conceptualized and does not necessarily correspond to any real difference in the type of events found in the world". That said, Intrinsicity is independent of the internal/external causation distinction.

On the other hand, to expect that our perception of relations deterministically yields the same sets of relational and intransitive verbs for all languages would be vastly overoptimistic, since lexicalization patterns enjoy some degree of freedom (which may be organized in a principled way). Admittedly, there is a flavor of circular reasoning here: the (un)availability of an intransitive in a given language encourages the speaker to perceive the relevant property as intrinsic or as relational (i.e, the weaker Sapir-Whorf hypothesis, see Whorf 1940). The above does not mean that lexicalization is arbitrary: *open*, *melt* and *break* show stable appearance in the intransitive set of verbs crosslinguistically, whereas *cross*, *read* and *carry* show stable absence from it. Some properties are compatible with being perceived as either relational or intrinsic, yielding different lexicalizations. For instance, *protect* has an unaccusative alternate in Hungarian, but for native speakers of languages that lack it, the idea of an object being protected without any reference to other individuals triggers some mental resistance. The factors governing the cognitive biases towards perceiving properties as intrinsic or relational are unfortunately beyond the scope of this paper and are left for future research.

The "lonely object" test is further argument in favor of the null hypothesis (see also Horvath & Siloni 2011b) that unaccusatives denote intrinsic properties and do not include an additional distinct individual in their representation:

(42)   **Intrinsicity of unaccusatives**

        Unaccusatives denote intrinsic properties (of their subjects)

The above excludes unaccusatives from denoting relational properties because a related distinct subject would have to participate in the semantic representation of the unaccusative, contrary to fact. Unergatives, which are also semantically intransitive verbs, are intrinsic as well. I will however withhold their discussion until section 3.4.3 which compares them with unaccusatives.

3.2. States of objects

3.2.1 A short introduction to states

We have seen that a COS interpretation is necessary for the availability of the alternation, but the notion of "state" itself relied, so far, on intuitive judgments. I now proceed to formally define states of objects and changes of states of objects. My goal is to derive the following relation between states and causation:

(43)   Lemma: Interaction of states and causation (to be modified later)
        if an event (denoted by an intransitive verb) depends only on (i.e, a function of) the states of its argument, d, then causation of that event entails COS of d.

As will be discussed subsequently (section 3.4), we will understand that causation, in the general case, does not entail COS (for instance, causing someone to drink does not entail that he did not drink previously, nor does it entail a change in his properties). This is expected because causation and states of objects are two independent linguistic entities. They may, however, co-appear. In such a case, their semantic interaction, which follows naturally from my account, yields the COS constraint. Hence, the fact that unaccusatives show the COS constraint strengthens their analysis as intransitives which depend only on (i.e. a function of) the states of their argument.

Intuitively speaking, a state (to be defined formally in section 3.2.2 below) is a "snapshot" of an object at a certain time. The snapshot is a list of pairs of intrinsic properties and their values, which describe the object at that time. According to the definitions of Intrinsicity in section 3.1, these properties depend only on the object itself. A graphic illustration of a state would be something like figure (i):

Figure (i): a state of a ball

The most important thing to understand about states is that they may be *compared*. Hence, not every intrinsic property is qualified to be a part of the list of properties in a state. The ability to compare states requires that for two given values of the same property, we can decide whether they are either the same value or two different ones (the object is not required to receive every possible value of the property). Slightly more formally, a property in the state of the object represents some scale (e.g. weight, location, color, animacy, and so forth).[18] The function which projects the argument along the appropriate scale is called a measure function and the value of that property along the scale is called a degree. A state ("a snapshot"), then, is a list of the results of measurements of intrinsic properties of the object.

  Change of State (COS) in an object exists if the object is in two different states at two different times, i.e. if the measurements along some relevant scale are not the same at two different times. Below is a figure showing that a ball dropped from height of 4 units to height of 2 units, at three times.

Figure (ii): Change of State in a ball (at three consecutive times).
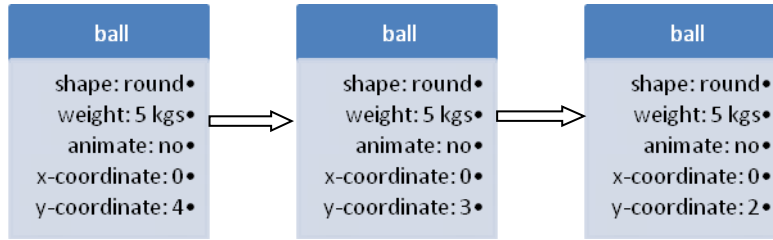
In what follows I formalize what has been argued now.

