The development of *before* and *after* in Greek

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Περίληψη

Η παρούσα έρευνα εξετάζει την κατάκτηση των διαδοχικών χρονικών συνδέσμων της Νέας Ελληνικής. Επικεντρώνεται στους χρονικούς συνδέσμους πριν (before) και αφού (after) και εξετάζει τη συσχέτισή τους με τα επιρρήματα πρώτα (first) και μετά (then). Στην πειραματική έρευνα συμμετείχαν συνολικά 51 παιδιά (3;0-6;0 ετών). Η κατανόηση των συγκεκριμένων συνδέσμων εξετάστηκε μέσω της μεθόδου της επιλογής της εικόνας (picture selection task). Τα αποτελέσματα δείχνουν ότι υπάρχει συσχέτιση μεταξύ της κατάκτησης του χρονικού συνδέσμου 'πριν' και του επιρρήματος 'πρώτα' και ότι το προτερόχρονο ('πριν') προηγείται της κατάκτησης του υστερόχρονου ('αφού'), το οποίο φαίνεται ότι παραμένει ατελές μέχρι και τα 6 χρόνια.

Λέξεις – κλειδιά: γλωσσική κατάκτηση, διαδοχικοί χρονικοί σύνδεσμοι, διαδοχικά χρονικά επιρρήματα

1 Introduction

The development of temporal concepts remains unresolved, mainly because the conceptualization of these notions requires both the development of language ability to express time and the cognitive abilities to reason about time. It has been assumed that there is a connection between cognition and language as far as acquisition of time is concerned and that the way we perceive time is a combination of both cognitive and linguistic components. For this reason, the issue has attracted a significant amount of attention among both cognitive and linguistic trends (see Zhang and Hudson 2018 for an overview). However, it remains an open question to what extent cognition and language affect the acquisition of time separately and to what extent, if at all, language serves exclusively as a mean to express temporal notions or if it contributes to the formation of temporal concepts.

Within this context, our main aim is to determine the order and the exact age of acquisition of sequential temporal connectives and adverbs. In doing so, we investigate whether there is a correlation in the acquisition of the semantic pairs *prin - prota* and *afu - meta*.

2 Literature review

Most studies on the development of temporal concepts have concentrated on the acquisition of temporal connectives and especially sequential temporal connectives *before* (1)-(2) and *after* (3)-(4). The latter attracted significant attention due to the position they can hold (i.e. initial (2) and (3) or medial (1) and (4)) within a sentence, affecting in principle both processing and the order of the events (i.e. chronological or reverse order). Consequently, examining the acquisition of sequential temporal connectives is more complex since knowing the meaning of a connective is not enough.

(1) Mary read ***before*** she ate. *Chronological event order*

(2) ***Before*** she ate, Mary read. *Reverse event order*

(3) ***After*** she read, Mary ate. *Chronological event order*

(4) Mary ate, ***after*** she read. *Reverse event order*

With respect to the developmental order of *before* and *after*, many studies have argued that the acquisition of *before* precedes the acquisition of *after* (Clark 1971, Johnson 1975, Feagans 1980, Richards and Hawpe 1981, Trosborg 1982, Blything 2016), while a different view is proposed in Barrie-Blackley (1973), French and Brown (1977) and Coker (1978) among others.

Similarly, there is no consensus regarding the precise age of acquisition of the temporal connectives; Clark (1971) concluded that children have acquired both *before* and *after* until the age of 5. Diessel (2004) claims that production of temporal connectives occurs around 3 years old. However, their comprehension is more complex and it continues to develop far beyond this age. A recent study (Blything 2016) noticed that children acquire sequential temporal connectives at about 7 years old. As far as temporal adverbs are concerned, Richards and Hawpe (1981) supported that temporal adverb *first* is earlier comprehended than *last*.

Several studies (Hatch 1971, Kavanaugh 1979, Carni and French 1984, Blything 2016 i.a.) measured linguistic factors (chronological or reverse sentence order) that may influence children's performance and concluded that chronological sentences are easier to process since they correspond to the actual order of events. On the contrary, reverse sentences are more demanding because they do not correspond to the appropriate mental representation of events and they require revising.

