Abstract

In sentence processing research involving the visual presentation of sentential stimuli, self-paced reading (henceforth, SPR) has become one of the most widely-accepted experimental tasks. However, just as it is incumbent on sentence processing researchers to scrutinize prominent theoretical claims, it is also necessary to probe this accepted methodology for weaknesses as well as to add new techniques to our methodological toolkits. Following this reasoning, the present paper addresses these methodological concerns by comparing the findings from the SPR and the cross-modal lexical priming (henceforth, CMLP) techniques on sentences involving unergative and unaccusative verbs in Greek.

1. The linguistic framework of the study

On the basis of Tsimpli’s (2006) account of unaccusativity, the disambiguation of NACT verbs between an unaccusative and a reflexive reading seems to be non-fixed as it is dependent on pragmatic factors as well as on the [± animacy] of the syntactic subject of the verb, while the classification of ACT verbs as unaccusatives is strictly lexically constrained. Pragmatic information applies to all verbal structures marked with NACT morphology in Greek, including passives and middles, whereas reflexive structures differ in that the subject DP is always an agent. As can be seen in the sentence o adras kriftike ‘The man hid-NACT’, in the absence of any disambiguating cues provided by the continuation of the clause, the NACT verb reaches a final reading (passive, unaccusative or reflexive) on the basis of individual lexical preferences.

Crucially, animacy appears to be relevant in the processing of ACT unaccusative verbs. Several event-related potential (ERP) studies (e.g. Kuperberg 2007) have found that the co-occurrence of an inanimate subject with a transitive verb results in P600 effect, despite the sentence being syntactically well-formed. Such findings evince that animacy and verb types modulate structural choices, with animate entities being preferentially mapped onto agents and inanimate entities onto themes.

2. Aims of the study

While examining task-based effects in the processing of unaccusativity, of particular interest were (i) whether the two tasks (i.e., SPR and CMLP) are capable of reveal-
ing processing differences among unergative and unaccusative sentences, as well as among unaccusative verbs with different morphological marking on their stem and both animate and inanimate entities in subject position; and (ii) whether these effects are indicated precisely at the same region. The current study has also taken advantage of the reported difficulty Broca’s patients face with the processing of non-canonical structures including unaccusatives, and has, thus, attempted to examine the animacy and the voice morphology effects in online unaccusative processing in a group of Greek-speaking patients with Broca’s aphasia. Due to fatigue reasons, though, the patients were only submitted to the CMLP task.

3. Methodology

3.1 CMLP

3.1.1 Subjects

The healthy group included 15 language-unimpaired native speakers of Greek (mean age = 69.2 years). The aphasic group included 8 Greek-speaking male adults (mean age = 69.6 years) diagnosed with Broca’s aphasia on the basis of (i) the administration of the Greek standardized version of the Boston Diagnostic Aphasia Examination battery (Goodglass, Kaplan & Barresi 2001); and (ii) the administration of the Greek adaptation of the Bilingual Aphasia Test (Paradis 1987; Greek version by Paradis & Kehayia 1987), in order to gain a more reliable view of the patients’ type of aphasia (Peristeri & Tsapkini 2011). Furthermore, the 8 aphasic individuals were submitted to a series of sentence-picture matching tasks (Peristeri 2007; 2010) that looked at the patients’ comprehension levels of non-canonical structures.

3.1.2 Method

Friedmann, Taranto, Shapiro & Swinney (2008) have recently used the CMLP method to test A-movement in English unaccusatives. This technique is based on the idea that the speed of access to a word during sentence processing is affected by semantic priming: an item – or crucially a reactivated item at the position of its trace – primes a related word. This phenomenon is used in psycholinguistic research to determine at what point during the course of auditory sentence processing word meanings are activated. Sentences are presented aurally at a normal speaking rate and at some point during the presentation of each sentence, a letter sequence (word or non-word) is briefly displayed on a screen. The participant is asked to listen to the sentence and make a lexical decision (word/non-word) about the letter sequence via a button press.

Crucially for our purposes, this method can also be used in the study of online processing of the trace of movement: if we assume that an antecedent is reactivated at its trace position, the reactivated item should prime a related word at that position. The idea is to check if there is a priming effect in the lexical decision at the trace position: if so, this means that the moved constituent has been reactivated at
the trace position, serving as a prime for a semantically associated visual target word. Our experiment designed to test the nature of Greek unaccusatives in both language-unimpaired and Broca’s aphasic populations was inspired by Friedmann, Taranto, Shapiro & Swinney’s (2008) experiment.

