Light-Headed Relatives

Barbara Citko

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Larson, Richard. 1990. Extraction and multiple selection in PP. *The Linguistic Review* 7,169-182.
Moro, Andrea. 1997. *The raising of predicates*. Cambridge: Cambridge University Press.
Partee, Barbara H. 1998. Copular inversion puzzles. Handout of a talk given at the University of Connecticut Workshop on Semantics.
Rapoport, Tova V. Copular, nominal and small clauses: a study of Israeli Hebrew. Doctoral dissertation, Massachusetts Institute of Technology, Cambridge, Mass.
Rullmann, Hotze. 1995. Maximality in the semantics of WH-constructions. Doctoral dissertation, University of Massachusetts, Amherst: GLSA.
Zubizarreta, Maria Luisa.1998. *Prosody, focus and word order*. Cambridge, Mass: MIT Press.

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German, Determiner Copulas are banned for independent reasons. A reasonable hypothesis worth investigation is to link the availability of Determiner Copulas in Equatives to the availability of null copulas in predicational statements. I leave such typological issues for further research.

References

Babtista, Marlyse. 1997. The morpho-syntax of nominal and verbal categories in Caperverdean Creole. Doctoral dissertation. Harvard University.

Bhatt, Rajesh. 1999. Locality in apparently non-local relativization: correlatives in the modern Indo-Aryan languages. Talk given at the Department of Linguistics and Philosophy, Massachusetts Institute of Technology.

Carnie, Andrew. 1995. Non-verbal predication and head movement. Doctoral dissertation, Massachusetts Institute of Technology, Cambridge, Mass.

Chomsky, Noam. 1995. *The minimalist program.* Cambridge, Mass.: MIT Press.

Citko, Barbara. 1998. ATB analysis of free relative clauses. In *Proceedings from the Main Session of the Chicago Linguistic Society's Thirty Fourth Meeting*, 69-83. University of Chicago, Chicago.

Fowler, George. 1987. The grammatical relevance of Theme/Rheme partition. In *Papers from 23rd Annual Regional Meeting of Chicago Linguistic Society*, 93-104. University of Chicago, Chicago.

Heycock, Caroline, and Anthony Kroch. 1998. Pseudocleft connectedness: implications for the LF interface level. To appear in *Linguistic Inquiry*.

Higgins, Roger. 1979. The pseudo-cleft constructions in English. *Outstanding Dissertations in Linguistics*. New York: Garland.

Izvorski, Roumyana. 1996. The syntax and semantics of correlative proforms. In *Proceedings of NELS 26*, 133-147. University of Massachusetts, Amherst: GLSA.

Jacobson, Pauline. 1995. On the quantificational force of English free relatives. In *Quantification in Natural Language*, ed Emmond Bach, Eloise Jelinek, Angelika Kratzer and Barbara H. Partee, 451-486. Dordecht: Kluwer.

Kiss, Katalin E. 1998. Identification focus versus information focus. *Language* 74, 245-273.

Klima, Edward. Negation in English. In *The structure of language; readings in the philosophy of language*, ed. Jerry A. Fodor and Jerold J. Katz, 246-323. Englewood Cliffs, New Jersey: Prentice-Hall.

5.2 Interpretation of Light-Headed Relatives

Another question concerns implications of this analysis for the semantics of Light-Headed Relatives. The semantics I would like to suggest for both Light-Headed Relatives and Correlatives essentially involves equation between two entities. Consider the Light-Headed Relative given in (40a) and its structure in (40b). Its meaning can be paraphrased as 'The thing that I will sing is/equals to the thing that Mary will sing' (40c).

(40) a. Spiewam to co Maria śpiewa.
I-sing DEMwhat Maria sings
'I sing what Mary sings.'

b. [$_{TP}$ T [$_{SC}$ [$_{CP1}$ to śpiewam] [$_{CP1}$ co Maria śpiewa]]
DEM I-sing what Maria sings

c. ιy [I sing y] = ιx [Mary sings x]

How do we arrive at the interpretation in (40c)? As far as the equation relation goes, for now I simply assume that it can come either from the nature of the copula itself or, alternatively, from the nature of the small clause.