3.2.2 States and Scales

In order to define states of objects, I use mathematical entities called scales. Following Hay, Kennedy, & Levin (1999), Kennedy & McNally (2005), Levin & Rappaport Hovav (2010) , Beavers (2008; 2011; 2013, see also Deo et al 2013) and Landman (p.c) I adopt here a model of change along a nominal/categorical scale. A scale $\mathbb{S}$ is a triple $<S, R_\mathbb{S}, \mu_\mathbb{S}>$ where:

(44) a. S = a set of degrees for having property δ, where δ is some intrinsic property/dimension (e.g. height, length, temperature, position). Intrinsicity is defined as in section 3.1.

   b. $R_\mathbb{S}$ = an inequality relation between members of S.

   c. $\mu_\mathbb{S}$ is a measure function. $\mu_\mathbb{S}$ is a partial function from objects, worlds and times to values in S. $\mu_\mathbb{S} : D \times W \times T \rightarrow S$ (D is the domain of objects, W is the domain of worlds, T is the domain of times).

For instance, scale $\mathbb{S}$ may be "height-in-inches". In that case, $\mu_\mathbb{S}$ assigns to objects their height-in-inches. The specific units are unimportant; what is relevant here is that there is a function from objects to values on the scale. We write $\mu_{s,w,t}(d)=s$, where d is an object and $s \in S$, the set of degrees. Also note that measurement is a function. Thus an object d at time t at world w cannot be mapped to more than one value.

  When an object changes in an intrinsic property δ (which has a scale $\mathbb{S}$ at a given world w), the object receives two different measurements: $\mu_{s,w,t1}(d) \neq \mu_{s,w,t2}(d)$. Namely, the object is mapped into two unequal degrees at two different times, $s_1 \neq s_2$. My model slightly deviates from common models (Hay, Kennedy, & Levin 1999, Kennedy & McNally 2005, Levin & Rappaport Hovav 2010) by relaxing the relation between the degrees. I leave open here the question whether the scale may be strengthened from a nominal scale to an ordinal scale by turning the inequality relation $R_\mathbb{S}$ into an ordering relation $<_\mathbb{S}$, since it

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[18] For the purposes of this chapter, I make no distinction between (scalar) properties of objects and locations of objects; I treat location as scalar property of physical objects (e.g. <x,y> coordinates or <radius, angle> coordinates relative to some arbitrary coordinate system). This decision is profitable since change-of-state and change-of-location pattern in object realizations in nearly identical ways (see also Tenny 1994; Levin & Rappaport Hovav 2010).

neither adds to nor detracts from my argument. I do not require measuring out of events (Tenny 1994) or telicity.

In order to define a state of an object, we need to determine what dimensions are relevant for it. Let Δ be a contextual dimension function which assigns to a property P an n-tuple of scales $\Delta_P = \langle \mathbb{S}_1, \mathbb{S}_2, \ldots , \mathbb{S}_n \rangle$ that are contextually relevant for the objects that fall under P. Let us also write Δ_P^i to be the i-th element of Δ_P. For instance, the property *being a ball*, in a given context, would involve the scales of weight, animacy, x-location, y-location, color, etc. Thus $\Delta_{(being\ a\ Ball)} = \langle$weight, animacy, x-location, y-location, color, ...$\rangle$ in some relevant context; $\Delta_P^1 =$ weight, $\Delta_P^2 =$ animacy, and so on.

Given this, we define a state function:

(45)   The state function

If P is a property, Δ_P a contextual dimension function, w a world, t a time, d an object such that <u>d has P in w at t</u>, then the state function is:

state $_{\Delta P,\ w,\ t}$ (d) = $\langle \mu_{\Delta P1,w,t}$ (d), $\mu_{\Delta P2,w,t}$ (d), $\ldots$, $\mu_{\Delta Pn,w,t}$ (d)$\rangle$

So, the state function maps an object d (relative to the dimensions in Δ_p) to its state: the tuple that consists of the measure values that the dimensional scales assign to d in w at t. In other words, the state of an object is a point in n-dimensional space of its relevant measurements.

Change of State (COS) in an object exists if the object is in two different states at two different times, i.e. if the measurements along some relevant scale are unequal at two different times. Since the measurements on each relevant scale stand in the inequality relation, the inequality relation extends to states too: two states (relative to the same ΔP) are unequal if there is at least one scale for which the measurements of the object are unequal (between the two states).

