A psycholinguistic analysis of NP-movement in English

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SUMMARY

The middle construction and the unaccusative construction in English are both said to involve a change in argument structure, but differ in how this change arises. Theoretical accounts of unaccusatives agree that NP-movement underlies the alternation in unaccusatives (Baltin, 2000). Conflicting analyses of the English middle construction exist, with some theorists proposing that the English middle is formed through NP-movement, while others positing a more lexical approach (Stroik 1992; Ackema & Schoorlemmer, 1995). The present study employed eye-tracking to test these conflicting theoretical accounts by comparing the processing effort associated with syntactic constructions that are or are not predicted to involve NP-movement (i.e. middle constructions, unaccusatives, inchoatives, unergatives and unergative instrumentals). The critical areas examined were the noun, verb and adverb regions. The data was analyzed using multiple linear regression models for continuous eye movement variables (e.g. total fixation time) and linear logistic regression models for categorical eye movement variables (e.g. regression rate) on the critical region as dependent variables, verb type as the critical independent variable and multiple controls. The analysis of total fixation time and regression rate into the critical verb and adverb region indicates that unaccusatives were fixated on the longest and had the highest rate of regressions. The unergative and unergative instrumentals, which showed no significant difference each other, were fixated on and displayed a rate of regression less than that of the unaccusatives but higher than that of the middles and inchoatives. The middles and the inchoatives, which showed no significant difference between each other, exhibited the lowest rate of regressions and were fixated on the least. We interpret this pattern as behavioural evidence contra the NP-movement hypothesis for English middle constructions and evidence for NP-movement in unaccusatives.

RÉSUMÉ

En anglais, la construction du milieu et la construction d’ inaccusative sont tous deux dit d'impliquer un changement dans la structure de l'argument, mais sont diffèrent dans la manière dont ce changement se fait sentir. Comptes théoriques des inaccusatives conviennent que sous-tend substantif mouvement de phrase de l'alternance dans les inaccusatives (Baltin, 2000). Analyses contradictoires de la construction du milieu anglais existent, avec certains théoriciens proposant que la construction du milieu anglais est formé par le substantif mouvement de phrase, tandis que d'autres posant une approche plus lexical (Stroik 1992; Ackema & Schoorlemmer, 1995). La présente étude a utilisé eye-tracking pour tester ces comptes théoriques contradictoires en comparant l'effort de traitement associé avec des constructions syntaxiques qui sont ou ne sont pas prévus pour impliquer le substantif mouvement de phrase (c. constructions intermédiaires, inaccusatives, inchoatives, unergatives et instrumentaux unergative). Les domaines essentiels examinés étaient les régions nom, verbe et adverbe. Les données ont été analysées à l'aide de multiples modèles de régression linéaire pour les variables continues de l'œil de mouvement (par exemple, la durée totale de

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fixation) et des modèles de régression logistique linéaire pour les variables des mouvements oculaires catégoriques (par exemple, taux de régression) sur la région critique comme variables dépendantes, le type verbe comme variable indépendante critique et de multiples contrôles L'analyse des temps de fixation totale et le taux de régression dans le verbe critique et la région adverbe indique que inaccusatives étaient fixés sur le plus long et le plus haut taux de régressions. Les instrumentaux unergative et unergatives, qui n'a montré aucune différence significative entre les uns les autres, ont été fixés sur et affichés un taux de régression inférieure à celle des inaccusatives mais supérieur à celui des milieux et inchoatives. Les constructions intermédiaires et les inchoatives, qui n'a montré aucune différence significative entre les uns les autres, présentaient la plus faible taux de régressions et étaient fixés sur le moins. Nous interprétons ce modèle comme une preuve comportementale contre l'hypothèse substantif mouvement de phrase pour les constructions moyennes anglaises et des preuves de non-échange dans les inaccusatives.

1 INTRODUCTION

The middle and unaccusative construction in English are both said to involve noun phrase movement (henceforth NP-movement). Existing analyses agree that the English middle construction (i.e. *The bread cuts easily*) involves a change in argument structure, specifically from object to subject, as in (1a/b (Stalmaszczyk, 1993).

(1) a. PRO cuts the bread easily.
b. The bread cuts easily.

(1a/b) denotes that in this English middle construction, the grammatical subject, the bread, is not the causer of the event of cutting. Instead, an unnamed agent is cutting the bread, such that the bread is the logical object of the sentence (Stroik, 1992; Stalmaszczyk, 1993).