We compared the online processing of two verb classes: unergatives and unaccusatives. We used 32 sentences for the unaccusative verb class and 14 sentences for the unergative verb class (46 target sentences). The 32 unaccusative sentences included 16 ACT unaccusative verbs (half [+ voice-alternating], e.g. lerose ‘spill-ACT’, and half [– voice-alternating], e.g. anbise ‘blossom-ACT’), and 14 unaccusative verbs bearing NACT voice morphology (half [+ voice-alternating], e.g. διπλονομε ‘fold-NACT’, and half [– voice-alternating], e.g. jatrevome ‘heal-NACT’).

All the antecedents were full DPs and included 15 inanimate and 31 animate nouns. More specifically, all syntactic subjects in the unergative sentences were [+ animate], 7 syntactic subjects in the NACT verb condition were [+ animate] and 7 were [– animate], and, finally, 8 syntactic subjects in the ACT unaccusative verb condition were [+ animate] and 8 were [– animate]. The letter sequences for lexical decision (i.e., the visually presented probes) included 92 words and 46 non-words.

Moreover, we used three probe positions to examine the different possible points of reactivation. Like Friedmann, Taranto, Shapiro & Swinney (2008), we used Position 1 (at the subject offset) to control for semantic priming, Position 2 (at the verb offset) whereby the subject trace of unaccusatives is located, and Position 3 (750 msecs after the verb offset) to test for ant late-occurring antecedent reactivation effect. Two probe types were used: probe-words that were semantically related to the subject noun (and thus possibly primed by the subject noun in the right positions) and probes that were semantically unrelated to it (and thus serving as control). Example [1] illustrates the position of the probes (indicated by #) for the NACT unaccusative verb condition.

[1] Ο αρσός # με τις λίχες μερες ζοις κσανικα ιατρεφτική # οταν επισκεφτηκε ενα μοναστηρι
prin liores meres # ke ekane tama
‘The ill man with the few days of life suddenly healed-NACT when he visited a monastery a few days ago and made an offering’

Related probe: jatros ‘doctor’
Unrelated probe: γατα ‘cat’
Non-word probe: poftokasi

3.1.3 Procedure

Participants sat in a quiet room in front of a laptop computer. The sentences were presented over headphones via a digital tape recorder. During the temporal unfolding of each sentence, a visually-presented lexical decision probe appeared centrally for 500 msecs on the screen. Subjects were asked to listen carefully to the sentences and to make a visual lexical decision whenever a letter string appeared on the screen as quickly and accurately as possible by pressing the key marked [1] for ‘yes’ or [0]
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for ‘no’ on the keyboard; response times for this decision were recorded by the computer. E-prime 1.0 software (Schneider, Eschman & Zuccolotto 2002) was used to deliver the stimuli and record reaction times (RTs) via the computer.

3.2 SPR

3.2.1 Subjects
The population examined in this task included 45 adult native speakers of Greek (mean age: 30, age range: 17–43, 24 females and 21 males). All the participants had higher education.

3.2.2 Method
The SPR task is a method largely used in psycholinguistic research, in which written sentences are presented in a word-by-word or phrase-by-phrase fashion. The increased reading times (RTs) on a particular segment (compared to the same segment in a control condition) are supposed to indicate relatively higher processing difficulty (Just, Carpenter & Wooley 1982). The method, thus, reflects initial parsing choices since the reader cannot go back to the words or phrases (s)he has previously read. For the purposes of our study we used the word-by-word fashion in order to examine possible factors that affected the time needed to process the verb segment (Fotiadou 2010).

Additionally, the participants performed a timed acceptability judgment (AJ) task at the end of each sentence. Namely, they were asked to determine the acceptability of the sentences they were presented with, on a rating scale from ‘1’ (= totally unacceptable) to ‘9’ (= totally acceptable), based on their intuition. The choice of a ‘?’ was also provided in case the participants were not able to judge the acceptability of the sentence due to non-experimental factors. RTs for the AJ task were also analyzed in order to investigate possible processing difficulties for specific conditions.