The two CPs comprising the small clause are interpreted as free relatives. With respect to the semantics of free relatives, I follow Jacobson 1995 and Rullmann 1996 and assume that they denote maximal individuals (MAX operator in Rullmann's system and iota operator in Jacobson's system).

(41) a. ιy [I will sing y]
b. ιx [Mary will sing x]

5.3 Further Questions

The analysis presented in this paper establishes a link between D elements in Equatives and D elements in Light-Headed Relatives. This link, however, cannot be totally straightforward, since Light-Headed Relatives exist not only in languages that have Determiner Copulas. Crosslinguistically, the range of languages that allow Light-Headed Relatives seems to be much wider than the range of languages that have Determiner Copulas. Languages such as Greek, German or Dutch do not use Determiner Copulas in equative statements but nevertheless allow Light-Headed Relatives (Sabine Iatridou, personal communication). At present, I am not aware of any language that has Determiner Copulas but does not allow Light-Headed Relatives. For the time being, I simply assume that in languages like Greek or

or Rheme. Furthermore, following Fowler 1987, I assume the existence of a rule of thematic extraction which can take any sentential constituent and move it out of the Focus domain. Thematic extraction in current terminology could be thought of as being movement to satisfy the EPP feature of Tense. Whatever constituent moves to check off this EPP feature ends up being interpreted as Theme.

A common test used determine the partitioning of a sentence into Theme/Rheme is the Wh-Question test, where what provides the response to a wh-question is the Focus.

Consider in this light the difference between a Light-Headed Relative and a Correlative. A Light-Headed Relative is an appropriate response to a wh question *When will you sing*? The relative CP *kiedy Maria zaśpiewa* 'when Mary sings' is thus the Focus and the matrix CP *wtedy zaśpiewam* 'I will sing then' is the Theme. On current assumptions this shows that it must have moved out of the Focus domain. This is precisely what happens during the derivation of (38); the matrix CP moves out of the small clause to [Spec, T] position (cf.(35) above).

(38) A: Kiedy śpiewasz?
when you-sing
'When do you sing?'
B: Spiewam wtedy [$_{SC}$ kiedy Maria śpiewa]
I-sing then when Maria sings
'I sing when Mary sings.'

By the same test, a Correlative is an appropriate response to a wh question *What will you do when Mary sings*?, which suggests that in this case the matrix CP *zaśpiewam* 'I will sing' is the Focus and thus the relative CP *kiedy Maria zaśpiewa* 'when Mary sings' must have moved out of the Focus domain. Again, this is exactly what happens; in this case it is the relative CP that moves out of the small clause to [Spec,T] (cf. (37d) above).

(39) A: Co robisz kiedy Maria śpiewa?
what you-do when Maria sings
'What do you do when Mary sings?'
B: Kiedy Maria śpiewa wtedy [$_{SC}$ śpiewam]
when Maria sings then I-sing
'When Mary sings, I sing.'

c. $[_{TP}\ [_{T'}$wtedy$_1$ $[_{SC}\ [_{CP1}\ t'_1$ śpiewam $t_1]\ [_{CP2}$ kiedy$_2$ Maria śpiewa $t_2]]]]$

then I-sing when Maria sings

d. $[_{TP}[_{CP2}$ kiedy$_2$ Maria śpiewa $t_2]_i$ wtedy $[_{SC}[_{CP1}t'_1$śpiewam $t_1]\ [_{CP2}\ t_i]]]$

when Maria sings then I-sing

The derivation of a Correlative parallels that of a Light-Headed Relative up to the point involving the raising of the CP out of the small clause; the first three steps are the same in the two cases (compare (37a-c) to (33-35)). The sole difference between Light-Headed Relatives and Correlatives lies in which of the two CPs undergoes raising out of the small clause. In the case of a Light-Headed Relative it is CP_1 that raises out of the small clause (the matrix CP), whereas in the case of a Correlative it is CP_2 (the relative CP).

To summarize, I have argued for an analysis of Light-Headed Relatives which structurally assimilates them to Equatives. In the next section, I discuss the implications of this analysis for the interpretation of Light-Headed Relatives.