It is also agreed upon that the unaccusative construction (i.e. *The waves recede slowly*) involves a change in argument structure, whereby the internal argument is raised to the external argument position via NP-movement. NP-movement is the movement of a noun phrase into an argument position, which is a position in the deep structure that can be occupied by an argument, as illustrated through the passive construction in (2a/b) (Baltin, 2000).

(2) a. [NP] will be put the car in the garage.
b. The car will be put [NP] in the garage.

Where (2a) is the deep structure before NP-movement from object to subject position and (2b) is the surface structure. If NP-movement had not occurred in this example, the surface structure would have resulted in an ungrammaticality, namely **will be put the car in the garage*.

There are different proposals about how this syntactic change is realized in the two structures. The unaccusative construction is known to involve NP-movement as per Baltin (2000). As for the English middle construction, an influential syntactic analysis by Stroik (1992) suggests that the object of a transitive verb becomes the subject of the sentence through the process of the

NP-movement. Alternative accounts exist that posit a lexical approach to the formation of the English middle (Ackema & Schoorlemmer, 1994).

Exploring the psychological reality of mental transformations, like syntactic movement, is essential for the development of linguistic theories. More broadly speaking, it is also important for understanding the cognitive mechanisms that speakers of a language employ when conveying meaning through speech or writing. Significant work has been done within psycholinguistics, which examines WH-movement and some on NP-movement with the use of eye-tracking (see for example Keyser and Roeper (1984) and Roberts (1987)). Yet, to date, we are unaware of any studies that have sought to provide psycholinguistic evidence for NP-movement in the unaccusative and English middle constructions.

This study sought to provide behavioural evidence for NP-movement in unaccusatives and evidence in favour of, or against NP-movement in English middle constructions with the use of eye-tracking. Eye-tracking is a good experimental technique to employ in the present study as previous studies have shown that constructions involving movement require readers to process traces and that these traces come with increased reading times (Dickey, Choy & Thompson, 2009; Staub, Clifton &Frazier, 2006; Staub & Rayner, 2007). As such, it is expected that if there is a psychological reality to NP-movement in the English middle construction and unaccusative construction, that this will be evidenced through increased reading times in these constructions. This paper will provide a brief overview of the theoretical approaches to the syntactic structures considered in this study, followed by a presentation and analysis of the present study.

1.1 NP-MOVEMENT AND ITS RULES IN ENGLISH

Most English NP-movement rules indicate that elements move to the left (e.g. Raising). The Trace theory naturally accounts for the ability to write rules to ensure that they are leftward movement rules. According to the Trace Theory, moved elements leave a trace at their original position in the surface structure. This trace must also be "properly" bound by the moved elements. i.e. the NP must command its trace at the surface structure (Dresher & Hornstein, 1979). It is important to note that in this rule an AdvP often follows the V, but it is not always required. (3a) and (3b) provides an example of how this rule would be employed in the English middle construction (where t in (3b) stands for trace).

(3) a. Ø reads the book$_i$ well.
b. The book$_i$ reads t$_i$ well

(3a) is the deep structure before NP-movement occurs, whereby the subject position is null and the NP is in the object position. (3b) is the surface structure after NP-movement has occurred, whereby the NP, which was originally in the object position, has made a leftward movement upwards to the subject position and left a trace in the object position. It can be assumed then that the NP, now in subject position, precedes and commands its trace at the surface structure

1.2 OVERVIEW OF SYNTACTIC CONSTRUCTIONS EMPLOYED

In the present study we considered five constructions that differed from each other in the number of arguments (and the presence of argument alternation), and the presence/absence of the

hypothesized NP-movement. The joint consideration of multiple syntactic types aimed at identifying the behavioural reflections of either NP-movement or argument alternation or both.

1.2.1 THE ENGLISH MIDDLE CONSTRUCTION

If NP-movement is hypothesized in the English middle construction then one can assume that English middles have a full argument structure to begin with (Figure 1), with the external argument being PRO, realized as a VP adjunct. The remaining internal argument, which is the complement of V moves to the external argument position (Figure 2).

Figure 1: Simplified deep structure of the English middle construction

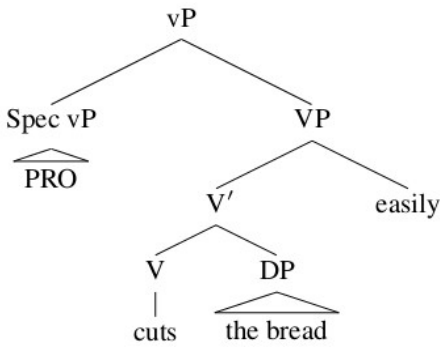
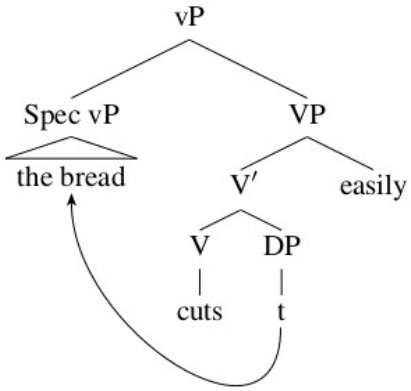


