

# Instrument subjects without Instrument role

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## Abstract

Large-scale linguistic resources that provide relational information about predicates and their arguments are indispensable tools for a wide range of NLP applications, where the participants of a certain event expressed by a predicate need to be detected. In particular, hand-annotated corpora combining semantic and syntactic information constitute the backbone for the development of probabilistic models that automatically identify the semantic relationships conveyed by sentential constituents in text, as in the case of Semantic Role Labeling (Gildea and Jurafsky, 2002). Even if attempts of standardization of semantic role annotations are being developed (cf. the LIRICS project, Petukhova and Bunt 2008), controversial points are still present. In this paper we examine a problematic semantic role, the Instrument role, which presents differences in definition and causes problems of attribution. Particularly, it is not clear whether to assign this role to inanimate entities occurring as subjects or not. This problem is especially relevant 1- because of its treatment in practical annotation and semantic role labeling, 2- because it affects the whole definition of semantic roles. We propose that inanimate nouns denoting instruments in subject positions are not instantiations of the Instrument role, but are Cause, Agent or Theme. Ambiguities in the annotation of these cases are due to confusion between semantic roles and ontological types associated with event participants.

## 1 Introduction

Semantically annotated resources have become widely used and requested in the field of Natural Language Processing, growing as a productive research area. This trend can be confirmed by looking at the repeated attempts in the implementation of annotated resources (FrameNet - Fillmore et al. 2002, VerbNet - Kipper-Schuler 2005, Propbank - Palmer et al. 2005, SALSA - Burchardt et al. 2006) and in the task of automatic Semantic Role Labeling (Gildea and Jurafsky 2002, Surdeanu et al. 2007, Màrquez et al. 2008, Lang and Lapata 2010, Titov and Klementiev 2012 among others).

Since their first introduction by Fillmore (1967), semantic roles have been described and defined in many different ways, with different sets and different level of granularity - from macro-roles (Dowty 1991) to frame-specific ones (Fillmore et al. 2002). In order to reach a common standard in terms of number and definition, the LIRICS (Linguistic Infrastructure for Interoperable Resources and Systems) project has recently evaluated several approaches for semantic role annotation and proposed an ISO (International Organization for Standardization) ratified standard (ISO 2013).

In this paper we examine a problematic issue in semantic role attribution. We focus on a single role, the Instrument role, whose definition and designation should be, in our opinion, reconsidered. The topic is particularly relevant since its treatment in different lexical resources is not homogeneous and the theoretical debate is still lively. Moreover, this issue highlights aspects of the nature of semantic roles, relevant both for their theoretical definition and for practical annotation, such as the difference between semantic roles and ontological types. The former refer to the role of participants in the particular event described by the linguistic expression, the latter to the inherent properties of the entities. We argue that despite the availability of different sets of tags for roles and types in lexical resources such as Framenet and VerbNet, roles (Instruments in particular) and types are still often confused.

## 2 Background

The analysis arises from the enrichment of the *Senso Comune* knowledge base of the Italian language (henceforth SC) (Vetere et al. 2012) with semantic role sets for predicates, to be used for linguistic research and NLP applications. In SC semantic roles sets are not assigned to predicate structures axiomatically but they are induced by the annotation of the usage examples associated with the *sensi fondamentali* (word meanings which are predominant in terms of use among the most frequent 2000 words in the language, cf. De Mauro, 1999) of the verb lemmas. The target corpus consists of about 8000 usage examples. Up to now we annotated about 6 % of the entire corpus in a pilot experiment we performed to release the beta version of the annotation scheme (details in Ježek et al. 2014). The methodology encompasses annotation of the role played by participants in the event described by the predicate (intentional agent, affected entity, created entity and so on) as well as annotation of their inherent semantic properties, expressed in the form of ontological categories (person, substance, artifact, and so forth) organized in a taxonomy. The dataset we focus here was composed of 66 examples without disambiguation, 3 each for 22 target verbs, and it was annotated for semantic roles by 8 annotators. Annotators were instructed with a guideline in which a set of 24 coarse-grained (high level) roles was defined, with examples and a taxonomy, based on LIRICS (Petukhova and Bunt 2008) and subsequent related work (Bonial et al. 2011 a, b). In designing the set, some LIRICS roles such as Agent and Partner (Co-Agent in VerbNet) were conflated, and some classical semantic roles like Experiencer rather than LIRICS’s ambiguous Pivot were used. The final set of roles for SC is given in Table 1, together with the mappings with the ISO roles of LIRICS.