We examined 14 activity verbs, classified as (non)-voice-alternating unaccusatives in the literature (see Theophanopoulou-Kontou 2000):

Class I: jerni ‘bend’, lijizi ‘bend’, ljoni ‘melt’, sapizi ‘rot’, vrazi ‘boil’, stegnoni ‘dry’, and klini ‘close’ which are preferably marked for ACT voice when used with an ergative/anti-causative reading and

Class II: leroni ‘spill’, kaθarizi ‘clean’, tripai ‘pierce’, xtipai ‘hit’, tendoni ‘stretch’, berδevi ‘mingle’ and tsalakoni ‘crumple’ which are used both with ACT and NACT morphology.

The materials consisted of 56 experimental sentences, all involving unaccusative structures: a subject DP + verb ((N)ACT). The verb was presented in ACT and NACT morphology and each form was included in sentences with an animate or an inanimate subject, giving rise to four experimental conditions (act-anim, act-inanim, nact-anim, nact-inanim), as exemplified in examples [2–3] below:

‘The boy crumpled-ACT or NACT after the guests had come’
The verbs examined in this task were all in the 3rd singular simple past or simple present tense. The critical 3rd segment always corresponded to the verb. From the fourth to the seventh (last) segment there was a subordinate clause that did not lead to ambiguity resolution with regard to verb reading. The sentences across the four conditions included the same words and they differed only in the syntactic subject (animate vs. inanimate) and verb morphology (ACT vs. NACT). However, the participants never saw the same context, since two quartets were designed for each verb in order to avoid any repetition effect on the RTs of the SPR or the AJ task, as well as on the degree of acceptability: in the alternative quartet, which also comprised 7 segments, the syntactic subject and the subordinate clause that followed the verb were different. The quartets were distributed across the four versions, so that in each version there were seven sentences per each experimental condition. The task also included 63 filler sentences which were divided into 7 segments and followed by an AJ question.

3.2.3 Procedure

The experiment was administered individually. The participants sat in front of a computer and were presented with a fixed set of instructions. The sentences were presented in a non-cumulative segment-by-segment fashion, with the presentation of each new segment being triggered by the participants’ pressing the ‘space’ button. The participants were instructed to read each segment as quickly as possible and then press the button in order to read the next segment. The times between button presses provided the crucial experimental measure. The sentences were divided into 7 segments as shown in [2–3] and ended with a full stop. All the sentences (filler and experimental) were followed by the 9-point rating scale and the “?” so that participants would judge their acceptability.

This experiment was also designed and set up with the E-prime 1.0 software. All RTs per segment as well as the RTs for the acceptability judgments were recorded.

4. Differences between the SPR and the CMLP task – Predictions on performance

Besides the fact that both the SPR and the CMLP are online tasks that measure the participants’ RTs in successive time-locked windows and manipulate the same variables (i.e., verb type, voice morphology and [± animacy] of the subject), these two techniques differ in their core properties. First of all, successful performance in CMLP requires the use of global grammar, like semantic (word vs. non-word) decisions and activation of the lexical properties of the antecedent, that extends beyond the establishment of syntactic dependencies between the derived subject and its post-verbal trace. In this sense, comprehension in the CMLP task is guided by an interaction
between structure and meaning, akin to that between syntax and semantics relative
to the SPR task that only necessitates syntactic processing of the sentences. The in-
teraction between the costs of performing two tasks that simultaneously tax pro-
cessing resources was expected to bring a slowing effect on gap-filling in the CMLP
task in comparison to the SPR task whose underlying operations are only relevant
to the gap-filling operation. Finally, while no disambiguation of meaning was in-
tended to take place in the SPR task (yet, transitive readings were strongly dis-pre-
ferred), participants in the CMLP task were expected to disambiguate the meaning
of the sentence after Probe Position 2 by paying close attention to the continuation
of the clause post-verbally. Such methodological difference was anticipated to affect
the precise region whereby the [± animacy] of the subject would take place across
the two tasks during the online processing of NACT unaccusatives with an animate
subject. More specifically, animate subjects in the SPR task were expected to elicit
faster RTs than inanimate subjects right after the NACT verb (i.e., at the gap posi-
tion) due to the predominance of the reflexive reading which is the computa-
tionally cheapest parsing option based on the non-derived status of its subject. On the
other hand, the reflexive reading in the CMLP task was anticipated to be excluded
no later than Probe Position 3 (i.e., the disambiguation point), such that the anima-
cy effect was expected to emerge at a late-occurring temporal window, i.e., at the
post-gap position.