States of an object are based on its intrinsic properties by definition (see (44a), but can any intrinsic property serve as a basis to define object states? The answer is negative because not every intrinsic property is scalar. To understand why a scale (minimally a two-point categorial scale) is necessary for states of objects, reflect on the identification of a certain state of an object. We need, at least, to be able to contrast it with other states of the same object. There would be no sense in speaking about the different states the object may be in, if we cannot take two states at two times during the event and decide whether they are not the same state. In other words, to have a discernible state of an object we must also have the ability to determine whether two states are unequal (i.e., to determine whether two degrees s_1, s_2, along the relevant dimension, differ). For instance, consider *John worked, John worried* or *John washed.* Imagine a hypothetical state of John at t_1 that is based on the intrinsic property of *working*, *worrying* or *washing,* respectively. As the relevant event unfolds, what would John's new states be? It is impossible to answer this question (without strong context) because we do not know if John's state (while *working*, *worrying* or *washing*) in t_2 is different from his state at t_1. Worse, we do not know even if John's state at a given t_2 is necessarily identical to his state at t_1.[19] By contrast, in *the window broke, the stone fell* or *the door opened*, the verbs are committed to an inequality relation between states of their subjects (say, defined by number of pieces for *break*, by location along a given vertical axis for *fall*, and by the angle of the door for *open*). That is, states of objects must be based on scalar intrinsic properties. Nonscalar intrinsic properties cannot give rise to states.

To further establish the distinction, recall that the successive object modification test identifies COS because an object cannot usually be in the same state again once the state has changed. Applying the

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[19] It is possible to imagine contextual scales. For instance, the degree of *work* at t could be the amount of money paid for it, or the degree of *worry* at t could be the number of people offering you a hug. Hence, an inequality relation between degrees (and hereby, a scale) for *work* or *worry* is imaginable if a sufficiently strong context is supplied (Horn 1972; Gazdar 1979). Crucially, these scales are not lexically assigned at the level of the verb. That is, the meaning of the verb does not provide scalar structure. Nonetheless, it is possible to force a scalar structure compositionally. The relevant question is whether contextual scales pattern with verbal scales with respect to argument realization. I do not have the room to expand on this here, but see section 4.2 for implications for representations.

test to the 2-place, namely causative alternates of *work, worry wash*, *ring* and *gallop* the presence of states of their objects may not be inferred. Consider the contrast between (46) and (47):

(46)   a. *John broke the window (too) right after Mary had done it.[20]

           b. *John emptied the pool (too) right after Mary had done it.

           c. *John killed the woman (too) right after Mary had done it.

(47)   a. John worked Mary hard (too) right after David had done it.

           b. John worried Mary (too) right after David had done it.

           c. John washed Mary (too) right after David had done it.

           d. John rang the bells (too) right after David had done it.

           e. John galloped the horse (too) right after David had done it.

We have already taken the ungrammaticality of (46) as evidence that states (and changes of states) are entailed for *break, empty* and *kill*. By contrast, the grammaticality of (47) shows that the objects of the transitive alternates of *work, worry,* [21] *wash, ring* and *gallop* are insensitive to COS detection. That is, either the intrinsic properties denoted by the latter verbs, being nonscalar, do not entail states of the object, or that they entail that an unchanged state of the object holds. I reject here the notion that the verb entails that its object is in an unchanged state because it is derived trivially across the board for any agentive predicate: if John performs the activity of X, then John might be said to be in the "state" of X (replace X by *working, washing*, *worrying*, *running*, *laughing*. That is, John's state when the predicate holds true): nothing can be learned from such a superfluous line of inquiry as it has no predictive power. To clarify, it is true that the subject may be in some unchanged state during the event, but this state is *not* entailed by the verb. For instance, one might be tempted to propose that *gallop* entails animacy. Thus, *the horse* in the sentence *the horse galloped* has a constant state during the galloping event (e.g. <…, alive: yes, …>). However, *gallop* only presupposes animacy, as evidenced by the fact that animacy is preserved under negation, conditionals and questions:

(48)   a. The horse didn't gallop.[22]

           b. If the horse galloped, it is tired.

           c. Did the horse gallop?

Instead, if states of objects require scales, the consequent that the nonscalar verbs in (47) do not entail states of their objects naturally follows. I emphasize that I do not address here the sources of transitive-unergative alternation (see Horvath & Siloni 2011a). Rather, my purpose is to point out that verbs such as *worry*, *work, ring* and so on are not on a par with verbs such as *break, empty* and *kill* with respect to state detection (see (46)-(47)).

      To summarize, I define state of an object d in world w at time t to be a point in n-dimensional space of its relevant measurements: state $_{\Delta P, w, t}$ (d) = $<\mu_{\Delta P1,w,t}$ (d), $\mu_{\Delta P2,w,t}$ (d), … , $\mu_{\Delta Pn,w,t}$ (d)$>$.

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[20] A counterexample has been pointed out to me by Fred Landman: *John broke the fence after Mary had done it*. The sentence is felicitous because a fence can be broken in more than one place.

[21] Experiencers (e.g *worry*) are analyzed here as devoid of states. However, Martin & Schäfer (2013) show that there is a class of "defeasible causers" (including experiencers) in which the result state cannot be denied if the subject is a cause. Since the definition of states in Martin & Schäfer's work differs from mine, I leave integration of their data to a future research.

[22] Presuppositions can be cancelled when embedded under negation, conditionals and questions by direct denial of the presupposition. Unlike conversational implicatures, they cannot be cancelled when unembedded (e.g. as in *the horse galloped*, see also Gazdar 1979).