Figure 2: Simplified surface structure of the English middle construction



It is significant to note that the argument that is complement to V before the alternation remains a patient thematically regardless of its syntactic position. The middles take the active form, but their meaning is relatively similar to that of passives. Their meaning is such that they describe some property of the surface subject as in (4) and as such they tend to denote states rather than events or actions (Chung, 2000). Middles generally take the present tense and a modifier, which could be either a manner adverbial, negation, a modal or focus (Chung, 2000). They also always have a transitive counterpart as in (5a/b) (Chung, 2000).

(4) The bottle breaks easily.

Where this sentence describes the property of the bottle that makes it easily breakable, i.e. it could be made of glass and that is why it breaks easily.

(5) a. John cut the bread.
b. The bread cuts easily.

Where (5a) is the transitive construction and (5b) is the English middle construction.

According to the so-called lexical approaches, such as that of Ackema and Schoorlemmer (1995), the subject of the verb is the external argument and is generated in the deep structure position. The theory by Ackema and Schoorlemmer assumes that the deep structure subject is VP internal (Ackema & Schoorlemmer, 1995). An example of the surface structure of English middles in accordance with Ackema and Schoorlemmer's lexical approach is as in (6).

(6) [lP walls$_i$ [I' I [VP t_i [V' paint easily]]]]

Chung (1996) notes that Ackema and Schoorlemmer, in their 1994 paper, provide their lexical analysis of middle constructions, which is not provided in their 1995 paper. In their 1994 paper, Ackema and Schoorlemmer propose that English middle constructions are derived at the pre-syntactic level of the lexical conceptual structure (Chung, 1996). The authors note that at the lexical conceptual structure exist the action tier, which encodes the affectedness relations between arguments, and the thematic tier, which contains the semantic information like arguments and allows for definitions of Agent, Theme, Patient, Actor, etc. (Chung, 1996). According to this system, an argument can appear in the two tiers at the same time (Chung, 1996), as portrayed in (7a). It is also important to note that these roles are arranged in the hierarchy as per Jackendoff (1990) as in (29b) (Chung, 1996). It is significant to note that in (7b) that the action tier arguments are more prominent than the thematic tier arguments.

(7) a. John went for a jog (John: Theme, Actor)
b. Actor-Patient-Agent-Theme-Goal

(Chung, 1996)

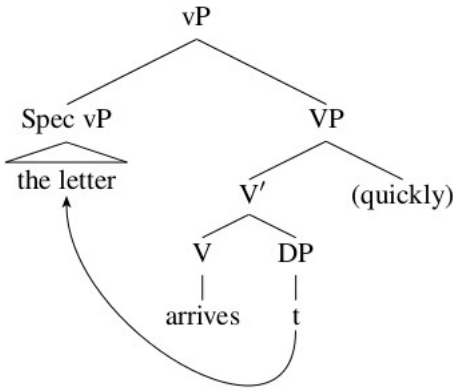
Ackema and Schoorlemmer (1994) assume the Recoverability Condition, which states generally that semantic arguments that are recoverable from the discourse or which have an ARB (arbitrary) interpretation do not project (Chung, 1996). In terms of the middle construction according to Ackema and Schoorlemmer (1994), the actor is arbitrary (ARB) and according to the Recoverability Condition, the actor will not project (Chung, 1996). Ackema and Schoorlemmer assume that the highest argument, being the actor, is the external argument (Chung, 1996). Since English middle constructions involve the suppression of the highest argument, once the actor is suppressed, the next highest argument becomes the external argument (Chung, 1996).

1.2.2 THE UNACCUSATIVE CONSTRUCTION

Unaccusatives depict non-agentive situations (Chung, 2000). They are associated with an internal argument, but no external argument (Baltin, 2000). In this construction, the surface structure is

realized through NP-movement, whereby the movement raises the internal argument to the external argument position, as in Figure 3 (Baltin, 2000). Unaccusatives assign theme to their subject (Chung, 2000). In Figure 3 (i.e. *The letter arrives quickly*), *the letter*, being the internal argument, is raised to the external argument positions (i.e. Spec vP) through NP-movement. It is important to note that the adverb, *quickly*, is in brackets because it is not required in this construction, but can be included (Baltin, 2000).