5 Consequences

5.1 Motivation for Movement

In the final section, I address some of the questions this proposal raises. Recall that the derivation of both a canonical Light-Headed Relative and a Correlative involves the raising of a CP out of a small clause into the specifier of T^0. A fairly straightforward way to motivate this movement is to assume that it is forced by the EPP feature of T^0. The possibility for any of the two CPs to satisfy the EPP feature could quite plausibly be thought of as being related to other properties of the Slavic languages, namely free word order and the differences in information structure associated with different word orders.

It has been long observed that Slavic word order marks the division of a sentence into Topic/Focus or Theme/Rheme structure. The term Focus here refers to Informational Focus in Kiss's 1998 sense; crucially to be distinguished from Quantificational or Identificational Focus. Theme is standardly defined as what is given or already known from the preceding utterance or what is taken to be the point of departure, and Rheme as what is new or what is the primary goal of the communication. I assume here, not uncontroversially, that in the unmarked case the entire sentence is the Focus

stituent composed of two CPs: CP_1 *Spiewam wtedy* 'I sing then' and CP_2 *Maria śpiewa kiedy* 'Mary sings when' (32b).

(32) a. Spiewam wtedy kiedy Maria śpiewa.
I-sing then when Maria sings
'I sing when Mary sings.'

b. $[_{TP}\ T^0\ [_{SC}\ [_{CP1}$ śpiewam wtedy$]\ [_{CP2}$ Maria śpiewa kiedy$]]]$
I-sing then Maria sings when

The first step in the derivation involves movement of the two pronominal elements, a wh-word *kiedy* 'when' and a D-word *wtedy* 'then' to the specifier positions of their respective CPs.

(33) $[_{TP}\ T^0[_{SC}\ [_{CP1}$wtedy$_1$ śpiewam $t_1]\ [_{CP2}$kiedy$_2$ Maria śpiewa $t_2]]]$
then I-sing when Maria sings

The next step involves the movement of the D feature of the D-word *wtedy* 'then' to T^0, pied-piping the entire XP. This movement is analogous to the movement of a D feature to T^0 in equative statements (cf. 25); in both cases it satisfies the requirement that the T^0 position be lexically filled.

(34) $[_{TP}\ [_{T'}$wtedy$_1[_{SC}[_{CP1}$t'$_1$śpiewam $t_1][_{CP2}$kiedy$_2$ Maria śpiewa $t_2]]]]$
then I-sing when Maria sings

The final step is the remnant movement of the CP_1 to [Spec, T].

(35) $[_{TP}[_{CP1}$ t'$_1$ śpiewam $t_1]_i\ [_{T'}$ wtedy$_1\ [_{SC}[_{CP1}\ t_i]\ [_{CP2}$kiedy$_2$ Maria śpiewa $t_2]]]]$
I-sing then when Maria sings

The result is a canonical Light-Headed Relative given in (32a) above.

As suggested above, this general line of thought extends in an interesting way to Correlatives, which are inverse Light-Headed Relatives. Consider the following derivation:

(36) Kiedy Maria śpiewa wtedy śpiewam
when Maria sings then I-sing

(37) a. $[_{TP}\ T^0\ [_{SC}\ [_{CP1}$ śpiewam wtedy$]\ [_{CP2}$ Maria śpiewa kiedy$]\ ]\ ]$
I-sing then Maria sings when

b. $[_{TP}\ T^0\ [_{SC}\ [_{CP1}$ wtedy$_1$ śpiewam $t_1]\ [_{CP2}$ kiedy$_2$ Maria śpiewa $t_2]\ ]\ ]$
then I-sing when Maria sings

'My good friend is Ivan.'

Head movement of the kind schematized in (25) is only one of the strategies languages use to satisfy this requirement. Naturally,languages like English use a different strategy. However, even in English we can see that the T^0 position in equative statements has to be filled. This is illustrated by the contrast in grammaticality between the a and b examples in (28-29).

(28) a. *I proved the King be that man over there. (Rapoport 1987)
b. I proved the King to be that man over there.
(29) a. I find David to be the King.
b. *I find David be the King.

4 Light-Headed Relatives

The analysis I develop in this section for Light-Headed Relatives essentially assimilates them to Equatives. We have seen in Sections 2 and 3 that both Light-Headed Relatives and Equatives exhibit a rather nonstandard use of demonstrative elements. This, I believe, reflects a deeper parallelism in structure, and suggests that Light-Headed Relatives also involve a small clause structure. This time, however, the small clause, instead of being composed of two Noun Phrases is composed of two clauses, as shown in (30).