3.2.3 States and recoverability

Having defined states (of objects), let us consider the possible relations between states of objects and the events in which they participate. We can immediately define two disjoint classes of relevant events: (i) events which depend only on states of their objects, and (ii) other events: those which do not depend only on the states of their objects or those which do not depend on them at all. In what follows, my goal is to show that the former class is theoretically expected to show the COS constraint.

Consider the class of events which depend only on the states of their objects. By "depending only on states" I mean the following: it is enough to look only at the entailed states of the object during an event in order to judge whether it occurred. I name this property *recoverability* (of events from states of objects). For instance, *die* is recoverable from the states "alive" and 'dead" of the argument:[23] if the person is in state "alive" and then is in state "dead", we know *die* occurred, no matter the exact circumstances: whether the person passed away naturally, was murdered, or died in a freak accident. On the other hand, events such as *strangled* cannot be inferred from looking at the states "alive" or "dead" of the argument; they depend on more than these states (for instance, marks of the hands of a killer, or a rope, are required).[24] In the same vein, *move* events can be inferred from locations of the argument alone, but *run*, *walk*, or *crawl* cannot. Recoverability is defined as follows:

(49)   Event Recoverability

An event e occurring in a time interval $[t_1,t_n]$ is recoverable from the states of the argument if the ordered list of states in $[t_1,t_n]$ is sufficient to decide whether e occurred or did not occur.

It is easy to see that if event e is recoverable, it is exclusively a function of the states specified in the state function. If the truth conditions of e had depended on information orthogonal to these states, it would have been impossible to decide, based on them, whether e occurred or not. The list of states is ordered because the corresponding event time points are ordered and the states are a function of time (see (45)). t_1 and t_n are the first and last time points that are included in the event.

3.3 Causation as a counterfactual dependence

The last milestone before addressing the source of the COS constraint in the alternation is the definition of causation itself. I shall use the traditional model of causation as a counterfactual dependence between two events (Lewis 1973):[25]

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[23] I write the formal states <…, animacy: alive, …> and <…, animacy: not-alive, ….> as "alive" and "dead" for the sake of brevity.

[24] The claim that *strangle* cannot be recovered from any choice of states (of objects) is not made here. Indeed, I do believe that the claim is true, but it merits a discussion beyond the scope of the paper (as a preliminary step, note that the marks of a rope or of a killer are not intrinsic properties of the deceased and cannot be used to define its state). However, I do make here the claim that *strangle* cannot be recovered from the states "alive" and "dead", from which *die* is recoverable.

[25] It is known that a counterfactual model of causation does not work in the general case, due to problems of late/trumping preemption or double prevention (see Collins, Hall, & Paul 2004). Nonetheless, scenarios in which those problems arise require contextual information whose representation is uncalled for in the domain of argument realization. To see why it is so, consider a late preemption scenario (taken from Collins, Hall, & Paul 2004): Billy and Suzy both throw rocks at a bottle. Suzy's rock gets there first, hitting the bottle and breaking it. Billy's rock flies through the now empty space where the bottle was standing. The problem here is that the breaking of the bottle fails to counterfactually depend on either of the two throwing events. However, for this scenario to pose a problem for a counterfactual analysis of *break* in the domain of argument realization, the relevant representation would include, upon emergence of syntactic structure (assuming a classic Y-model of the grammar), not only the cause for the breaking event, but also the potential alternative cause and the order of competition between the two. Worse, the example above extends to include countably many potential breakers (all throwing rocks at the same time) who must be represented in the correct order of their competition. Undoubtedly one could construct these elaborate contexts, but to assume that such lists of fail-safe causes are represented at the level of the verb is

(50)   *Causation*: e_1 causes e_2 when both counterfactual conditions hold in the set of worlds participating in the cause relation: (Lewis 73)

a. For every world, if e_1 occurs, then e_2 occurs: $e_1 \Box\rightarrow e_2$.[26]

b. For every world, if e_1 had not occurred, e_2 would not have occurred either: $\neg e_1 \Box\rightarrow \neg e_2$.

