Ambiguity resolution, processing and cognitive control in Greek monolingual and bidialectal ageing

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Περίληψη

Η παρούσα έρευνα εξετάζει την επεξεργασία δομικά αμφίσημων προτάσεων στην ελληνική 16 μονόγλωσσων και 16 διδιαλεκτικών ομιλητών της ποντιακής μεγάλης ηλικίας (Μ.Ο.: 61 έτη) με την τμηματική ανάγνωση προτάσεων και τις γνωστικές δεξιότητες της διατήρησης της προσοχής, επιλεκτικής προσοχής και εναλλαγής προσοχής. Οι διδιαλεκτικοί συμμετέχοντες προτίμησαν να προσκολλήσουν το αντικείμενο στο ρήμα της φράσης που βρισκόταν υπό επεξεργασία, σύμφωνα με την Αρχή του Όψιμου Κλεισίματος (Late Closure effect), ενώ οι μονόγλωσσοι δεν έδειξαν κάποια προτίμηση σε πραγματικό χρόνο. Στη δοκιμασία γραμματικότητας οι δύο ομάδες είχαν παρόμοιες επιδόσεις. Επίσης, οι διδιαλεκτικοί συμμετέχοντες εμφάνισαν γνωστικό προβάδισμα στη δεξιότητα της εναλλαγής προσοχής.

Λέξεις-κλειδιά: αμφισημία υποκειμένου-αντικειμένου, γνωστικός έλεγχος, υγιής γήρανση, διδιαλεκτισμός.

1 Introduction

Despite the great number of studies focusing on on-line ambiguity processing and resolution of various locally and temporally ambiguous structures, the domain of structural subject-object ambiguities has received less research interest in the past years. Empirical evidence on the topic has provided insight primarily on monolingual (L1) and second language (L2) English speakers, whereas what we know about Greek L1 and L2 subject-object ambiguity resolution is mostly based on Papadopoulou and Tsimpli's (2005a; 2005b) leading work. As a result, there is still considerable need for research on the field by investigating the impact of healthy ageing on the resolution of this type of structure. What is more, no previous study to date has considered subject-object ambiguity resolution in conjunction with the effect of bidialectalism, and more specifically speakers of the endangered and understudied Pontic-Greek variety. A final aim of this study is to address the question of whether differences in cognitive abilities determined by experiential factors, such as bilingualism, confer a possible advantage in older adulthood and whether this extends to the case of bidialectalism as well.

2 Literature Review

Although research on structural subject-object ambiguities had reached its peak in the 2000's, there is still gap of evidence on processing and resolution of such structures in healthy ageing, and more interestingly in older bidialectalism. Greek, a morphologically rich language, constitutes an ideal candidate for this investigation.

2.1 Processing of structural subject-object ambiguities

Earliest attempts on mapping the resolution and processing of structural subject-object ambiguities have mainly focused on L1 English speakers and have thus provided us with an abundance of English-based data on this phenomenon. According to the serial processing account (Frazier 1978), one of the most prevalent sentence processing accounts proposed, subject-object ambiguities in English are computed in two processing stages. During the first processing stage the reader relies mainly on syntactic information in order to construct the initial computations, while in the second stage s/he subsequently draws on the pool of thematic information. Looking at Frazier's and Rayner's (1982: 179) example below (1b: adapted here as 1), during sentential processing the reader initially interprets the NP *the mile* as the object of the subordinate clause verb *jogs*.

(1) Since Jay always jogs a mile seems like no distance to him.

This tendency for an object-reading preference in such locally ambiguous sentences involving a subject-object ambiguity in English has been established as the Late Closure principle (Frazier 1978). It concerns an automatic processing preference according to which the reader tends to attach each new constituent to the phrase currently being processed rather than to initiate a new clause so as to avoid cognitive load.

However as soon as the parser encounters the verb of the main clause *seems* the original analysis becomes ungrammatical. Due to this structural ambiguity the parser experiences the so-called garden path effect under the Garden Path Theory (Frazier & Fodor 1978) of the serial processing account, where the reader is lead down a wrong analysis during the initial processing stage. In order to resolve this ambiguity the reader now has to discard the previous computation of the NP as the direct object of the adjunct clause (*Since Jay always jogs ~~a mile~~*) and revise a correct analysis by taking into account the argument structure of the NP *the mile* as the subject of the second clause verb *seems* (*a mile always seems like no distance to him*). Such reanalysis in real-time processing has been reflected on longer reading times during readings of the matrix clause verb *seems* and is considered the aftermath and manifestation of the garden path effect.