(30) $[_{TP}\ T^0\ [_{SC}\ CP_1\ CP_2]\ ]$

Just as in the case of Equatives, either of the two constituents comprising the small clause can raise out of the small clause to [Spec,T]. If CP_1 raises, we get a canonical Light-Headed Relative (31a). If CP_2 raises, we get an inverse Light-Headed Relative (31b).

(31) a. $[_{TP}\ CP_1\ T^0\ [_{SC}\ t_1\ CP_2]\ ]$
b. $[_{TP}\ CP_2\ T^0\ [_{SC}\ CP1\ t_2\ ]\ ]$

Consider first the derivation of a canonical Light-Headed Relative given in (32a). Underlyingly, it involves a null copula selecting a small clause con-

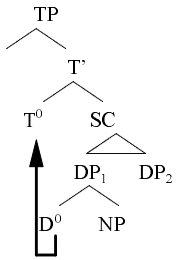
If DP_1 raises, we get a canonical structure (24a), and if DP_2 raises we get an inverse structure (24b):

(24) a. $[_{TP}$ Jan$_i$ T^0 $[_{SC}$ $[_{DP1}$ $t_i]$ $[_{DP2}$ mój najlepszy przyjaciel]]]]
Jan my best friend

b. $[_{TP}$ Mój najlepszy przyjaciel$_i$ T^0 $[_{SC}$ $[_{DP1}$ Jan] $[_{DP2}$ $t_i]$]]]
my best friend Jan

Note that the Determiner Copula *to* is absent in an underlying structure. This raises the obvious question of how to account for its presence in the surface representation (cf.(21a-b)). The suggestion that I would like to make here is that Determiner Copulas are derived by means of feature movement: a D feature of the Determiner heading a Noun Phrase adjacent to T^0 (in the case at hand DP_1) undergoes head movement to T^0, as schematized in (25). This results in the presence of D^0 element in T^0, which is spelled out as a Determiner Copula *to*.

(25)



The immediate question that arises here is what motivates this D^0 to T^0 feature raising. I believe the answer follows from a very general property of equative statements, i.e. the requirement that the T^0 position be lexically filled. Thus, even in languages like Russian or Hebrew, which allow null copulas in predicational statements (26), null copulas are banned from equative statements, which require a demonstrative or a pronominal element in the T^0 position (33) (Rapoport 1987, Carnie 1995).

(26) a. Ivan - durak
Russian
Ivan fool
'Ivan is a fool.'

(27) a. Moj xorosij drug *(eto) Ivan.
my good friend DEMIvan.

Some evidence in favor of the conclusion that the Determiner Copula *to* in Polish is equative comes from the fact that it is banned from sentences with AP or PP predicates, where again only the lexical verb 'be' is allowed.

(19) a. * Jan to [$_{AP}$ mądry]
Jan DEM clever
'John is clever.'

b. Jan jest mądry.
Jan is clever
'John is clever.'

(20) a. *Jan to [$_{PP}$ pod mostem]
Jan DEM under bridge
'John is under the bridge.'

b. Jan jest pod mostem.
Jan is under bridge
'John is under the bridge.'

Furthermore, copular sentences involving the Determiner Copula *to* are reversible; hence the alternation between (21a) and (21b):

(21) a. Mój najlepszy przyjaciel to Jan.
my best friend DEM Jan
'John is my best friend.'

b. Jan to mój najlepszy przyjaciel.
Jan DEM my best friend
'My best friend is John.'

I assume here a fairly straightforward analysis of Equatives, on which they involve a small clause constituent composed of two Noun Phrases.[5]

(22) [$_{TP}$ T^0 [[$_{SC}$ DP_1 DP_2]]

I also assume, following the insight of Moro (1997) that in a small clause of the kind given in (22) either of the two Noun Phrases can raise out of the small clause into [Spec,T] position.[6] Thus, underlyingly both (21a) and (21b) involve the same structure, given in (23).

(23) [$_{TP}$ T^0 [$_{SC}$ [$_{DP1}$ Jan] [$_{DP2}$ mój najlepszy przyjaciel]]]
Jan my best friend

[5] The assumption that are equative small clauses, while not uncontroversial, is not unprecedented. See Heycock and Kroch 1998 for relevant discussion.