The studies on the development of temporal connectives on Greek are very limited. Natsopoulos and Xeromeritou (1988) investigated Greek sequential temporal connectives and concluded that *before*-chronological sentences are better comprehended.[1] More recently, Papakonstantinou (2015) found that children acquire temporal connective *before* first and that acquisition of *after* is incomplete even at the age 11;0.[2]

3 The present study

We run an experimental study (in the spirit of Blything 2016) aiming at investigating the comprehension of the Greek sequential temporal connectives and adverbs. Our study had three main goals. Firstly, we intended to test if linguistic and/or processing factors (chronological versus reverse order of events) that have been suggested to affect the developmental order, show similar effects in Greek. Secondly, we wanted to examine potential interdependencies between cognitive conceptualization of order of events (temporal adverbials *prota* and *meta*) and linguistic realization of temporal

[1] Another study for Greek temporal connectives is that of Natsopoulos & Abadzi (1986).

[2] It must be mentioned that Papakonstantinou (2015) examined temporal connectives afu (after/since), eno (whilst) and kaθos (while/since), which are considered to be ambiguous as well as the unambiguous prin (before) and otan (when). As far as sequential temporal connectives are concerned, the data she presented cannot lead to clear conclusions regarding the factors that may affect the development of temporal notions, as she did not take into account the place of a connective within a sentence.

relations (temporal connectives *prin* and *afu*). Finally, we intended to shed light on the developmental trajectory and the precise age that these two connectives have been fully acquired.

For these reasons, we focused on the acquisition of *before* (prin) (chronological and reverse sentence order, (5a) and (5b) respectively) and *after* (afu) (chronological and reverse sentence order, (6a) and (6b) respectively) in Greek and we compare children's performance on these two temporal connectives to the development of the semantically corresponding temporal sequential adverbs *first* ('prota') (6) and *then* ('meta') (7).

(5) a. To strumfaki tragudise, **prin** fai pagoto
'The Smurf sang ***before*** he ate ice-cream'.
b. **Prin** fai pagoto, to strumfaki tragudise
'Before he eats ice-cream, the Smurf sang'.

(6) a. **Afu** zografise, o Winnie magirepse
'***After*** he drew (a picture), Winnie cooked'.
b. O Winnie magirepse, **afu** zografise
'Winnie cooked, **after** he drew (a picture)'.

(7) O Winnie xorepse ke **meta** efage meli
'Winnie danced and **then** he ate honey'.

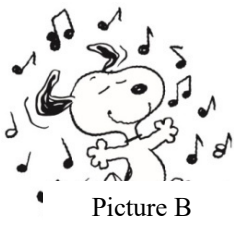
(8) O Snoopy **prota** etrekse ke efage pagoto
'**First** Snoopy ran and then he ate some ice-cream'.

3.1 Methodology

The method we used to test children's comprehension was a picture selection task. Children were presented with two pictures at a time, depicting a cartoon character in a different action. Cartoon images were presented in a booklet and the tested items were counterbalanced across conditions. The experimenter uttered the stimulus sentence and asked the relevant question. Pictures (9)-(12) are examples of the experimental procedure.

(9)

Picture A



Picture B

Experimenter: O Snoopy xorepse, prin zografisi (Snoopy danced before he painted)
Ti ekane o Snoopy prota? (What did Snoopy do first?)
Expected answer: Picture B

(10)

Picture A

Picture B

Experimenter: Afu efage pitsa, to strumfaki mazepse luludia (After he ate pizza, the Smurf picked up flowers)
Ti ekane to strumfaki prota? (What did the Smurf did first?)
Expected answer: Picture A

(11)

Picture A

Picture B

Experimenter: O Mickey magirepse ke meta diavase (Mickey cooked and then read)
Ti ekane o Mickey prota? (What did Mickey do first?)
Expected answer: Picture A

(12)

Picture A

Picture B

Experimenter: O Winnie prota epekse musiki ke diavase ena vivlio (Winnie first played music and read a book)
Ti ekane o Winnie meta?[3] (What did Winnie do after?)
Expected answer: Picture A

[3] It is important to note that stimulus sentences in example (12) (i.e. see Condition 6 in the next subsection) are somehow complex in their interpretation and the question 'ti ekane o Winnie meta' unnatural for many speakers. Given that we wanted the question on this example to be about meta ('after') without using the adverb in the stimulus and after testing it with the adult-control group who had no difficulty in interpreting it within this context, we decided to keep it in our experimental procedure. Nevertheless, we acknowledge that it is not ideal but we decided to included it in our presentation of our study as no strong conclusion is derived by this item and the reader can freely disregard it. From methodological point of view, we consider the presentation of the study as exactly it took place and it is interesting that adults had no problem interpreting it. It is also worth mentioning that this sentence may be dialectally more acceptable, as all speakers who find it less unnatural are Cretan-dialect speakers.