Apart from English L1in adults (Pickering and Traxler 2003) and children (Traxler 2002) the object-reading preference and Late Closure tendency has been also evidenced in English as an L2 (Juffs 1998), whereas Spanish has shown an Early Closure preference along with French, Dutch and German. However research on subject-object ambiguities in Greek has not progressed further the past fifteen years, ever since Papadopoulou and Tsimpli's original work in Greek as an L1 and L2 (2005a, 2005b). What is more no evidence is available yet on the processing of structural ambiguities in L1 older adulthood, nor in older Greek bidialectalism.

2.2 Structural subject-object ambiguities in Greek

Morphologically rich and highly inflected languages, like Greek, offer an ideal ground for the investigation of structural subject-object ambiguities because disambiguation is achieved via morphosyntactic means, such as morphological case.

As a result morphological case plays a vital role in the disambiguation process, even more important than syntactically-based parsing strategies like Late Closure.

Seminal research in the processing and resolution of subject-object ambiguities in Greek L1 young adults (Papadopoulou and Tsimpli 2005a) indicated that in Greek the structural ambiguity is rather located in determiner phrases (henceforth DPs) which are marked in morphological case (nominative & accusative) and are following an optionally transitive verb. The researchers established that there are two processing stages involved in the disambiguation of such case-bearing constructions: the first stage is evident on the determiner and the second on the noun, depending on the transitivity of the preceding verb. To take an example, while reading the sentences (2a) and (2b) the reader encounters the subject-object ambiguity of the DP following the adjunct clause verb *majireve* "was cooking". This occurs because the verb of the pre-posed adverbial clauses optionally transitive while the following DP is marked for either nominative (*i astaki* "the lobsters–NOM") or accusative case (*tus astakus* "the lobsters–ACC"). Thus, based on its morphological cues, the DP is interpreted as either the object of the embedded verb (2a), or the subject of the main verb (2b):

(2) a. *Καθώς μαγείρευε οι αστακοί κάηκαν στην κατσαρόλα.*
while was-cooking the-NOM lobsters-NOM burnt-3PL in the pot
"While (s)he was cooking the lobsters burnt in the pot."

(2) b. *Καθώς μαγείρευε τους αστακούς κάηκε στην κατσαρόλα.*
while was-cooking the-ACC lobsters-ACC burnt-3SG in the pot
"While (s)he was cooking the lobsters (s/he) burnt herself in the pot."

In their experiment participants' reaction times (RTs) of each segment were recorded along with a timed grammaticality judgment task at the end of each sentence. The findings suggested that in the determiner segments of the DPs young Greek L1 adults experienced a garden path effect. This was evident in their increased reading times in the subject conditions (when determiners were in nominative case; 2a) when compared with the object conditions. Therefore, young Greek monolinguals exhibited an object-reading preference (for determiners that were in accusative case; 2b) and hence showed a Late Closure preference in this segment. This revealed that, up to this segment, participants followed syntactically-based parsing strategies in their processing and that no argument properties affected their resolution preferences thus far.

However, when the adjunct clause verb is intransitive like *etrehe* "was running" (3a-b) followed similarly by a DP in nominative (*i astaki* "the lobsters-NOM") or in accusative case (*tus astakus* "the lobsters-ACC") analyses of participants' RTs showed that young Greek monolingual adults now favoured subject readings instead, as evident by their faster RTs in this condition.

(3) a. *Καθώς έτρεχε οι αστακοί κάηκαν στην κατσαρόλα.*
while was-running the-NOM lobsters-NOM burnt-3PLin the pot
"While (s)he was running the lobsters burnt in the pot.

(3) b. *Καθώς έτρεχε τους αστακούς κάηκε στην κατσαρόλα.* *
while was-running the-ACC lobsters-ACC burnt-3SG in the pot
"While (s)he was running the lobsters (s/he) burnt herself in the pot."