<b>SensoComune role</b>	<b>LIRICS role</b>
Agente (AG)	Agent, Partner
Causa (CAUSE)	Cause, Reason
Strumento (INSTR)	Instrument, Means
Paziente (PT)	Patient
Tema (TH)	Theme, Pivot
Goal (GOAL)	Goal
Beneficiario (BEN)	Beneficiary
Origine (SOURCE)	Source
Luogo (LOC)	Location, Setting
LuogoFinale (ENDLOC)	EndLocation
LuogoIniziale (INITLOC)	InitialLocation
Percorso (PATH)	Path
Distanza (DIST)	Distance
Tempo (TIME)	Time
TempoFinale (ENDTIME)	EndTime
TempoIniziale (INITTIME)	InitialTime
Durata (DUR)	Duration
Risultato (RESULT)	Result
Quantità (AMOUNT)	Amount
Maniera (MANNER)	Manner, Medium
Esperiente (EXP)	Pivot, Patient
Scopo (PURPOSE)	Purpose
Frequenza (FREQ)	Frequency
Attributo (ATTR)	Attribute

Table 1: Semantic roles set

As referenced above, each role in SC is defined by a gloss and a set of examples, in the LIRICS style.

During the evaluation process, the major cases of disagreement were highlighted. The present study is based on the evidence coming from these data; the Instrument role caused several misunderstandings (see also Varvara 2013). Nevertheless, our analysis will look primarily at examples from literature and other resources in order to rethink this role and to reach a standardization. We propose to consider what are called instrument subjects (Alexiadou and Schäfer 2006) as instances of three different roles, namely

Cause, Agent and Theme, rather than as Instrument. In the following, we first define instrument subjects (section 2) and highlight the problems that arise in the assignment of the Instrument role to these cases (section 3), then we provide examples and arguments that support our proposal (section 3.1-3.3). We conclude by highlighting the mutual dependence between theoretical analysis and practical annotation.

### 3 The case of instrument subjects

With “instrument subjects” we refer to examples in which a noun, denoting an inanimate entity frequently used as instrument by humans (and occurring in *with*-phrases), is the subject of the sentence, as in the examples below (Levin 1993:80, Schlesinger 1989:189):

- (1) “**The hammer** broke the window.”
- (2) “**The stick** hit the horse.”

It has been frequently asserted that these subjects cover the role of Instrument (Fillmore 1967, Nilsen 1973, Dowty 1991), similarly to the nouns preceded by the preposition *with* in (3) and (4); in Levin (1993)’s terms, these are called “Instrument-Subject alternation”<sup>1</sup>.

- (3) “David broke the window **with a hammer**.”
- (4) “Marvin hit the horse **with a stick**.”

Several authors have argued against the interpretation of Instrument subjects as Instrument roles, suggesting other roles to these cases (Schlesinger 1989, DeLancey 1991, Van Valin and Wilkins 1996, Alexiadou and Schäfer 2006, Grimm 2013, among others). Their basic claim is that the class of instrument subjects does not correspond to the class of instruments occurring in *with*-phrases. Nevertheless, also in the implementation of lexical resources the trend is still to consider instrument subjects as instances of the Instrument role. In Verbnets, for example, instrument subjects are tagged with the role Instrument, as can be seen in the annotation of the verb *hit*:

- (5) “**The stick** hit the fence.”
- (6) “**The hammer** hit the window to pieces.”
- (7) “**The stick** hit the door open”.

In the LIRICS guidelines (Schiffrin and Bunt 2007:38) the Instrument-Subject alternation is used as exemplification of the definition of the Instrument role: “He opened the door [with the key (Instrument)]”; “[The brick (Instrument)] hit the window and shattered it.” The reason of the annotation of these last examples is not clear if we look at the role definition (as annotators usually do). In the guidelines, the Instrument is defined as the “participant in an event that is manipulated by an agent, and with which an intentional act is performed” (2007:38). In the definition, the agent and the intentionality of the act are explicitly mentioned, but while annotating examples such as the ones above a question arises: in order to tag a noun phrase with the role Instrument, should the Agent be linguistically expressed, could it be just inferable or even totally absent?

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<sup>1</sup>The term “instrument subject” is used by many to cover also other Levin’s alternations, such as Characteristic property alternation (1993:39) or Middle alternation (1993:26). Even the examples that will be a matter of discussion in the present study can be ascribed to different alternations. We will then use the term “instrument subject” in a broad sense, taking into account every noun that can occur both in a *with*-phrase and in subject position. Even if this term may cause confusion with the true semantic role Instrument, we will adopt it because of lack of other appropriate terms. To avoid difficulties, we will use the capital initial letter for semantic roles and the lower initial for the words used in their common sense (e.g. Agent vs agent).