3.2 Participants

51 children (26 girls and 25 boys), aged between 3;0-6;0 years old participated in the study. They were all monolingual Greek speakers and they were recruited from two private kindergartens in Heraklion, Crete. Participants were divided in three age-groups:

Group A: 3;0-4;0 (N=15), Mean age: 3;4,
Group B: 4;0-5;0 (N=19), Mean age: 4;5, and
Group C: 5;0-6;0 (N=17), Mean age: 5;6).
Moreover, the control group consisted of 20 adults (mean age 32) who were tested on exactly the same material as children.

3.3 Material

The experiment included six different conditions and each condition was tested by four items (6 conditions x 4 sentences, 24 items in total). Moreover, we included four training trial sentences, one for each condition (1)-(4) and we also included 12 fillers. The order of the test sentences was pseudorandomized. The experimenter made sure that the child was familiar with the main characters in each sentence and would always ask to child to describe the action depicted in the picture prior to any stimuli (see also in section 3.5). Examples (13)-(18) are representative items of the tested conditions.

3.4 Conditions and type of sentences tested

Condition 1 [mainCP…Before-CP] → Before-chronological order
(13) Η Μαρία χόρεψε *πριν* παίξει.
'Mary danced *before* she played'.

Condition 2 [Before-CP…mainCP] → Before-reverse order
(14) Prin peksi, i Maria xorepse.
'*Before* she played, Mary danced'.

Condition 3 [After-CP...mainCP]→After-chronological order
(15) Afu xorepse, i Maria epekse.
'*After* she danced, Mary played'.

Condition 4 [mainCP…After-CP] → After-reverse order
(16) I Maria epekse, afu xorepse.
'Mary played *after* she danced'.

Condition 5-Two main sentences-Adverb conveying before meaning
(17) O Jianis epekse ke meta efage ena milo.
'John played and *then* ate an apple'.

Condition 6-Two main sentences-Adverb conveying after meaning
(18) I Maria prota epekse ke diavase ena vivlio.
'Mary *first* played and read a book'.

3.5 Procedure

First the experimenter introduced the cartoon character to the child and each participant was asked about what the cartoon seemed to be doing in each picture. Afterwards, the experimenter read the stimulus sentence and would ask the child to show which picture depicted what the cartoon character did first[4] (see also section 3.1). The correct answer corresponded to the event that happened first, irrespectively of whether this was depicted in Picture A or Picture B. The testing session lasted approximately 20-25 minutes.

4 The results

4.1 Acquisition of temporal connectives

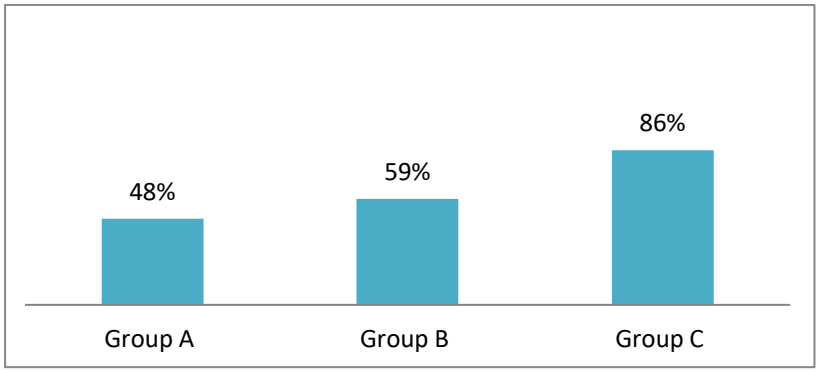


Figure 1 | Condition 1: correct responses

Correct responses for *Condition 1* indicated that there was significant difference in performance across all groups (Ustat=14,786, p=0.001). There was an age effect for Group A and C and Group B and C (Group A<Group B<Group C). Thus, as children get older, their comprehension of *prin*-chronological sentences improves. Children between 3-5 years old develop comprehension of temporal connective *prin* and they manage to have almost acquired it until age six.