Therefore participants detected the ungrammaticality of sentences that involve the combination of an intransitive verb followed by a DP marked in accusative and did not show a preference for conditions in which the DP was interpreted as the object of the intransitive verb. This gradual disappearance of the previous object preference suggested that the garden path effect on the Determiner is probably not as conscious in Greek as it is in English. The previous Late Closure effect on the Determiner has now given its place to a Grammaticality effect on the Noun readings, meaning that the thematic information of the embedded verb, namely the argument structure, was now available to the readers during the second processing stage. The disambiguation process is thus achieved within the DP, due to the availability of morphological cues, even before the readings of the main verb that comes afterwards. It was therefore shown that morphological cues play a very important role in the disambiguation process of subject-object ambiguities in Greek and even override structurally-based parsing strategies, which apply in English.

The same self-paced reading paradigm was used to examine L1 Greek children (and L2 Greek adults, but this is beyond the scope of this paper). Data showed that L1 Greek children also follow a two-staged analysis on the Determiner and Noun respectively but their processing is not guided entirely by similar principles and shows developmental deviations. Specifically during the first processing stage Greek children showed no preference for either subject or object readings, unlike L1 Greek adults, whereas during the Noun readings children exhibited the adult-like Grammaticality effect by showing a subject preference in the intransitive conditions. This suggested that L1 Greek children relied more on morphological cues, rather than structural parsing strategies, to resolve subject-object ambiguities.

Taken together, the results from the above studies offer insight on the nature of subject-object ambiguity processing in Greek monolingual adults and children. However, there is still need for research on the processing of such locally ambiguous structures and the disambiguation strategies followed by older adults and even more interestingly by older bidialectal speakers.

2.3 Cognitive decline and language effects in healthy ageing

As the numbers of older people around the world are growing drastically, increasing research interest is directed towards the effects of ageing. Typical ageing processes are associated with an expected cognitive decline, the repercussions of which are evident on both verbal and non-verbal processing.

Research in the cognitive domain has showed that ageing effects are manifested in slower RTs in recall and recognition tasks, which have been interpreted as either a sign of reduced capacity or a problem with resource allocation (Titone, Prentice, and Wingfield 2000). Titone et al. (2000) also showed that cognitive ageing has been linked with declining speed and performance in the linguistic domain, observed in older adults' slower processing of ambiguity resolution. Particularly visible age differences in speed are manifested in garden-path sentences that involve the resolution of a locally ambiguous structure (Stine-Morrow, Ryan, and Leonard 2000), although it has been noted that comprehension and resolution accuracy of such structures seems to remain relatively intact with age (Light and Capps 1986). It would therefore be interesting to investigate the effect of ageing on the processing and resolution of subject-object temporal ambiguities.

2.4 Bilingual advantage in healthy ageing

Although studies unequivocally point towards the negative impact of healthy ageing on cognition, most recent research has also acknowledged the protective effects of bilingualism in older adulthood and its contribution to cognitive reserve. The general finding is that bilinguals outperform monolinguals in cognitive tasks that require selective attention and cognitive control (Bialystok, Craik, Green, and Gollan 2009). Bilingualism has even been suggested to ameliorate cognitive decline and aid as a protective shield against neurodegenerative diseases, such as dementia (Bak and Alladi 2014). As a result, one may wonder whether these advantageous effects also extend to different forms of bilingual experience, such as in older bidialectalism. Based on recent research any combination of typologically close varieties of a language suffices to give rise to similar cognitive advantages (Antoniou, Grohmann, Kambanaros, and Katsos 2016) and we would therefore expect to see analogous benefits in older Pontic-Greek bidialectals due to their extensive exposure to an additional dialect since childhood.

3 Research Hypotheses

This study has a two-fold aim: First, we wanted to investigate whether there is an impact of bidialectalism on language in healthy ageing. Processing patterns were expected to differ between older monolingual and bidialectal adults, although no group differences were predicted in their grammaticality judgment accuracy. Second, we aimed at examining whether Pontic-Greek bidialectals of older age would exhibit a cognitive resources advantage compared to their monolingual peers.