5. Results

5.1 CMLP

Following Friedmann, Taranto, Shapiro & Swinney’s (2008) method of data analy-
sis, we conducted repeated measures ANOVAs focusing on each experimental group
separately (i.e., controls, Broca); what we were mainly interested in the repeated
measures ANOVA outputs were the trend analyses for linear and quadratic contrasts
that are specifically designed to assess change of the priming effect and the type of
the priming effect’s change over time for the different verb classes. More specifical-
ly, a linear (straight-line) curve would mean that there is a continuous decrease or
increase in priming effect from Probe Position 1 to Probe Position 2 and Probe Po-
sition 3; this would mean that there is priming for the subject DP and then the an-
tecedent reactivation effect progressively decays or increases as a function of the
post-verbal domain (Probe Positions 2 & 3) of the sentence. On the other hand, a
quadratic trend indicates that a group’s priming effect increases at Probe Position 2
and then decays at Probe Position 3 (inverted U-shaped pattern) or decays at Probe
Position 2 and then increases at Probe Position 3 (U-shaped pattern). Such curves
would translate either into a priming effect immediately after the subject DP and an
even stronger antecedent reactivation effect (i.e., an even greater difference between
the RTs elicited by the related and the unrelated probes) for the position immedi-
ately after the critical verb, or a priming effect at Probe Position 1, decay in activation at the gap position and reactivation of the antecedent at a later point in time (i.e., at Probe Position 3).

The pre-planned trend analyses for the control group with unergative and unaccusative items (sentences) as the random variable, yielded a significant linear trend for the unergative verbs, suggesting that the antecedent was activated at Position 1, it then decayed and it was not reactivated at a later point in time ($F_2(1, 15) = 63.420$, $p < .000$), and a quadratic trend for the unaccusative verbs, meaning that the antecedent reactivation effect grew stronger at Position 2 and decayed at Position 3 ($F_2(1, 29) = 31.002$, $p < .000$). With respect to the aphasic group, the trend analysis of their data across the three probe positions yielded a significant linear trend for both the unergative and the unaccusative verbs ($F_2(1, 15) = 14.499$, $p < .005$; $F_2(1, 29) = 4.438$, $p < .05$, respectively).

Further within-group trend analyses with alternating and non-voice-alternating unaccusatives as the between-subject factor revealed an effect of the [+voice-alternation] dimension on unaccusative sentence processing. More specifically, the analyses for the control group yielded significant quadratic trends for the ACT alternating and NACT non-voice-alternating unaccusatives, while the quadratic trends for the ACT non-voice-alternating and NACT alternating unaccusatives were found to be marginally significant ($F_2(1, 7) = 42.699$, $p < .000$ for ACT alternating unaccusatives; $F_2(1, 7) = 5.098$, $p = .059$ for ACT non-voice-alternating unaccusatives; $F_2(1, 6) = 5.110$, $p = .06$ for NACT alternating unaccusatives; $F_2(1, 6) = 16.625$, $p < .01$ for NACT non-voice-alternating unaccusatives). On the other hand, the ACT non-voice-alternating unaccusatives for the aphasic group showed a linear trend ($F_2(1, 7) = 10.039$, $p < .02$), while the NACT unaccusative verb categories yielded marginally significant quadratic trends, indicating a stronger (than Position 1) priming effect at Position 2 and antecedent decay at Probe Position 3 ($F_2(1, 6) = 5.196$, $p = .063$ for NACT alternating unaccusatives; $F_2(1, 6) = 4.898$, $p = .069$ for NACT non-voice-alternating unaccusatives). Most interestingly, the analysis for the ACT alternating unaccusatives also yielded a near-significant quadratic trend ($F_2(1, 7) = 5.042$, $p = .06$), which was, yet, characterized by a U-shaped activation pattern, thus, implying that there was priming for the subject DP at Position 1, then decay in activation at the gap position, and then reactivation of the antecedent at Probe Position 3.