With respect to (transitive) causatives, I assume neo-Davidsonian event semantics: I take e_2 to be the caused event associated with the object of the transitive and e_1 to be the causing event associated with its subject (Dowty 1979; Levin & Rappaport-Hovav 1995; Parsons 1990; Piñón 2001; Chierchia 2004). It is important to mention at this point that whether e_1 or e_2 are syntactically realized is a question orthogonal to the model. In *John broke the window,* e_1 may conveniently be taken as the subpart of John in *break*; e_2 may be taken as the window's subpart. e_1 and e_2 are entities in a semantic representation of the event and do not necessarily (though possibly) reflect equivalent detectable syntactic counterparts. For the sake of convenience, a formal representation (following Parsons (1990)) would be:

(51)   *break*: $\lambda x \lambda y \lambda e \lambda e_2 \exists e_1 [\text{CAUSE} (e_1, y) \wedge \text{CAUSED-EVENT}(e_2, e) \wedge \text{THEME}(e_2, x) \wedge e_1 \text{ causes } e_2]$

If the semantic representation is a part of lexical information about the event, there is no reason to assume strong compositionality (or even compositionality), because syntactic structure has not yet emerged (given a classic Y-model of the grammar). I take (51) to express the relations between events, sub-events and arguments. The expression is interpreted in a flat way; it does not reflect syntactic structure hierarchy. The question of which lexical information is mapped or realized in syntax concerns mapping systems, which are an independent topic in their own right.

3.4 Accounting for the COS constraint

3.4.1 Lack of causative alternates

Let us remind ourselves that I seek to prove the following claim ((43) repeated):

(52)   Lemma: Interaction of recoverable events and causation:
Assume an event e_2 (denoted by an intransitive verb) that is recoverable from the states of its argument, d.
For an event e with sub-events e_1 and e_2, such that e_1 causes e_2, e entails COS of d.

If lemma (52) is correct, given a causative alternate for an intransitive verb, and given that the event denoted by that intransitive is recoverable, it follows that the causative entails COS (since the complex causative event, e, is denoted by the causative verb). Below I present a formal derivation of the logic involved.

Consider an event e_2, which is recoverable from the states of its argument, d. Let us examine the states that d occupies during the course of event e_2, which occurs in some time interval $[t_1\ldots t_n]$. t_1, without loss of generality, is the first time point included in the event. There are two possibilities for d: either d occupies at least two different states at different time points during e_2, or d occupies a single state during e_2.

If d has different states at different time points during e_2, e_2 entails COS of d by definition. In more detail, states s_1 and s_2 of d exist during e_2. Let t_1 and t_2 be the time points during e_2 at which s_1 and s_2 hold, respectively (assume $t_1 < t_2$ without loss of generality). Then, d has changed state from s_1 to s_2 (recall that a state is a function of time, see (45)).

Given that e_2 occurs in $[t_1,t_n]$, then if an event e occurs (such that e_2 is caused sub-event, as in (52)), e trivially entails COS of d because the object changes state from s_1 (at t_1) to s_2 (at t_2) during the

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unwarranted. Such an assumption further predicts there are sentences such as **Suzy [conj] Billy broke the bottle* that describe the scenario above, contrary to facts.

[26] $e_1 \Box\rightarrow e_2$ is a counterfactual statement and means: "if e_1 were true, e_2 would be true". It is written in such a form in order to distinguish it from other kinds of conditional statements.

occurrence of e_2, as shown above. For instance, if a soup cools, causing it to cool also entails a change in its temperature.

Alternatively, the state of d is unchanged during e_2: d has the same state, s, for all time points of e_2. We assumed that e_2 is recoverable from s: if the argument d has the state s, then e_2 occurs. Now let us again examine an event e (such that e_2 is caused sub-event, as in (52)) and observe the state of d at the earliest moment, t_0, prior to the caused event, e_2. There are two options for the state of d at t_0: (a) d has a different state from s at t_0, call it s_0, or, (b) d has the state s at t_0. I show below that option (b) leads to a contradiction given some assumption about possible lexicalizations, and hence it follows that (a), d has different state from s at t_0.

Let us address the latter option, (b), first: d has the state s in t_0. Crucially, e_2 occurs at t_0 too by definition since it is recoverable from s. However, e_2 is not caused by the causing sub-event, e_1, at *that* time, because t_0 was defined to be the earliest moment prior to the caused event. We ask ourselves: for all causally related worlds in which the state of d is s at t_0, what could have been the state afterwards if e_1 had not occurred?

If the state would have remained s in every world, a contradiction to the definition of causation arises because the caused event e_2 occurs in every world in absence of the causing event e_1.[27] For example, John cannot be said to cause the door to be open if the door was already open and would still be open without John's actions; John cannot be said to cause Mary to die if she was previously dead, etc. In other words, the scenario of a constant state of the object before and during the caused event (across worlds) is inconsistent with the notion of causation.

Therefore, if d has the state s at t_0, it follows that the state of d after t_0 must be different than s in some counterfactual world, in which COS has taken place. The event e entails therefore COS of d in the counterfactual world and a prevention, or a negation, of COS of d (henceforth NCOS) in the actual world, since the state of d remains unchanged in the actual world.