4 Methodology

4.1 Participants

We recruited 16 Pontic-Greek bidialectals of older age (8F; Mean age: 60.8 years; SD: 3.6) and 16 older Greek monolinguals (3F; Mean age: 60.4 years; SD: 2.9) matched in age, education and SES. All participants resided in Thessaloniki and were native speakers of Greek. A demographic information questionnaire established background information (language history, education, socioeconomic status, level of literacy and literary habits). Potential signs of dementia or other cognitive impairments due to age were eliminated with the successful completion of the Mini Mental State Examination (Fountoulakiset al. 2000 for Greek) since all participants scored 27/30 or higher. The bidialectals were heritage speakers of the endangered Pontic-Greek dialect, whose parents or grandparents had migrated to Greece from the region of Pontus in Turkey. They all reported to be very active and fluent speakers of Pontic-Greek since childhood.

4.2 Materials

4.2.1 Self-paced reading paradigm

We investigated the resolution of local subject-object ambiguities involving morphological case with the use of an on-line self-paced reading paradigm (Papadopoulou and Tsimpli 2005a, 2005b). The sentences were presented in a word-by-word fashion following the moving-window technique, where participants controlled for the rate of appearance of the next word with a key press. A timed grammaticality judgment task, with the key presses "YES" or "NO", followed each sentence to measure accuracy and ensure attainment. The stimuli were 24 experimental sentences, equally distributed across four conditions (Transitive Subject, Transitive Object, Intransitive Subject and Intransitive Object), and 72 fillers. The experimental items' structure involved a pre-posed adverbial clause with either an optionally transitive or intransitive verb directly followed by a DP marked in case, Nominative or Accusative (examples 4a-4d). Participants had to rely on the cues of morphological case of the DP to resolve the ambiguity. The transitive conditions were designed as such in order to explore parsing strategies, while the intransitive ones to investigate on-line ungrammaticalities.

(4a) Transitive subject condition (TS)
Καθώς/ μαγείρευε/ οι/ αστακοί/ κάηκαν/ μέσα/ στην/ κατσαρόλα.
While/was-cooking/the-NOM/lobsters-NOM/burnt-3PL/in the/ pot
"While (s)he was cooking the lobsters burnt in the pot."

(4b) Transitive object condition (TO)
Καθώς/ μαγείρευε/ τους/ αστακούς/ κάηκε/ μέσα/ στην/ κατσαρόλα.
While/was-cooking/ the-ACC/ lobsters-ACC/ burnt-3SG/ in the/ pot
"While (s)he was cooking the lobsters (s)he burnt in the pot."

(4c) Intransitive subject condition (IS)
Καθώς/ έτρεχε/ οι/ αστακοί/ κάηκαν/ μέσα/ στην/ κατσαρόλα.
While/ was-running /the-NOM/ lobsters-NOM/ burnt-3PL/ in the/ pot
"While (s)he was running the lobsters burnt in the pot."

(4d) Intransitive object condition (IO)
* Καθώς/ έτρεχε/ τους/ αστακούς/ κάηκε/ μέσα/ στην/ κατσαρόλα.
While/ was-running /the-ACC/ lobsters-ACC/ burnt-3SG/ in the/ pot
"While (s)he was running the lobsters (s)he burnt in the pot."

4.2.2 Test of Everyday Attention (TEA)

For the examination of the participants' executive functions we administered three auditory subtests of the TEA (Robertson et al. 1994). The Elevator Task (ET) measured participants' sustained attention since they were asked to count a string of same-pitched simple tones. In the Elevator Task with Distraction (ETD) participants were requested to only count the simple tones while ignoring the high tones and therefore this subtest examined their selective attention ability. Finally, the Elevator Task with Switching (ETS) measured their attentional switching ability since participants had to alternate between higher and lower tones and reverse count.

5 Results

5.1 Self-paced Reading Paradigm

For the analysis of the linguistic task dependent variables were considered the reading times (RT) for the Determiner and Noun and the accuracy scores in the timed grammaticality judgment task. Following Marinis, Blom, and Unsworth (2010) extreme values and outliers (RTs exceeding 2SD) (i.e. 6% of the overall RTs) were replaced with the mean value in each condition per participant.