[4] It is important to make clear that for conditions 1-5 the question was about what happened first. However, question in Condition 6 asked about what happened last.

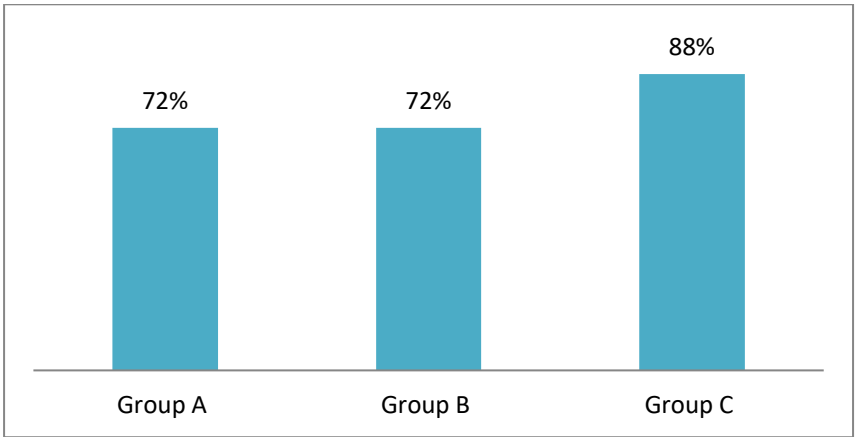


Figure 2 | Condition 2: correct responses

As far as Condition 2 is concerned, significance was obtained for Group A and Group C (Ustat=5,835, p=0.05). Comparison between 3-4-year-olds to 5-6-year-olds revealed that within a year children improve significantly regarding the comprehension of *prin*-reverse sentences.

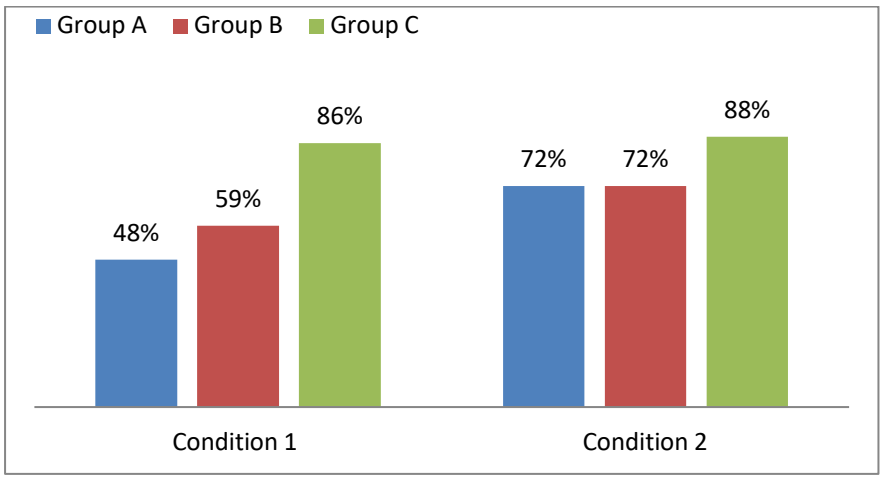


Figure 3 | Conditions 1 & 2: comparison

The comparison between children's performance on *Condition 1* and *Condition 2* revealed that there was no significant difference between the two (p=0.708). *Prin*-reverse sentences show higher success rates across all groups. This was surprising since chronological sentences were assumed to be easier to process than the reverse order. Specifically, for Group A there seems to be a big difference between *Condition 1* and *Condition 2*. However, statistical analysis revealed that the apparent difference is not significant. As for Group C, performance rate in *Condition 1* and *Condition 2* is essentially the same and no significant difference was found (p=1.000). Consequently, children seem to treat temporal connective *prin* in a similar way no matter the context in which it appears.