It turns out that, empirically speaking, NCOS verbs are quite rare whereas COS verbs are very common. We do not have a productive set of verbs that mean *not-break*, *not-melt*, *not-open*, etc. Why would it be the case? From the perspective of the set of causally related worlds, there is no difference between COS in one world or in another. I propose here a cognitive bias: the lexicalization of NCOS is blocked because it leads to evaluation of double negation. Recall that causation involves evaluating an unreal conditional: if e_1 causes e_2, then if e_1 hadn't occurred, neither would have e_2 (see (50)). In the unfortunate case where e_2 is itself a negation of a COS event in the actual world, we need to consider an unreal conditional for a negation of an event. If e_1 hadn't occurred, then the negation of e_2 would have not occurred either. Lexicalization of such a hypothetical causative is simply too cognitively demanding.

Given that the caused event, e_2, (that is denoted by some intransitive verb) cannot be grasped as expressing a negation of COS in the general case due to lexicalization factors, then the state of d after t_0 remains s in every causally-related world, and hence contradiction to the definition of causation arises, as explained above.

Therefore, option (b), d has the state s at t_0, leads us to a contradiction. We must revert to the former option (a): d has a different state from s, call it s_0, at t_0. This option directly means that e, the event that contains the caused event e_2 as a sub-event, entails COS of d. In more detail, d has changed state from s_0 at t_0 to s at any time point in e_2, and without the loss of generality, at the first time point t_1.[28] In simple words, the crux of the derivation is this: one cannot cause an object to occupy a state it occupies anyway. Thus, even if a recoverable event lacks, of itself, a COS interpretation, causation of that event entails COS nonetheless. The reasoning may almost sound trivial, but the formal derivation of the constraint crucially hinges on the presence of states and on the relation between the verbal event and the states of the object. If no states are present, or the event is not recoverable from the states of the argument, then causation is *not* restricted in the same way, and the lemma does not hold.

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[27] I assume non-reduced causality: events are not necessary. It is not necessary that e_2 happens after t_0. For instance, if a vase broke, it is not necessary that it had to break in all causally related worlds.

[28] In this case, the interval in which COS occurs is not contained in e_2. S_0 is a state which obtains at a time point outside the boundaries of (i.e, before) e_2.

3.4.2 Lack of intransitive alternates

Before I advance to the fully-fledged COS constraint immediately below (section 3.4.3), let us examine whether causatives without intransitive alternates pose a problem for my account. Can there be a corresponding intransitive for a causative whose direct object has a single unchanged state during the course of the event, such that the event denoted by the intransitive is recoverable from that state? The answer is negative: the existence of such intransitive would violate lemma (52). To demonstrate it, consider, as a mental exercise, the contrast in meaning between *break* and a hypothetical verb *HIT*. Suppose *HIT* is taken to refer to the same scale as *break*, but minimally differs from it in the number of states the object occupies during the event. *Break* entails that the object has at least two states in different time points, whereas HIT entails that the object has just one state for all time points of the event. *The window HIT* means that the window is in one piece during the event. *John HIT the window* would mean that John caused the window to be in one piece. This is a contradiction because the window is in one piece even if John would not have done anything (barring contextual information, not at the level of argument realization, see footnote 19). This is not to say that there cannot be a verb such as *HIT* (which mean something like "be intact"). Rather, if a causative alternate exists for that verb, then that causative must have a COS interpretation.

What does the actual verb *hit* mean then? Does the fact that it does not have an intransitive alternate show us that it is not a causative verb? Lemma (52) places a constraint on causatives of intransitives which correspond to recoverable events, but the lemma does not constrain causatives across the board: there is no guarantee that there is a recoverable event from the states of the object of *hit*. Recall that for an event e to be causative, we require sub-events e_1 and e_2 such that e_1 causes e_2. Unlike COS verbs, the caused event in *hit*, e_2, is not an intransitive event but e itself: the hitting of the window by the external argument. In other words, *hit* is a relational verb: one cannot imagine the window being hit without the hitter.[29] This is perfectly expected because I have just shown above that *hit* cannot alternate with an intransitive verb which is recoverable from the states of its object.

Consider this point in more depth. What does it mean that there is no such intransitive? Since states are generated by a certain choice of relevant intrinsic (scalar) properties, it means that one cannot find any intrinsic property of the object of *hit* such that the event of hitting can be recovered from states buildings on that intrinsic property (e.g. color, location, temperature, width, opacity…). To flesh it out, let us return to the relational verbs presented in section 2.2.1 (e.g. *support, cross, surround…*). It is possible to define states of their objects as we please, but crucially, for *any* choice of states, the event cannot be recovered from them:

(53)   a.   The armies / the water / the walls surrounded the city.

      b.   John / the hurricane / the ship crossed the ocean.

      c.   John / the river / the infrastructure guaranteed fresh water.

In other words, since the verb does not project the direct object on a scale, the events of surrounding, crossing or guaranteeing cannot be recovered from the state of the city, the ocean, or the fresh water in (53) above. Hence, the result that these causatives do not have corresponding intransitive alternates (which correspond to recoverable events) is fully expected.