We ran a 2x2 repeated-measures ANOVA with Verb type (transitive vs. intransitive) and Syntactic function of the DP following the embedded verb (subject vs. object) as within-subject variables. This could indicate possible differences in the strategies that the two groups followed in their sentential resolutions. When statistically significant results were yielded, paired-samples t-tests revealed significant differences.

In the Determiner of the DP following the embedded verb there was a statistically significant Group Effect ($F(1, 190)= 4.193$; $p= .042$). Thus, we further conducted separate analyses for each group. Analyses of the bidialectal data revealed a statistically significant interaction between Syntactic function and Verb type ($F(1, 95)= 4.339$; $p= .40$) due to the faster RTs for the object than for the subject readings ($t(96)= 2.041$; $p= .044$), meaning that the group of older bidialectals exhibited a garden path effect upon reading the transitive conditions that involved determiners in the nominative case (Figure 1). Monolingual data showed no significant effects and therefore no particular parsing strategies in this segment.

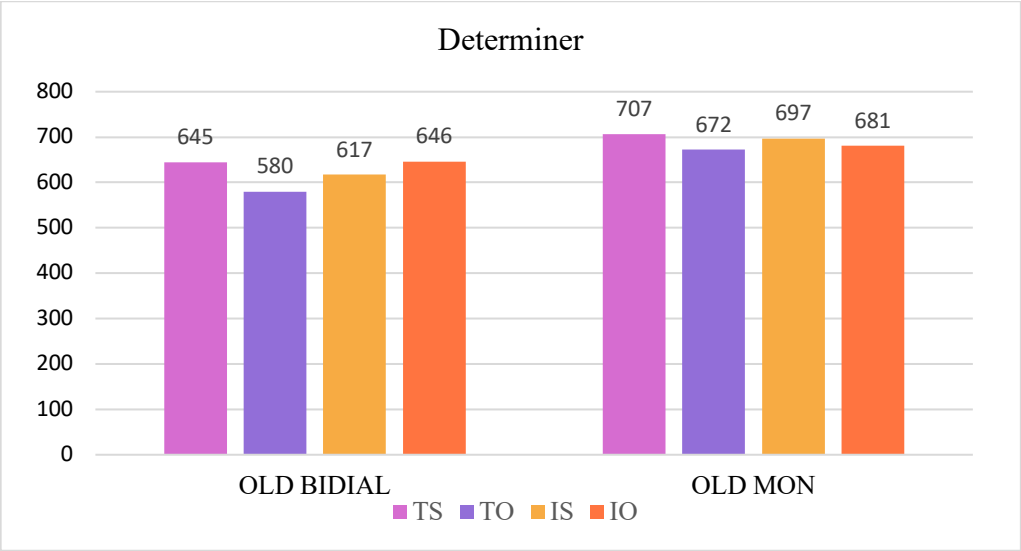

Figure 1 | Determiner: Mean RTs per group per condition

Analyses of the Noun of the DP showed a main effect of Syntactic function ($F(1, 190)= 6.690$; $p= .010$), a main effect of Verb type ($F(1, 244)= 14.382$; $p< .001$) and a significant interaction between Syntactic function and Verb type ($F(1, 244)= 14.878$; $p< .001$), while no Group effect was evinced. Hence, the two older groups, bidialectals and monolinguals, exhibited the same pattern of processing in this segment. More specifically, a main effect of Verb Type (BIDIAL: $F(1, 95)= 6.939$; $p= .010$; MON: $F(1, 95)= 7.729$; $p= .007$) was revealed for both groups. Bidialectals also

showed a significant interaction between Syntactic function and Verb type (F(1, 95)= 13.463; p<.001), whereas older monolinguals showed a main effect of Syntactic function (F(1,95)= 4.530; p= .036). This was due to the fact that the ungrammatical condition IO was read significantly slower than the IS one (BIDIAL: t(96)= -3.195; p= .002; MON: t(96)= -2.547; p= .012). No parsing strategies towards a subject or an object preference in the transitive conditions were revealed in this segment.