Still, it is important to clarify why performance was better in reverse sentences since it is generally admitted that chronological sentences and especially *before*-chronological sentences are considered easier in processing (Blything 2016). Our results are in accordance with Pyykkönen and Järvikivi (2012) who have argued that sentences in which a temporal connective is placed initially facilitate processing.

According to their reasoning, children build their mental representation of event sequence instantly without the need to revise it in case that temporal connectives are placed in the middle of a sentence. Moreover, our finding corroborates Papakonstantinou's (2015) finding regarding the pattern on Greek: chronological or reverse order of sentence did not play a role in performance of temporal connective *prin*.

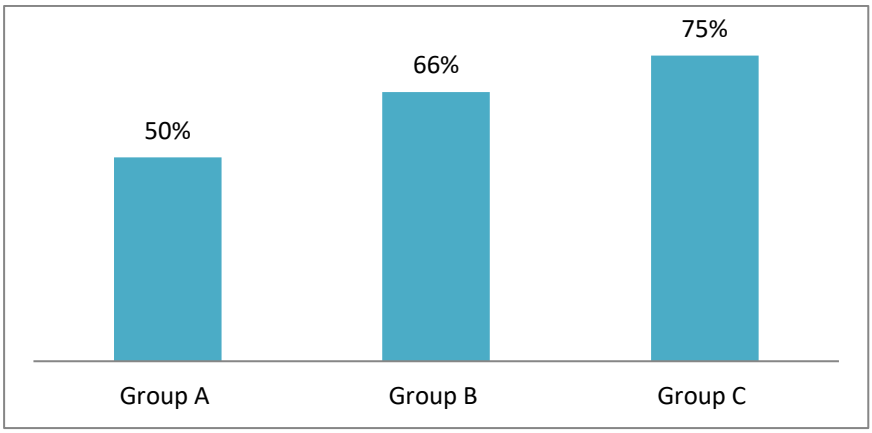


Figure 4 | Condition 3: correct responses

Group C had significantly higher success rate compared to Group A in *Condition 3*. Comprehension of *afu* improves as children get older. Younger children (Group A) show chance-performance (50% correct responses), whereas Group C is significantly better. This comes as no surprise, assuming Clark (1971) who argues that children comprehend *afu*, after they have acquired its semantic features and that this is first obvious in the chronological sentences.

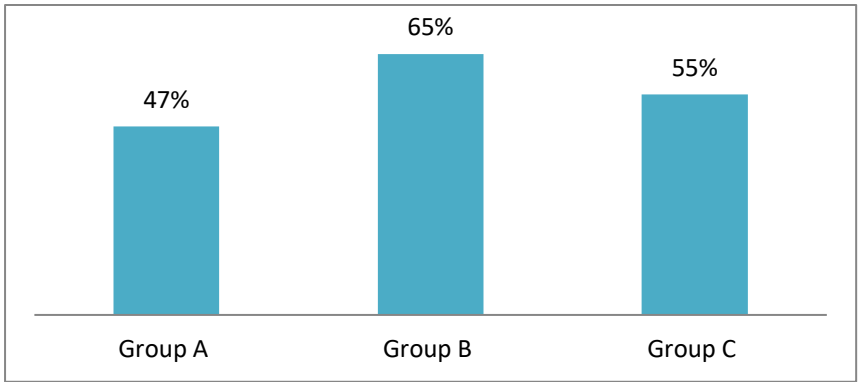


Figure 5 | Condition 4: correct responses

Interestingly and most importantly no significant difference in *Condition 4* was found across the groups, neither was found any age effect. Correct responses were at a chance level even for Group C. This indicates that comprehension of *afu* is still incomplete even at the age of 6.