3.4.3 A wider view and the relation to mapping

In light of the above, analyzing events denoted by unaccusatives as recoverable from the states of their argument gives us the consequent (via the lemma) that the corresponding causative verbs must have COS interpretation in their objects.

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[29] Identifying the caused sub-event, e_2 with the complex causative event is consistent, because the causative event, e, is not the causing sub-event, e_1, nor does e cause e_2 (i.e itself).

However, the possibility of a stative unaccusative, and a corresponding causative that productively adds a COS component to its direct object is theoretically viable. Yet, the data does not manifest it. In order to arrive from the lemma obtained above to the COS constraint a single assumption must be added to my account: the entailments of the internal argument are invariant under the alternation.

If the causative productively adds a new COS interpretation to the internal argument, then the argument undergoes a certain sequence of states in the causative and a different one in the unaccusative: the entailments involving the same argument are quite different. I therefore assume that the alternation keeps the entailments of the internal argument intact. Why it should be a property of a verbal alternation is a question which I will not explore here (it follows from neo-Davidsonian semantics, but also from decausativization approaches). I do not have, at present, a theoretical motivation for it, but the same result surfaces in most argument realization theories and educates us about the nature of verbal alternations.

Now, if the causative entails COS in its direct object (lemma (52)), the unaccusative also entails COS in its subject (since entailments are preserved). The option, that the unaccusative does not entail COS but the causative does, is thus ruled out (unless the unaccusative has both COS and non-COS interpretations). Formally:

(54)   **The COS constraint**

No COS → No causative-unaccusative alternation.

Identifying unaccusatives with the class of verbs which correspond to events that are recoverable from the states of their argument explains not only the COS property of the causative-unaccusative alternation, but also why existence verbs, measure verbs and spatial configuration verbs map their arguments internally: these non-alternating unaccusatives describe an unchanged state of their object (i.e. the measure function is constant). Knowing the relevant state allows us to judge that the corresponding event indeed occurred. For instance, existence verbs (section 2.2.2) map their argument into the state where the relevant measurement is specified in spatio-temporal coordinates of their subject (often expressed in a PP). Measure verbs map their argument into the state where the relevant measurement is specified in the measure phrase. Spatial configuration verbs, in their simple location sense, map their argument into the state where the relevant measurement is specified in the locative PP. *Fill*-verbs map their internal argument into the state(s) where the relevant measurement(s) are specified by the degree to which the argument is filled, etc. States are entailed for the arguments of these verbs: we have inequality relations between different spatio-temporal locations, between different weights, between different degrees of fullness, and so forth.

Hence, the hypothesis that the property of being recoverable from states (scalar measurements) of the subject is a defining property of unaccusativity has merits. Levin & Rappaport Hovav (2010) suggest a related line of thought in which many unaccusatives show scalar structure.

4 Summary

4.1 Revisiting the main points

Fillmore (1970) first showed that surface contact verbs such as *hit* do not show the causative-unaccusative alternation. This paper expands upon the set of non-alternating verbs addressed in current linguistic literature (Levin & Rappaport Hovav 1995, Beavers 2011, Rappaport Hovav & Levin 2014, Spalek 2014, among others). I offered some (typological) classification in the empirical part (section 2.2): *cross* verbs, *attack* verbs, *surround* verbs, *guarantee* verbs, *description* verbs, *fill* verbs, and many others (see (24) for a complete list). Intuitively, they all share the meaning of an object which does not change its state; this intuition may be probed by my COS detection tests presented in section 2.3. Moreover, it was shown that those causatives exemplify but one side of the coin. The other side consisted of unaccusatives which do not show causative alternates: *existence* verbs, *measure* verbs, spatial configuration verbs and so forth: all share the meaning of a subject which does not change its state. In light of the above, there is a generalization to be abstracted from the data:

(55)   **The COS constraint**

No COS → No causative-unaccusative alternation.

Naturally, a question springs to mind: why? What is the linguistic motivation for the constraint? Even if one accepts a shift from surface contact verbs to an abstract class, why would the unaccusative-causative alternation depend on such a pre-condition? Is this constraint arbitrarily fixed and the state of affairs could have been otherwise, and perhaps actually is otherwise in languages unexplored here? My belief is that in order to answer this question one must carefully examine what is being asserted in the generalization. Namely, one must explicitly define states and changes of states.

Under my account, the state of an argument in world w at time t is a point in n-dimensional space of its relevant measurements located along a scale generated by intrinsic properties of the argument (where Intrinsicity is defined by Lewis (1986): a property P is intrinsic if a lonely object can have P). A state function maps an object d (relative to contextually relevant dimensions) to its state: the tuple that consists of d and the measure values that the scales assign to d in w at t. State $_{\Delta P, w, t}$ (d) = <μ $_{\Delta P1,w,t}$ (d), μ $_{\Delta P2,w,t}$ (d), … , μ $_{\Delta Pn,w,t}$ (d)> (see section 3.2.2 for a full discussion). Since the measurements on each scale stand in the inequality relation, an inequality relation between states also follows.