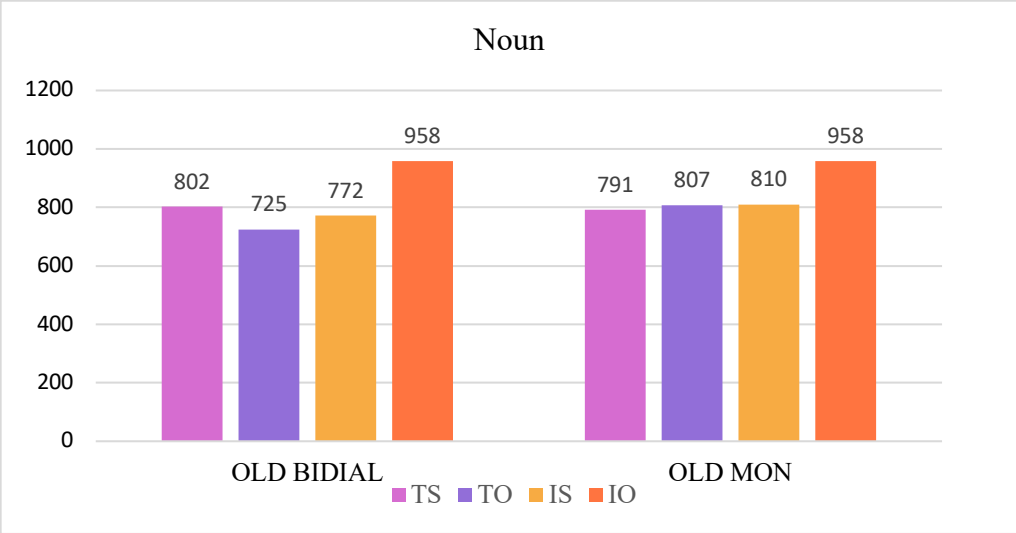

Figure 2 | Noun: Mean RTs per group per condition

5.2 Grammaticality Judgment Task

In this section we report on the accuracy findings from the judgment task, derived from participants whose accuracy in the fillers was approximately 90%. No Group effect was obtained for the participants' accuracy scores. Both older bidialectal and monolingual data revealed a similar pattern in their response accuracy. There was a main effect of Syntactic function (BIDIAL: (F(1, 15)= 11.560; p= .004; MON: (F(1, 15)= 11.560; p= .004) and a significant interaction between Syntactic function and Verb type in both groups' data (BIDIAL: (F(1, 15)= 12.246; p= .003; MON: (F(1, 15)= 7.075; p= .018). Comparison of the accuracy per condition revealed that both older groups alike responded significantly less accurately in the IS than in the ungrammatical IO condition (BIDIAL: t(15)= -4.204;p= .001; MON: t(15)= -3.511;p= .003). Also the TO condition was responded to significantly less accurately than the ungrammatical IO condition (BIDIAL: t(15)= -3.596; p= .003; MON: t(15)= -4.163; p= .001).

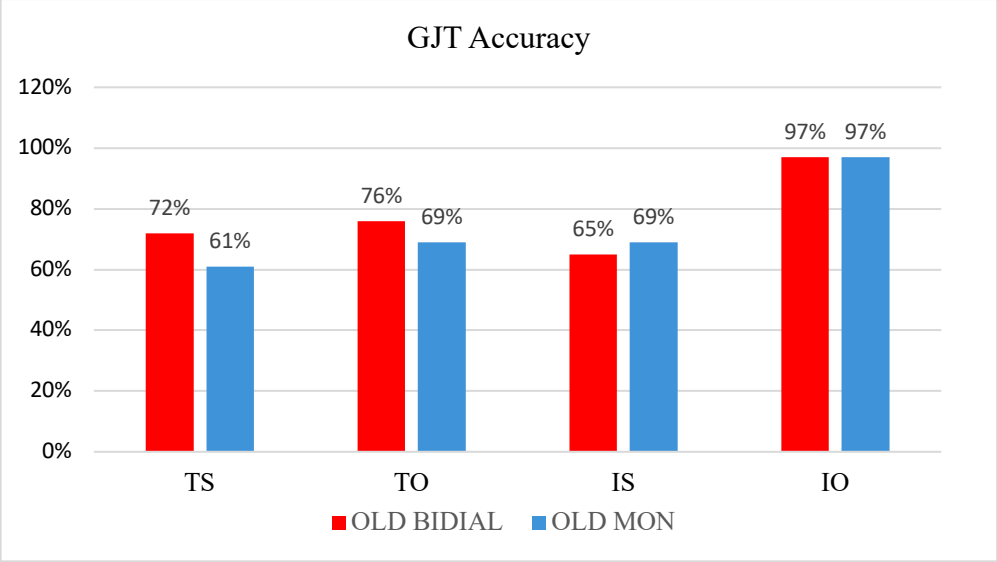

Figure 3 | Grammaticality Judgment Task: Accuracy Scores

5.3 Cognitive measures: Test of Everyday Attention

Finally we considered participants' sustained attention, selective attention and attentional switching performance.