Finally, the manipulation of the [+animacy] feature of the syntactic subject of the verbs across both ACT and NACT unaccusatives in the CMLP task allowed us to evaluate our initial hypothesis that animacy drives syntactic predictions during the processing of two verb categories. With respect to the control group, the results from the comparison between the unergatives and the ACT unaccusatives revealed a significant effect of verb type at Probe Position 2: the priming effect for ACT unaccusatives was reliably stronger relative to the unergatives ($F_1(1, 28) = 3.983$, $p < .05$), which probably implies that the unaccusative verb sub-categorization drove syntactic expectations about argument realization as early as immediately after the verb,
thus, disregarding animacy violations. In fact, the trend analysis for the animate trials in the ACT unaccusative verb condition, with subjects as the random variable, yielded a significant quadratic trend ($F_{1}(1, 14) = 7.604, p < .02$), suggesting that there was priming for the syntactic subject DP, then reactivation of the antecedent at Probe Position 2, and there was no reactivation of the antecedent at a later temporal point. With respect to the aphasic patients, the same analysis yielded no significant difference between the two verb types for neither position; the trend analysis for the animate trials in the ACT unaccusative verb condition has yielded a non-significant linear trend ($p = .14$).

On the other hand, the analysis comparing the priming effect between animate and inanimate trials in NACT unaccusatives revealed a significant effect of animacy at Probe Position 2 for both groups; the priming effect for the inanimate trials was found to be considerably stronger relative to the animate trials ($F_{1}(1, 28) = 5.219, p < .03$ for the controls; $F_{1}(1, 14) = 8.769, p < .01$ for the Broca group). More specifically, the trend analyses have yielded significant quadratic effects for the inanimate trials ($F_{1}(1, 14) = 11.419, p < .005$ for the controls; $F_{1}(1, 7) = 6.535, p < .04$ for the patients), indicating reactivation of the antecedent at the gap position and then decay of the priming effect. On the contrary, the trend analyses for the animate trials in the NACT unaccusative verb condition yielded significant for the controls but non-significant for the patients U-shaped trends ($F_{1}(1, 14) = 16.139, p < .01$ for the controls; $F_{1}(1, 7) = 4.021, p = .08$ for the patients), thus, suggesting decay in activation at Probe Position 2, and then reactivation of the antecedent at Probe Position 3.

5.2 SPR

The statistical analyses presented below come from 43 participants (2 out of 45 were excluded because in many cases their RTs were 2 Standard Deviations above the Mean of each condition).

The data from the 1st and 2nd segment, during sentence processing, did not reveal any statistically reliable differences among the four conditions. RTs from the 3rd (critical) segment onwards indicated divergent processing preferences depending on the experimental manipulations, particularly an effect of voice rather than verb class. This is evidence for a syntactic processing of movement dependencies or activation of a trace on the NACT verb segment. To explore whether these findings were statistically significant we ran 2×2 repeated-measures ANOVAs with Voice (ACT vs. NACT) and Animacy (animate vs. inanimate subject) as the within-subjects factors. The statistical analyses have been performed with two random effects, subjects ($F_{1}$, $t_{1}$) and items ($F_{2}$, $t_{2}$). The ANOVA performed on the RTs on the 3rd (verb) segment exhibited only a significant voice effect ($F_{1}(1, 42) = 26.527, p < 0.001; F_{2}(1, 26) = 18.510, p < 0.001$), supporting models which suggest the priority of syntax over semantics in the course of sentence processing, while no verb class or animacy effect were found significant. Analyses on the 4th segment did not exhibit any significant effects: only
when we conducted an ANOVA with voice (ACT and NACT) as the within-subject factor and verb-class (voice-alternating and non-voice-alternating) and animacy (animate and inanimate subject) as the between subjects factors we got a significant voice effect ($F(1, 598) = 4.939$, $p = .027$) as well as a significant effect between voice and verb class ($F(1, 598) = 6.731$, $p = .010$), suggesting that verb class effect is evinced on later stages, after the verb segment. On the 5th segment, i.e., the beginning of the subordinate clause, a significant voice effect ($F(1, 42) = 4.945$, $p = .032$, $\eta = .105$; $F(1, 26) = 7.508$, $p = .011$, $\eta = .224$) was also found. Furthermore, an effect of the interaction between voice and animacy ($F(1, 42) = 4.879$, $p = .033$, $\eta = .104$; $F(1, 26) = 7.054$, $p = .013$, $\eta = .213$) was attested: in the presence of animate subjects, participants read faster sentences with NACT than ACT verb forms ($t(42) = 3.148$, $p = .003$; $t(26) = 3.337$, $p = .003$), while the reverse pattern was attested with respect to sentences with inanimate subjects, though with no statistical significance ($t(42) = 1.201$, $p = .236$; $t(26) = 2.044$, $p = .051$). Furthermore, the RTs received for the combination of NACT verbs with animate subjects were faster than those received for NACT verbs with inanimate subjects, but not significantly so ($t(42) = -1.644$, $p = .108$; $t(26) = -1.802$, $p = .083$), pointing towards an explanation based on the derivational difference between reflexive and non-reflexive readings. RTs on the 6th segment were also shown to be affected by voice ($F(1, 42) = 4.677$, $p = .036$, $\eta = .100$; $F(1, 26) = 6.223$, $p = .019$, $\eta = .193$) as well as by the interaction between voice and animacy ($F(1, 42) = 4.365$, $p = .043$, $\eta = .094$; $F(1, 26) = 4.919$, $p = .036$, $\eta = .159$). Paired-samples $t$-tests showed that inanimate subjects did not differentiate processing of ACT and NACT verbs but animate ones facilitated the reading of sentences with NACT over ACT verbs ($t(42) = 2.492$, $p = .017$; $t(26) = 2.893$, $p = .008$). Furthermore, the combination of NACT verbs with animate subjects was again read faster than its combination with inanimate subjects ($t(42) = -2.110$, $p = .041$; $t(26) = -1.354$, $p = .187$).