[6] I differ from Moro 1997 in that the raising of either noun phrase out of the small clause yields an equative statement.

(15) a. wh-word = WH + indefinite
b. D-word = D + indefinite

The feature decomposition of demonstrative pronouns heading Light-Headed Relatives is crucial to the analysis I develop in Section 4. First, however, let me examine another construction where demonstratives appear, and whose syntax will serve as background for the analysis of Light-Headed Relatives.

3 Equative Statements

One of the demonstrative pronouns, namely *to* 'this', besides heading nominal Light-Headed Relatives, has another rather nonstandard use. It occurs in specificational and equative statements, as shown in (16-17).[3]

(16) Mój najlepszy przyjaciel to Jan
my best friend DEMJan
'My best friend is Jan.'
(17) Gwiazda poranna to gwiazda wieczorna.
star morning DEMstar evening
'The morning star is the evening star.'

I assume that *to* in (16-17) is a D^0 element situated in T^0; henceforth, I refer to it as a Determiner Copula. In Polish the demonstrative *to* can function only as an equative copula.[4] In unambigously predicational sentences the lexical verb *być* 'be' is used instead.

(18) Jan jest studentem
Jan is student-INSTR
'Jan is a student.'

[3] The use of pronominal like elements in nominal copular structures is by no means unique to the Slavic family of languages; we find it in a number of languages typologically unrelated to Slavic: Hebrew, Arabic, Haitian and Capeverdian Creoles, to name just a few.

[4] On the assumption that specificational statements involve some form of identification, and are thus related to specificational statements, the fact that we find the same copula element in both is to be expected.

(12) a. Zaśpiewam wtedy kiedy Maria zaśpiewa. *temporal*
I-sing-PERF then when Maria sings-PERF
'I will sing when Mary sings.'
b. Kiedy Maria zaśpiewa wtedy zaśpiewam.
when Maria sings-PERF then I-sing-PERF

(13) a. Zaśpiewam dlatego dlaczego Maria zaśpiewa. *reason*
I-sing-PERF DEMwhy Maria sings-PERF
'I will sing for the same reason that Mary sings.'
b. Dlaczego Maria zaśpiewa dlatego zaśpiewam.
why Maria sings-PERF DEMI-sing-PERF

Furthermore, these examples show a clear morphological relationship between wh-words and demonstrative words; the relative clause always contains a wh-word and the matrix clause a corresponding demonstrative word (henceforth referred to as D-word).[2] In Polish the two differ only with respect to the initial morpheme; *k-* in wh-words and *t-* in D-words.

(14) a. <u>wh-words</u>

c-o	'what'
k-to	'who'
j-ak	'how'
gdzie	'where'
k-iedy	'when'
dla-*cz*-ego	'why'

b. <u>D-words</u>

t-o
t-en/*t*-a
t-ak
t-am
w-*t*-edy
dla-*t*-ego

D-words can thus be thought of as being a result of lexical incorporation of a reduced form of a definite morpheme into the indefinite pronoun. This accords with quite an old insight, going back at least to Klima 1964, that wh-pronouns are indefinite pronouns plus an interrogative feature, and by analogy that demonstrative pronouns are indefinite pronouns plus a D feature.

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[2] We see a similar morphological opposition in English:

(*i*) a. <u>wh-words</u>

wh-o
wh-om
wh-ere
wh-at

b. <u>D-words</u>

th-ey
th-em
th-ere
th-at

Relatives *kto* 'who' is perfectly grammatical as a relative pronoun. This is shown by the contrast in grammaticality between (8) and (7b) above.

(8) Przepytam studenta który/*kto pierwszy przyjdzie.
I-question-PERF student which/ who first comes-PERF
'I will question the student who comes first.'

2.2 Word Order in Light-Headed Relatives

In Light-Headed Relatives, the order between the matrix and the relative clause is quite free. In addition to 'canonical' Light-Headed Relatives (9a), Polish allows 'inverse' Light-Headed Relatives, in which the relative clause precedes the matrix clause (9b). Inverse Light-Headed Relatives are standardly referred to as Correlatives.[1]

(9) a. Jan śpiewa to co Maria śpiewa.
Jan sings DEM what Maria sings
'John sings what Mary sings.'
b. Co Maria śpiewa to Jan śpiewa.
what Maria sings DEM Jan sings
'What Mary sings, John sings.'