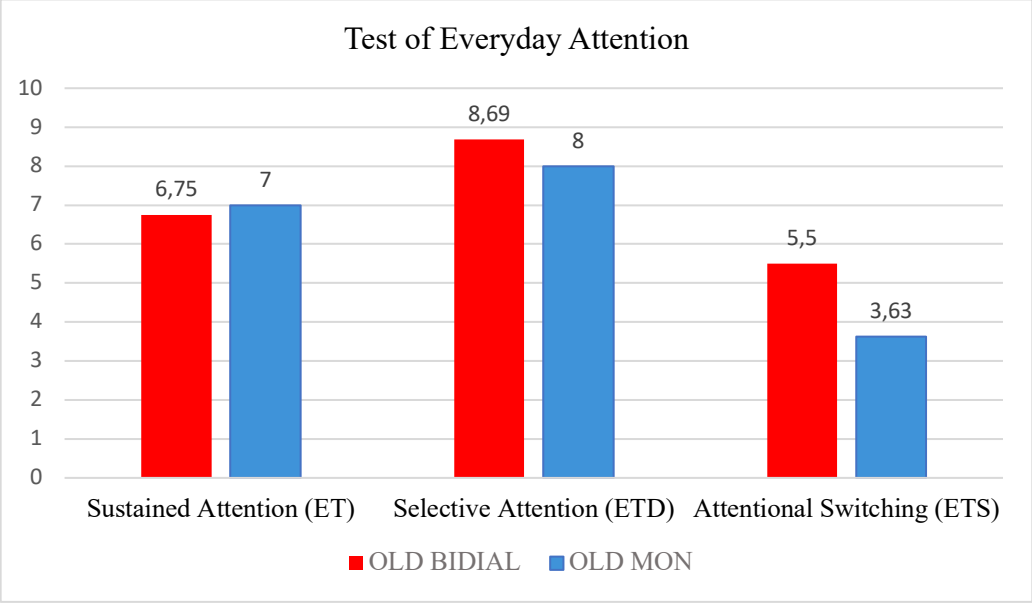

Figure 4 | TEA Scores per Group

We ran a one-way ANOVA with ET, ETD and ETS as the dependent variables and group as the between-subject factor. No significant Group Effect was found for ET and ETD and therefore the two groups' performance did not differ significantly in the tasks measuring sustained and selective attention. However older bidialectals scored better than their monolingual peers in ETS, although the effect did not reach high significance ($F(1, 30)= 3.610$; $p=.067$), probably due to the small sample size. Thus,

data showed that Pontic-Greek older bidialectals exhibited a trend and possible advantage in their switching ability when compared to their monolingual peers.

6 Discussion

The present study investigated the impact of bidialectalism in the processing and resolution of subject-object ambiguities on DPs resolved by case morphology as well as its effect on cognitive control in healthy ageing. Results from the linguistic task revealed that during the Determiner readings older Pontic-Greek bidialectals showed the expected Late Closure effect, in line with previous research in young monolingual adults, offering support to cognitive reserve and the facilitative effect of bidialectalism. Older Greek monolinguals on the other hand did not show any processing preference here, evidence that points towards age-related cognitive decline. During the Noun readings the two older groups showed the same processing preferences and the expected Grammaticality effect, in line with young monolingual adults, suggesting that the thematic information was available to both older populations in this segment. Grammaticality judgment accuracy did not differ between older bidialectals and monolingualsas predicted. Finally in the cognitive resources task, a trend was revealed in favour of Pontic-Greek older bidialectals in their attentional switching ability, a benefit that possibly derives from their long-term experience in switching between two dialects and exercising their cognitive control.

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