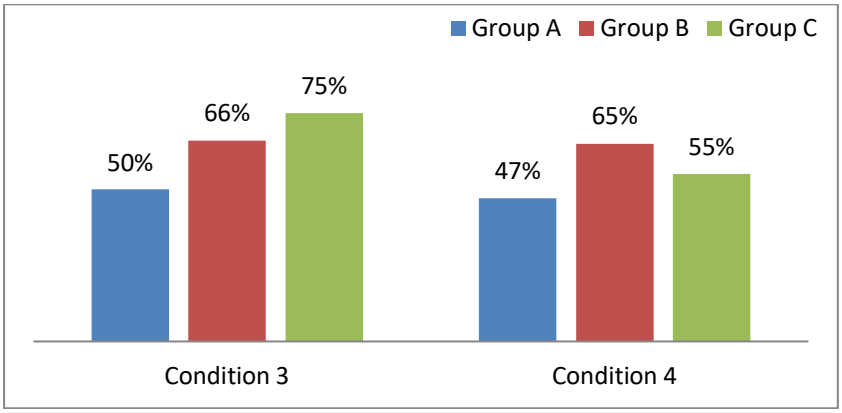


Figure 6 | Conditions 3 & 4: comparison

The comparison between the two conditions revealed that there was no significant difference (p=0.315). It is observed that success in afu-chronological sentences is superior for all groups comparing with afu-reverse sentences. Group A performed almost the same for both sentence types and there was no significant difference (p=0.884). The second group's success rate did not differ and this was also confirmed from the statistical analysis as well. Although, there was a 20% difference in Condition 3 and 4 for older children, it was not significant (p=0.130).

4.2 Acquisition of temporal adverbs

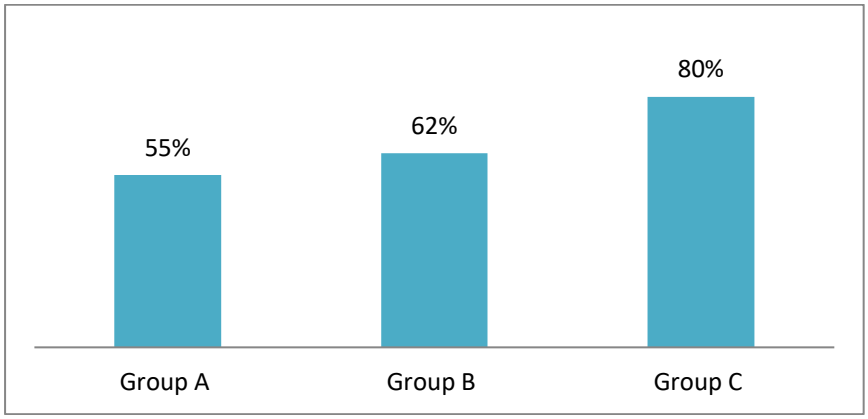


Figure 7 | Condition 5: correct responses

In condition 5, Group C had significantly higher success rate compared to Group A. It is worth mentioning that 5-6-year-old participants performed well enough. There was significant improvement in comprehension of *prota* from age 3-4 to 6. This practically means that older children comprehend temporal adverb 'prota' adequately.

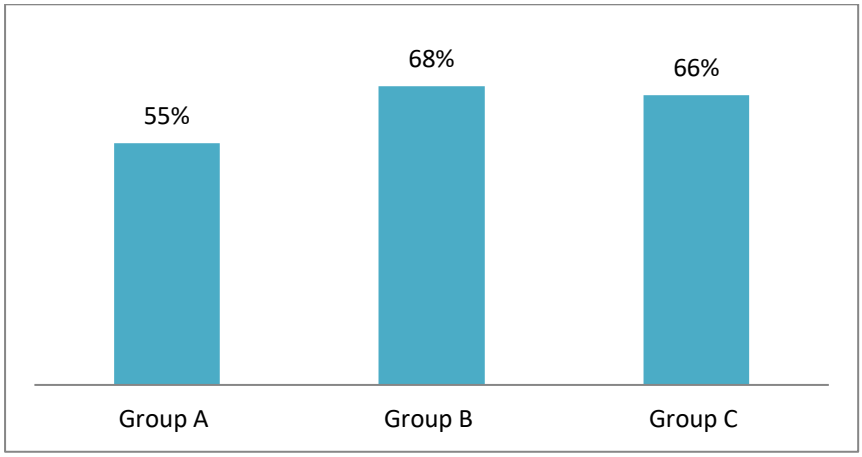


Figure 8 | Condition 6: correct responses

On the other hand, no significant difference was revealed across groups for Condition 6. It is worth mentioning that children's performance in comprehension of *meta* remains low even at the age of 6.