## 4 Why instrument subjects do not perform the Instrument role

Nowadays it is a shared opinion that semantic roles are relational notions that express the role of participants in the event expressed by the verb. As pointed out by Pethukova and Bunt (2008), semantic roles should be defined not as primitives “but rather as relational notions that link participants to an event, and describe the way the participant is involved in an event, rather than by internal properties”(2008:40). We follow this line of reasoning but in addition, we claim that semantic roles should be considered as qualities attributed to participants considering their role not only in the particular event, but more specifically in the way the event is encoded syntactically and semantically in the language. Particularly, we claim that in order to assign the Instrument role, an Agent should not only be present in the event in the world, but it should be specified in the event representation reported by the predicate and be linguistically expressed. We argue that in the presence of instrument subjects, this condition is not satisfied. There is not another participant expressed as playing the Agent role; and even if an Agent is not expressed but inferrable from the previous context, the instrument subject does not play the Instrument role. In linguistic expressions with instrument subjects, it is clear that there are reasons for which speakers left the intentional Agent out of the scope of their utterance. Their intention could be to describe the instrument noun as an autonomous entity, as the only known source of causation, not as an Instrument manipulated by an Agent, and as such its role in the event should be considered.

Consider again the following example of Instrument-Subject alternation, in the light of what we just said: “The janitor opened the lock *with a key*” and “*The key* opened the lock”. As referenced above, it is frequently asserted that the arguments in italics express the same semantic roles in both sentences. “The underlying argument is that since “*the key*” in 19 (the first example) is an Instrument, and since 19 and 20 could refer to the same scenario, “*the key*” must be Instrument in 20 (the second example) as well” (DeLancey 1991:348). In line with Delancey, we argue that this is an unfounded idea. The same event can be the object of two different sentences that represent the event from different perspectives and the instrumental noun can not stand in both contexts as Instrument role. In the words of DeLancey (1991:350): “case roles, like any other semantic categories, encode construals of events rather than objective facts”. We believe that, looking at corpus data, it appears clearly that subjects like “the key” are not usually represented as an instrument used by a human, but as a Cause that substitutes for an unknown Agent in the causal chain (as in the previous example) or as an entity (a Theme) whose characteristic is described (e.g. the property of opening a lock in an example such as “This key opens the lock”). As referenced in the Introduction, our proposal is that instrument subjects usually cover the role of Cause, Theme or, metaphorically or metonymically, Agent. In the next sections, we will list and group into classes the occurrences of instrument subjects that we have encountered in our data, according to our proposal.

### 4.1 Instrument subject as Cause

Most frequently instrument subjects cover the role of Cause<sup>2</sup>. It is usually the case when: 1- it is not possible to find an Agent or general causer other than the instrument inanimate subject; 2- it is possible to imagine an Agent that has “activated” the inanimate entity, but it is no longer present in the scene or it is not known. This could be a choice of the speaker that does not want to include or talk about the Agent or it could be the case with generic events with non specific agents. Consider the example:

(8) “**The clock** was ticking so loudly that it woke the baby” (DeLancey 1991: 347)

It is not possible to find another participant causing the event other than the clock. The same can be seen in this sentence taken from the corpus ItTenTen (Jakubček et al. 2013):

(9) “Un masso caduto da una galleria ha messo fuori uso la metro. **Il sasso** ha rotto il pantografo, l’antenna che trasmette l’energia al treno, e ha interrotto la tensione per 600 metri di linea aerea.”

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<sup>2</sup>The definition of the role Cause in SC is the following: “participant (animate or inanimate) in an event that starts the event, but does not act intentionally; it exists independently from the event”.

‘A stone falling down from a tunnel put the metro out of order. **The stone** has broken the pantograph, the spar that transmits the energy to the train, and it has interrupted the tension for 600 meters.’

The stone is a Cause because nobody has thrown it, but it has taken its own energy by its falling.<sup>3</sup> The same interpretation could be applicable to the sentence cited before from the LIRICS guidelines “The brick hit the window and shattered it”; from this context we do not know if there is an agent that has thrown the brick; if we do not have evidence about that, we cannot consider “the brick” an Instrument in this sentence.

There are cases in which our real-world knowledge enables us to understand that the instrument subject has been manipulated by somebody, but it has been focused on in the sentence as the principal or the only known element of the causal chain<sup>4</sup>:

(10) “**The poison** killed its victim.”

(11) “**The camomile** cured the patient”.