Turning to the Aj task, data showed that participants accepted ACT non-voice-alternating unaccusatives (‘high’ (169/602) vs. ‘low’ (92/602): $\chi^2 = 22.716$, $p < .001$) but not NACT ones (‘high’ (23/602) vs. ‘low’ (237/602): $\chi^2 = 176.138$, $p < .001$). Moreover, despite the tendency to accept them in ACT voice, there were also 92/602 (15.28%) low evaluations, that came from their combination with animate subjects (animate (79) vs. inanimate (13): $\chi^2 = 47.348$, $p < .001$). The reverse pattern was attested among voice-alternating unaccusatives: participants accepted NACT forms (‘high’ (82/602) vs. ‘low’ (150/602): $\chi^2 = 23.581$, $p < .001$) but not ACT ones (‘high’ (168/602) vs. ‘low’ (90/602): $\chi^2 = 19.931$, $p < .001$). Thus, despite the fact that they are assumed to freely alternate, except from the case of the combination of ACT verb forms with animate subjects, NACT forms proved to be more accepted, while the accepted ACT forms were mostly derived from the combination of the verb with inanimate (52/82) as well as animate (30/82) subjects. The RT analysis in the Aj task revealed that deciding whether to accept a sentence containing an unaccusative verb has been a more difficult task when the verb was in ACT morphology than in NACT: a 2×2 repeated-measures ANOVA with voice (ACT vs. NACT) as the within-subjects factor, and
animacy (animate vs. inanimate subject) as the between-subjects factor revealed only a voice effect \( (F(1, 170) = 4.770, p = 0.030) \). Further analysis performed by taking into account the two verb classes (i.e., voice-alternating and non-voice-alternating unaccusatives) showed that the voice effect was significant \( (F(1, 84) = 10.814, p = 0.001) \), as well as the interaction between voice and verb class \( (F(1, 84) = 9.303, p = 0.003) \). Furthermore, a verb class effect was found \( (F(1, 84) = 4.805, p = 0.031) \), while the interaction between verb class, animacy and voice just reached significance \( (F(1, 84) = 3.918, p = 0.051) \). This finding reveals a different degree of significance in the voice and animacy effects among the two verb classes: in non-voice-alternating unaccusatives, voice effect was significant \( (F(1, 84) = 12.245, p = 0.001) \), but animacy was not, while in voice-alternating unaccusatives neither voice nor animacy effect were significant. A final note with regard to RTs and AJ ratings is that among the verbs tested, low scores were only received for NACT forms of non-voice-alternating unaccusatives and ACT voice-alternating forms with animate subjects. The participants were very fast in rejecting the former verbs in NACT, regardless of animacy. However they were very slow in rejecting the latter verbs in ACT forms with animate subjects. With respect to the rest of the conditions, participants were very slow in deciding on the acceptability of voice-alternating verbs in ACT voice with inanimate subjects, although the rates received were not elevated; similarly they were slow in giving high rates for ACT non-voice alternating verbs with inanimate subjects and voice-alternating verbs irrespective of animacy.