In order to account for the constraint, two further definitions have been necessary: of recoverability and of causation. I define recoverability (of events from states of objects) such that, given states of an object in a given period of time, it is possible to decide whether an event occurred or did not occur. Recoverability means that the event denoted by the verb depends only on the states of the argument and on no other information (i.e. the event is exclusively a function of the argument's states). Lastly, I assume a standard analysis of causation à la Lewis (1973) as a counterfactual dependence between two events.

I have shown in section 3.4 how the COS constraint is formally derived from these definitions. In a nutshell, if an event can be recovered from the states of the object, the object cannot be caused to occupy the same states it would occupy anyhow (i.e. if the causing event has not occurred). Therefore, a COS interpretation is obligatory for a causative alternate. The above reasoning may almost sound trivial, but the formal derivation of the constraint crucially hinges on the presence of states and on the relation between the verbal event and the states of the object. If no states are present, causation is *not* restricted in the same way.

4.2 Open Issues

This paper serves as a point of departure point for a theory of states of objects, of the COS constraint and of unaccusativity itself. Any research is non-final by nature and (temporarily) unresolved issues surface. Addressing those issues takes us too far afield in the current scope. I mention below some of them in the hope that they are addressed in future research.

First, the factors governing the cognitive biases towards perceiving properties as intrinsic or relational require psycholinguistic and philosophical research. I assumed, based on Lewis's philosophical criterion (see section 3.1), that properties such as *break* and *melt* are conceived as intrinsic whereas properties such as *surround* and *carry* cannot be conceived as such. Undoubtedly, there are also borderline cases which can be construed as either intrinsic or relational in different languages. The organization of the conceptualization of properties is an independent fruitful topic.

Second, there is the issue of "mental states". I suggest that verbs depicting human emotions, perceptions and experiences do not involve scalar structure, because it is not clear how a set of comparable degrees can be defined for experiencer verbs (see discussion of *worry* around example (47)). Because the intransitive alternates of experiencer verbs are unegatives (Reinhart 2002, to appear), they do not directly fall under the present discussion. Nonetheless, Martin & Schäfer (2013) show cases in which a change in the experiencer is entailed (as in (56) below). The connection between these mental changes, so called "mental states", and states of objects as defined in the paper is yet to be explored.

(56)   Being chosen last insulted Mary, #but she didn't take it to heart at all.

Lastly, the paper does not address the issue of atemporal changes of state. I have tacitly taken the object to be a single, indivisible entity (an atom). For most verbs, this assumption is a satisfactory approximation, but clearly is a simplification; objects can be viewed as composite. I cannot do justice to the topic of objects as mereological sums and the consequences it bears on the definition of the state of an object. This is a vast topic in its own right (Krifka 1989, Rothstein 2001, among others). If the object is not an atom,

then an atemporal COS unaccusative, as well as a corresponding causative, are both possible (see (57) below). The present account needs to be generalized to include the treatment of composite objects.

(57)   a. The trail narrowed at the summit.

       c. The road widens between San Francisco and San Jose.   (Deo et al 2013)

       c. Santa Barbara has received so much rain this winter and spring that the upper part of the road is interrupted by a rock slide every few hundred meters and in between, an eruption of grasses and scrub oak narrows it to a single track.

       d. The current proposed design widens the street for three blocks in the Pioneer Square area. (Rappaport 2014)

4.3 Implications on representations

The account is based on semantic grounds alone: it does not necessitate syntactic information. Whether RESULT states of objects are grammatically realized (RESULT state, von Stechow 1996, Tenny & Pustejovsky 2000; Embick 2004; Beck 2005, Folli & Harley 2005; Ramchand 2008, Harley 2012, among others) is irrelevant for the present account.[30] I also remain silent on the issue of directionality of derivation. Whether the causative is derived from the unaccusative or vice versa, or whether both are derived from a common stem, is orthogonal to the paper: the semantic relations between the alternates are enough to predict the necessity of COS interpretation.

My account makes clear that it is perfectly possible to keep causation and alternation theoretically separable, without assuming pre-conditions on the alternation and without assuming specific (ad-hoc) syntactic structures for the participating alternates. Rather, given an event which can be recovered from the states (scalar measurements) of its argument, the semantic presence of causation inevitably leads to the COS constraint.

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[30] It is possible to postulate that the presence of states is determined by a RESULT state syntactic unit. I will not make this additional postulate because my argument minimally stands without making it. Quoting Beavers (2011): "*However, such approaches run the risk of circularity if the heads themselves are not also identifiable by independent semantic diagnostics; otherwise they are what Koenig and Davis (2006) call "syntactic diacritics"*". Furthemore, not every COS verb entails a RESULT state (e.g. *widen, cool, roll…*).

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