There is a case of this sort in the dataset of the SC’s annotation experiment. The subject of the sentence

(12) “**Leggi** che colpiscono il contrabbando.”

‘**Laws** that hit the smuggling.’

has been tagged by 2 annotators upon 8 as Instrument role instantiation; it is possible that they have thought that there was an inferred Agent (the legislator) that was using the laws as an instrument.

This kind of interpretation can emerge also with instrumental nouns not occurring as subjects. During the annotation experiment, the argument in bold in the example

(13) “l’aereo è stato colpito **da un missile**”

‘the airplane was hit **by a missile**’

was tagged as Instrument by 6 upon 8 annotators. In our opinion this is a case of the role Cause rather than Instrument; it is introduced by the preposition *da* (english “by”) that is usually associated with the expression of Agents and Causes in passive constructions. It can be inferred that somebody has used the missile as a means to hit the airplane, but the speaker of this sentence does not provide evidence about this eventuality. The same scenario can be expressed with an Instrument role by using a sentence like “l’aereo è stato colpito dai nemici con un missile” (‘the airplane was hit by enemies with a missile’), in which the preposition “with” overtly expresses the Instrument.

It is true that there are differences in the nature of the entities that we encountered so far expressed as instrument subject. A missile is different in nature from a stone. The first is an artifact, while the second is a natural object. Moreover, from our world-knowledge, we know that the first is more frequently used intentionally than the second one. A missile is less likely to be activated accidentally than a stone, also because, in Pustejovsky’s (1995) terms, it has in its telic quale the goal of being shot (to attack). Nevertheless, in our opinion, these characteristics and differences are inherent properties of the entities described, that could be relevant in the definition of an ontology of instruments, but they do not emerge in semantic role structure. Such an ontological distinction has been recognized by various scholars, such as Nilsen (1973), Kamp and Rossdeutscher (1994:144-145) among others. Kamp and Rossdeutscher proposed to distinguish a class of *Instrument Causers*, i.e. “Instruments which can be conceived as acting on their own, once the agent has applied or introduced them”, from *Pure Instruments*, defined as “Instruments whose action is conceived as strictly auxiliary to that of the agent by whom they are being

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<sup>3</sup>A reviewer pointed out that the real Cause is the event of falling, not the stone. Although this is a true inference, we argue that the stone is metonymically reinterpreted as the falling of the stone and for this reason the cause of the event. This interesting matter deserves a deeper analysis that will be subject of further work.

<sup>4</sup>Alexiadou and Schäfer note: “They are Causers by virtue of their being involved in an event without being (permanently) controlled by a human Agent. The fact that this involvement in an event might be the result of a human agent having introduced these Causers is a fact about the real world, not about the linguistic structure” (2006: 42-43).

employed”. This is of course a correct distinction, which could lead us to classify mechanical devices (such as *clock*) and natural forces as Instrument Causers, but again this would be only an ontological classification. These differences may, of course, have interfered during the annotation.

As referenced above, we claim that even if an Agent is expressed in the previous context, the instrument subject should not be considered as Instrument. To better explain this position, consider the example in (14), kindly brought to our attention by a reviewer:

- (14) “She swung at the charging wolf *with her broom*. Luckily **the broom** caught the wolf’s throat and succeeded in pushing him back.”

We claim that in the first sentence, the *broom* is a real Instrument, since it is described as being manipulated by somebody. In the second sentence, *the broom* as instrument subject plays no more an Instrument role, but is a Cause, since the predicate *caught* does not describe the event of the broom being used, but the event of the broom’s catching the throat of the wolf. In other words, in the second sentence, the speaker highlights only the intermediate part of the causal chain. An event can be described in various ways, focusing on its parts in a narrow or wide way. For example, we can just say “I broke the window”, describing only the initial and the endpoint, or we can say “I took a stone, I raised my arm, I applied all my strength to my arm, lowered my arm and the force applied to the stone broke the window”, explicitly expressing all the sub-events that compose the main event <sup>5</sup>. Saying that “The stone broke the window” or that “The broom caught the wolf’s throat” means to focus a part of the causal chain and to represent it as the Cause. It is important to note that it is the predicate (chosen by the speaker) that provides which part of the chain is represented as the Cause. Indeed, every events can be subdivided in different sub-parts, but it depends on the specific sentence that is used which part is linguistically described.