Figure 3: Simplified surface structure of unaccusatives



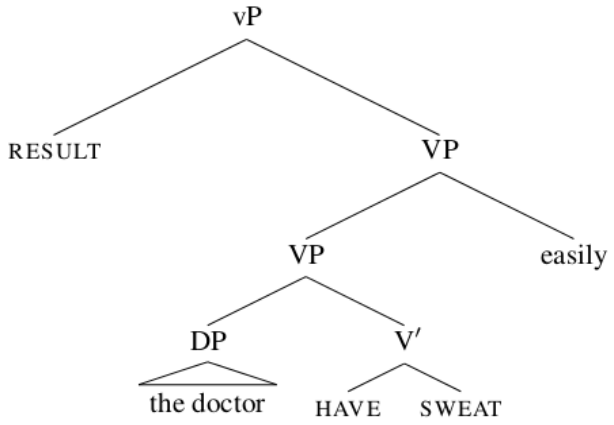
1.2.3 THE INCHOATIVE CONSTRUCTION

This study employed the view of Alexiadou and Anagnostopoulou (2003) in terms of the formation of the inchoative construction. Their view is such that a causative analysis should be applied to all change of state verbs and that these causative verbs possess a root that denotes a result state. They suggest that this result state is associated with the theme argument of the verb and it combines with the vCAUS head (Levin, 2009). vCAUS introduces a causal relationship between the result state and a causative event (Levin, 2009). Alexiadou and Anagnostopoulou (2003) also note that the root-vCAUS combination can also combine with a Voice head with certain root types (Levin, 2009). Ultimately then, the inchoatives can be found in the syntactic structure as per (8; Figure 4).

(8) [(Voice) [v CAUS [root]]]

It is also important to note that inchoatives are associated with only an internal argument according to Alexiadou and Anagnostopoulou (2003). In Figure 4 (i.e. *The doctor sweats easily*), *the doctor*, being the theme argument is associated with the result state and it combine with the vCAUS head (i.e. *HAVE SWEAT*). It is important to note that, *HAVE SWEAT*, indicates possesses the ability *to sweat*. In this case, the causative event depicted in Figure 4 results in *the doctor* possessing the ability *to sweat easily*.

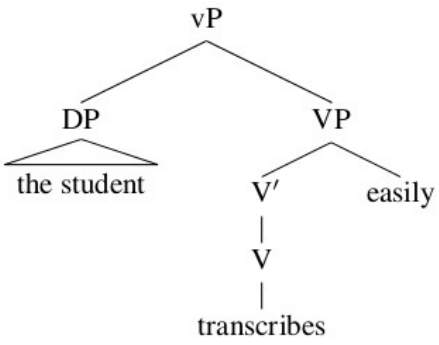
Figure 4: Simplified surface structure of inchoatives (Alexiadou & Anagnostopoulou, 2003)



1.2.4 THE UNERGATIVE CONSTRUCTION

Unergatives depict agentive situations and as such their subjects are agents or actors (Chung, 2000). The unergative construction is associated with an external argument (Chung, 2000). For an illustration of the syntactic structure please see Figure 5.

Figure 5: Simplified surface structure of unergatives

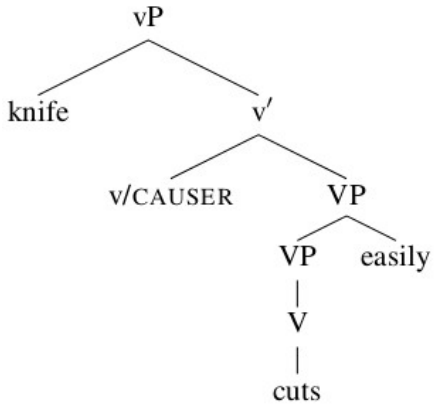


It is also significant to note that Hale and Keyser (1993) suggested that unergatives are actually inherently transitive and proposed that an unergative verb will take an object (Chung, 2000). This object incorporates with V, thus becoming an intransitive in the surface structure (Chung, 2000).

1.2.5 THE UNERGATIVE INSTRUMENTAL CONSTRUCTION

The unergative instrumental construction is a form of the unergative construction and is associated with only an external argument. In this construction the argument that would normally appear as a third argument or an adjunct, surfaces as the external argument. In other words, a non-obligatory argument replaces an obligatory argument, as shown in Figure 6.

Figure 6: Simplified structure of unergative instrumentals



It is significant to note that in this construction, the theta roles change from instrument in the deep structure to causer in the surface structure, as illustrated in (9). This change in argument structure cannot be due to NP-movement based on the notion that NP-movement does not alter the theta roles of the argument in question. It also does not allow movement from an adjunct position on independent grounds. Instead this construction may be a result of the third argument being merged directly into a causative projection followed by some form of semantic coercion.