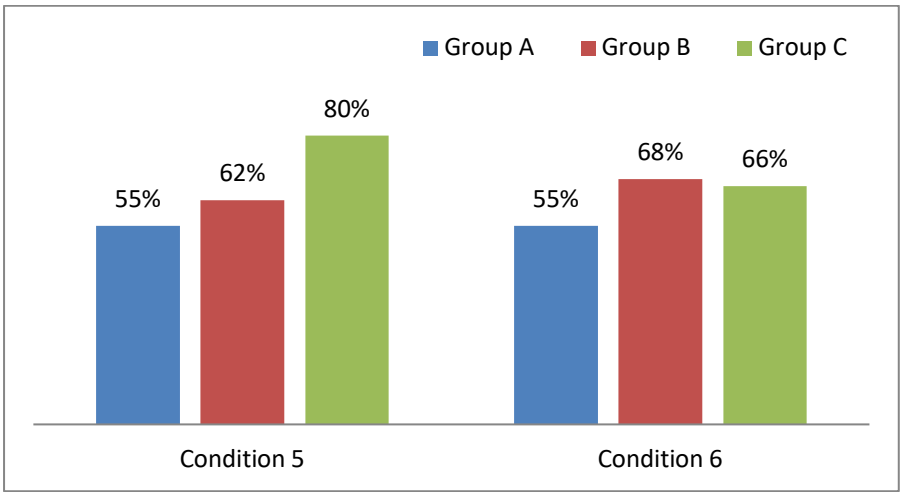


Figure 9 – Conditions 5 & 6: comparison

The comparison between the two conditions did not reveal any significant difference. It is obvious that Group A's performance reached the same success rate for both conditions and consequently there is no statistical difference. Group B performed almost in the same level for *prota* and *meta* and once again significance was not observed. Older children seemed to comprehend better temporal adverb *prota* than *meta* but still difference between percentages is not significant.

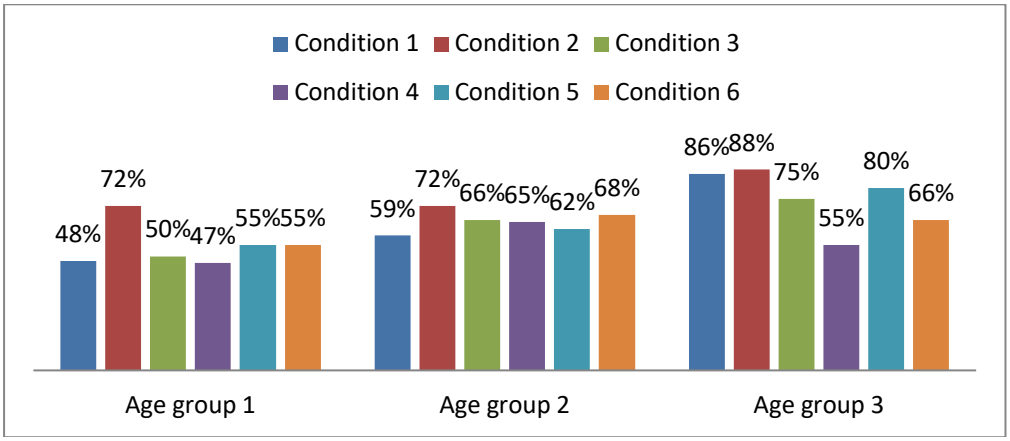


Figure 10 | Overall results: correct responses

A Kruskal-Wallis H test was performed in order to check whether age significantly affected success rate in each condition[5]. Statistical analysis revealed that there was an age effect. The effect of age was statistically significant for Condition 1 (Ustat=14.786, $p < 0.01$), Condition 2 (Ustat=5,835, p=0.05), Condition 3 (Ustat=7,581, p=0.023) and Condition 5 (Ustat=9,099, p=0.011). On the other hand, there was no age effect for Condition 4 (Ustat= 3,398, p=0.183) and Condition 6 (Ustat=4,857, p=0.088).

4.3 Correlations

The Spearman's Rank was applied in order to find out whether there are correlations among the tested conditions that could enlighten us about potential interactions in the development of temporal notions. Table (1) shows the results of the correlation analysis.