## 4.2 Instrument subject as Agent

We argue that the cases in which an instrument subject covers the role of Agent are sporadic and involve metaphorical or metonymical interpretations (Jezek et al. 2014). It should be kept in mind that it is widely assumed that the Agent role implies animacy and intentionality; as such an inanimate entity like an instrument cannot be Agent. This view contrasts with what has been claimed by some linguists (Schlesinger 1989, Alexiadou and Schäfer 2006) that, while agreeing that the Instrument role attribution to instrument subjects is incorrect, claimed that in most cases they are Agents. We claim that the Agent role can be fulfilled by instrument subjects in case of personification or metaphorical/metonymic extension of the meaning of the lexeme:

- (15) “Un giorno **una forbice gigante** tagliò della carta a forma di burattino. Un altro giorno ha ritagliato due palle giganti che erano il sole giallo e la Terra.”  
‘Once upon a time a giant scissor cut a paper into a puppet. Later, it cut two giant balls, the yellow sun and the Earth.’
- (16) “**Tante penne** scrivono su Napoli, usano Napoli per vendere copie.”  
‘A lot of pens (writers) write about Naples, they use Naples to sell.’
- (17) “**Tutto l’ufficio** ha lavorato bene.”  
‘All the office has worked well.’

## 4.3 Instrument subject as Theme

Analyzing the SC dataset, a case has been found that to our knowledge has not been previously discussed systematically in the literature on semantic roles. The following are examples:

- (18) “**La penna** scrive nero.”  
‘The pen writes black.’

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<sup>5</sup>For similar ideas see Talmy 1996.

- (19) “**Forbici** che tagliano bene.”  
‘**Scissors** that cut well.’

These subjects have been tagged as Instrument by respectively 3/8 and 4/8 annotators. As previously claimed, the ambiguity is caused by the possibility of these nouns to occur as true Instruments with the preposition “*with*” (ex. “I have written the letter with this pen”). We suggest that in cases such as (18) and (19) the instrument subjects are neither Instrument, nor Cause, because they are not presented as causing an event or as being used by an expressed Agent. The verb predicates a property of the subject and as such the Theme role is fulfilled. The Theme is defined in SC as “participant in an event or state, which, if in an event, it is essential for it to take place, but it does not determine the way in which the event happens (it doesn’t have control) and it is not structurally modified by it; if in a state, it is characterized by being in a certain condition or position throughout the state and it is essential to its occurring”. In other resources, these examples could be referred to by roles similar to our Theme, such as the role Pivot in LIRICS.

These cases can be ascribed to the class of *gnomic imperfective* proposed by Bertinetto and Lenci (2010). These sentences express a generalization of some kind with a characterizing function; they ascribe a defining property to the intended referent. This brings the examples in (18) and (19) to be partly similar to other habituals like “John smokes” or “John smokes cigars”, defined by Bertinetto and Lenci (2010) as *attitudinal*. However, even if they both denote a state and they both ascribe a characteristic to the referent, we argue that they are intrinsically different: a sentence like “this pen writes black” or “this knife cuts meat” denotes an inherent property of the referent and its aspect can be defined as *potential*. This does not hold for attitudinals; we cannot say “John can smoke cigars” to mean that John usually smokes cigars. This is a property that John acquires by iteration of smoking events, i.e. as a result of a series of intentional acts. By contrast, the property of writing black is provided by how a pen is built, not by the fact of having participated repeatedly in the act of writing black. It is an inherent property that cannot be intentionally controlled.

## 5 Conclusions and future work

In this paper we have shown how theoretical and data analysis can mutually improve each other. Theoretical literature offers critical discussion about the Instrument role and the case of instrument subjects. The discussion can be useful for the definition and annotation of semantic roles in the implementation of lexical resources. Moreover, the analysis of annotated data can reveal fallacies in the reliability of the set, coming back from application to theoretical topics.

We claim that semantic roles should be assigned considering the specific linguistic encoding of the event, not the event itself. The same scenario, indeed, can be represented by more than one linguistic expression, in which the same participant can cover different roles.

At last, our study highlights the importance of distinguishing between semantic roles - relational notions belonging to the level of linguistic representation - and ontological types, which refer to internal qualities of entities. We believe that this topic is still not well understood and deserves detailed case studies on single roles at the interface between linguistic theory and data analysis, as the one presented here.

A problematic point that we leave open for future work is the amount of context that should be provided to annotators. Is it better to tag single sentences, as we did, or should the context be expanded with previous text? Future annotation experiments could shed light on this point. However, the problems highlighted in this paper about the definition of semantic roles holds anyway. It is our duty to explicitly clarify and agree on how do we interpret semantic roles (Instrument roles particularly), before asking annotators for high agreement on segmented portions of text or larger linguistic units.

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