6. Discussion

The findings of the two experiments have a number of methodological implications. Most importantly, it is clear that both the CMLP and the SPR task have revealed a voice morphology effect with the NACT verbs elicitizing significantly higher RTs than the ACT verbs. The overall slowing down of the experimental subjects’ processing for NACT forms did not differ across the two tasks; the highest RTs for the specific structures were calculated on the verb form and right after the verb, at the gap position, for the SPR and the CMLP task, respectively. Most importantly, the CMLP task has yielded the highest RTs (especially, for the aphasic group, as expected) due to its higher complexity. Syntactic and semantic composition was implemented simultaneously, while the SPR task provides more ‘localized’ indications of incremental sentence processing difficulty only relevant to the level of syntax.

Of particular interest is both tasks’ capability of revealing processing differences among voice-alternating and non-voice-alternating unaccusative verbs. Such verb-type effect was found on the 4th segment (right after the verb) in the SPR task, as well as on the decision making segment in the acceptability judgment task. Most interestingly, voice-alternating vs. non-voice-alternating distinctions in the CMLP task were only evident for the Broca individuals who showed no antecedent reactivation for ACT non-voice-alternating unaccusatives and a delayed priming effect
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(i.e., antecedent reactivation at Probe Position 3) for ACT alternating unaccusatives. Such findings may be interpreted in terms of a deficit preventing patients from easily accessing lexicon-filtered information responsible for the valuation of some intransitive verbs as unaccusatives in the absence of a NACT morphological marking on their stem. Nevertheless, occasional access to the ACT alternating verb’s underlying layer of medio-passive morphology appeared to facilitate antecedent reactivation, par consequence, grammatical encoding for the specific verb type. The total absence of a parallel verb-type effect for the control group in the CMLP task (the reader is reminded that controls in the CMLP task have exhibited a post-verbal priming effect for all unaccusative verbs irrespective of their [± voice-alternation] properties) may be accounted once more in terms of the task’s higher processing demands which tended to neutralize the alternating distinction and retained only the argument structure differences between unergatives and unaccusatives.

We end by elaborating on the evidence highlighting the crucial role played by the [± animacy] of the subject in the modulation of the experimental subjects’ parsing performance for the unaccusative sentences across both tasks. Animate subjects in the SPR task were found to affect RTs after the NACT verb segment, in terms of speeding up the subjects’ responses for the [+ animate] (vs. inanimate) subject trials. Such performance, as already mentioned, may be attributed to the prevalence of the reflexive reading which was preferred as the computationally less demanding parsing option by the participants. On the contrary, the RTs were slowed down once the subject of the ACT unaccusative verbs was animate, as already mentioned. On the other hand, the presence of an animate subject in the NACT unaccusative verb trials appeared to considerably slow down both controls’ and patients’ performance during the temporal unfolding of the sentence. We believe that the U-shaped trajectory of the priming effect in NACT unaccusatives with an animate subject is attributed to a garden-path effect caused by the early interference of the reflexive reading during on-line sentence processing. Most interestingly, the comparison between the Broca group’s priming effects elicited by animate and inanimate subjects in ACT unaccusatives points once more towards the crucial role played by the animacy of the subject. The total lack of a priming effect for ACT unaccusatives with an animate subject implies that the Broca patients have misperceived the animate syntactic subject as an agent, and, thus, (mis)interpreted ACT unaccusative structures as unergatives.

7. Conclusions

Taken together, these results highlight the role that task effect may play in online sentence processing and, more specifically, in the parsing of unaccusative structures. Our findings suggest that at best, the CMLP task does pose higher processing demands to the human parser relative to the SPR task which is less cognitively costly. The higher complexity value attributed to the CMLP task was especially evident in
the performance of the Broca’s aphasic individuals who have been extensively reported in the literature to have trouble processing complex syntactic structures. Moreover, the analyses suggest that not only argument structure distinctions between unaccusatives and unergatives, but also voice morphology cues and information on the animacy features of the derived subject in unaccusatives constitute crucial factors in modulating both language-unimpaired and language-deficient populations’ parsing options during online unaccusative sentence processing.

References


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