The examples in (10-13) show that the same kind of variation in the order of the matrix and the relative clause occurs not only in relatives headed by nominal elements, but also those headed by place, manner, temporal and reason adverbials.

(10) a. Pojadę tam gdzie mnie wyślesz. *place*
I-go-PERF there where me you-send-PERF
'I will go where you send me.'
b. Gdzie mnie wyślesz tam pojadę.
where me you-send-PERF there I-go-PERF
(11) a. Zaśpiewam tak jak Maria zaśpiewa. *manner*
I-sing-PERF DEMhow Maria sings-PERF
'I will sing the way Mary sings.'
b. Jak Maria zaśpiewa tak zaśpiewam.
How Maria sings-PERF DEMI-sing-PERF

[1] I am glossing over the nontrivial issue of whether Slavic languages have true Correlatives of the kind found in the Indo-Aryan languages. For relevant discussion, see Izvorski 1996 and Bhatt 1999.

The paper is structured as follows: I begin by examining the properties of Light-Headed Relatives that distinguish them from Headed and Headless Relatives. Next, I discuss the parallels between Light-Headed Relatives and Equatives. I argue that both Equatives and Light-Headed Relatives involve an equative copula selecting a small clause constituent. The only difference between them lies in the internal structure of the small clause. In the case of equative statements, it is composed of two Noun Phrases (5a), whereas in the case of Light-Headed Relatives it is composed of two clauses (5b).

(5) a. $[_{TP}\ T^0\ [_{SC}\ DP_1\ DP_2]\ ]$ *Equatives*
b. $[_{TP}\ T^0\ [_{SC}\ CP_1\ CP_2]\ ]$ *Light-Headed Relatives*

2 Properties of Light-Headed Relatives

2.1 Light-Headed Relatives versus Headless and Headed Relatives

The most notable difference between Headless and Light-Headed Relatives concerns their behavior with respect to Case Matching. Matching in this context refers to the requirement for the case of a wh-pronoun inside the relative clause to match the item selected by the embedding predicate.

(6) Case Matching: $\beta\ [\text{wh-word}_{\alpha case}\ \ldots\ ]_{\alpha case}$

The contrast in grammaticality between (7a) and (7b) shows that only Headless Relatives are subject to the matching requirement.

(7) a. *Przepytam $[\text{kto}_{NOM}$ pierwszy przyjdzie$]_{ACC}$
I-question-PERF who first comes-PERF
'I will question who comes first.'
b. Przepytam tego_{ACC} kto_{NOM} pierwszy przyjdzie.
I-question-PERF DEM who first comes-PERF
'I will question the one who comes first.'

This might suggest that Light-Headed Relatives are simply Headed Relatives, where instead of a full nominal the head is a demonstrative element. If this were the case, any differences between the two would remain hard to account for. They differ, however, in at least one respect, i.e. the range of relative pronouns they allow. Thus, in Polish Headed Relatives the only admissible relative pronoun is *który* 'which'. By contrast, in Light-Headed

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1 Introduction

In addition to the familiar Headed and Headless Relatives (1-2), many languages allow relatives headed by demonstrative pronouns (3). I refer to such relatives as Light-Headed Relatives. This paper, drawing primarily on data from Polish, provides a new account of their syntax and semantics.

(1) Jan śpiewa piosenkę którą Maria śpiewa. *Headed Relatives*
Jan sing song which Maria sings
'John sings the song that Mary sings.'

(2) Jan śpiewa cokolwiek Maria śpiewa. *Headless/Free Relatives*
Jan sings whatever Maria sings
'John sings whatever Mary sings.'

(3) Jan śpiewa to co Maria śpiewa. *Light-Headed Relatives*
Jan sings DEM what Maria sings
'John sings what Mary sings.'
(*Lit.* 'John sings this what Mary sings.')

The analysis I develop for Light-Headed Relatives relies crucially on the contribution of a demonstrative pronoun, which I argue parallels the contribution of a demonstrative pronoun in an equative statement (4).

(4) Cycero to Tully. *Equatives*
Cycero DEMTully
'Cycero is Tully.'

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