	Condition 1	**Condition 2**	**Condition 3**	**Condition 4**	**Condition 5**	**Condition 6**
Condition 1						
Condition 2	**r:0.424****					
Condition 3	**r:0.487****	**r:0.305***				
Condition 4						
Condition 5	**r:0.395****	**r:0.399****	**r:0.442****			
Condition 6						

Table 1 | Correlations

It is observed that there is a significant correlation between *Condition 1* and *Condition 2* (r=0.424**).[6] Both conditions regard temporal connective *prin* and they differ only in order, i.e. chronological or reverse. It is worth pointing out that although

[5] Significance was set at p=0.05.
[6] Two stars (**) next to numbers denote that correlation is significant at the 0.01 level. One star (*) denotes that correlation is significant at the 0.05 level.

this correlation does not feel counterintuitive, it is, to the best of our knowledge, the first time that it has been reported in the literature and it is expected given that our participants performed equally well to *prin*-conditions, independently of the order of the connective.

Moreover, a strong correlation ties *Condition 1* and *Condition 3* (r=0.487**). These two conditions contain different temporal connectives, *prin* and *afu* respectively, but they do have something in common, namely, the chronological order. Perhaps this correlation is a matter of their mutual order. At the same time correlation between *Condition 3* and *Condition 2* (r=0.305*) cannot be easily interpreted. They differ in order and temporal connective included. The only syntactic feature they share is that the temporal connective is placed in the initial position in both cases.

Correlations are also observed between temporal adverb *prota* (*Condition 5*) and temporal connectives. There is a correlation of *Condition 5* to both *Condition 1* and *Condition 2* (r=0.395** and r=0.399** respectively). This is expected since *prota* semantically corresponds to temporal connective *prin*. Moreover, *Condition 5* correlates to *Condition 3* (r=0.442**). Recall that *Condition 5* included temporal adverb *meta*, which is semantically allied with the order of the temporal connective *afu* in *Condition 3*. Finally, it is important to note that no correlation was found for *Condition 4* and *Condition 6* as one would expect, but this can be due to the low degree of acceptability of example (18) (see also footnote 3).

5 Conclusion

The present study examined Greek sequential temporal connectives *prin* (before) and *afu* (after) in correlation to the temporal adverb *prota* (first) and *meta* (then, afterwards).

A primary consideration of our study was to determine at what age children seem to have an adult-like comprehension of these temporal connectives and to shed light on their order of acquisition. A second objective of our study was to check for correlations with the respective temporal adverbs. Finally, we wanted to inspect whether children apply strategies in their responses regarding development of time-notions, as it has been proposed by previous studies (Clark 1971, among others).

According to our findings, children have acquired *prin* by the age of 6 but not *afu*. This finding confirms previous studies which have claimed that *before* is acquired earlier than *after*. The development of the latter seems to goes beyond the age of 6 and further research is necessary in order to determine the exact age of its acquisition.

Semantic connection between *prin-prota* and *afu-meta* was the trigger for the hypothesis that if children are indeed better at *prin*, so they are expected to do with *prota*. Our results showed a strong correlation in the development of this pair. This suggests that the development of a temporal notion (facilitated or not by the linguistic input) is expected to be attested in all the environments in which this notion is relevant. However, correlation did not occur for *afu* and *meta*. This was expected to a certain degree given that the experimental linguistic stimulus for *meta* was not ideal.

Previous literature has reported that chronological sentences are easier to process. However, this was not confirmed in all cases: children's performance on *prin*-reverse sentences was better than chronological sentences.[7] On the other hand, regarding temporal connective *afu*, chronological sentences displayed a better performance, while

[7] It is subject to further research whether this conclusion can be explained on the basis of spontaneous speech data if the temporal connective *prin* is more commonly placed in initial position in everyday speech and that affects the way children comprehend *prin*-reverse sentences.

afu-reverse sentences are the most difficult. The delayed development of *afu* compared to *prin*, is also found in almost all the previous studies on the topic. However, it is worth pointing out that in Greek, the development of temporal *afu* is probably expected to be even more delayed compared to other languages, due to its semantic opacity with the causative connective *afu* ('since', 'because') in Greek. The latter was not addressed at all in this study as it goes beyond our scope. Finally, the detailed error analysis of our results revealed no use of any strategy.

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