(9) a. John cuts the apple easily with a knife.
b. The knife cuts easily.

where (9a) is the transitive variant, whereby the knife is the third argument acting as an instrument and (9b) is the unergative instrumental variant, whereby the knife, in the external argument position, is the causer of the event of the bread being cut.

The critical properties of the five syntactic constructions examined in this study are summarized below in Table 1.

Table 1: Synopsis of stimuli

Verb Type	Number of Arguments	Associated Argument	Movement?	Example from Stimuli
English middle	2 arguments, 1 removed	Internal argument	Yes (To be tested)	The bread cuts easily.
Inchoative	1 argument	Internal argument	No	The illness develops rapidly.
Unaccusative	1 argument	Internal argument	Yes	The waves recede slowly.
Unergative	1 argument	External argument	No	The attendant apologizes quickly.
Unergative-instrumental	2 arguments, 1 obligatory argument replaced by a non-obligatory argument	External argument	No	The paste cements poorly.

2 METHODOLOGY

2.1 PARTICIPANTS

35 undergraduate students from McMaster University participated. The undergraduate students were either recruited from McMaster University's Department of Linguistics and Languages' Linguistics Research Participation System or externally. Participants were compensated for their time with course credit if applicable. In the present study, it is significant to note that the data was collected in two sessions. The first 19 participants took part in an experiment that included the inchoative, unergative, middle and unergative instrumental verb types as stimuli. The later 16 participants took part in a study that included sentences of the inchoative, unaccusative and unergative syntactic construction.

2.2 STIMULI

2.2.1 VERB DISTRIBUTION

A total of 371 stimuli sentences were used, with 297 being used as part of one experiment and the latter 74 as part of another experiment. The stimuli were distributed between the two experiments such that there were 131 English middles, 69 inchoatives, 58 unergatives, 75 unergative instrumentals, and 38 unaccusatives. All stimuli were distributed between two lists, such that no participant saw a given verb twice. Examples of stimuli are provided in Table 1. About 15% of

the critical sentences were followed by yes/no comprehension questions. There were also unrelated filler sentences in both experiments.

2.2.2 MATCHING

2.2.2.1 THE UNERGATIVE INSTRUMENTAL CONSTRUCTION

Lexical frequencies were closely matched for both nouns (e.g. *apple*) in the critical region and adverbs (e.g. *easily*) in the critical region. More specifically, the nouns were closely matched for frequency to other nouns in the critical region across sentences and verb types. The adverbs were also closely matched for frequency to other adverbs in the critical region across sentences and verb types as exemplified in (10).

(10) Melanie knows that **the bread cuts easily** because it is soft (English middle construction)

where the bold text refers to the critical region.

(10) is meant to illustrate that the nouns in the critical region in all construction types were matched against each other for frequency to the best of our ability and the adverbs were matched against each other similarly within the critical region only.

Noun-verb bigrams (e.g. *bread cuts*) in the critical region were also matched for frequency across sentences and verb types, also shown by (10). All frequencies were determined through the 420-million token Corpus of Contemporary American English.

2.2.2.2 TEMPLATE

All stimuli were matched on a part-of-speech sequence (i.e. DET-N-V-ADV) and were embedded into similar sentence structures (i.e. Pepito knows that the bread cuts smoothly because it is soft). The sentences structures were formulated as in (11).

(11) [name] [verb of thinking or mind] that [construction in critical region] because/since/when [a reason]

2.2.2.3 EYE-TRACKING MEASURES

The eye-tracking measures explored in the present study are the total fixation time, gaze duration, second run duration and regression rate in the critical areas. The critical areas of interest are the noun, verb and adverb in the critical region, as exemplified in (12).

(12) Anita thinks that the apple bruises easily because it is soft.

where the critical noun region is *apple*, the critical verb region is *bruises* and the critical adverbial region is *easily*.

The critical area of specific interest is the verb (i.e. *bruises* in (12)) and to some degree the adverbial region (i.e. *easily* in (12)). The verb in the critical region is of particular interest because this is where the effect of the differences between syntactic types should appear. It is expected that this increased processing difficulty in sentences such as (12) and those in the present study

would be seen at the verb region, as the participant will expect to see an object in object position, when there is none. This will cause the participant to either regress or re-read the sentence, particularly the verb, in order to comprehend the meaning, resulting in a longer fixation time. The same logic can be applied to the adverb region, since the participant will expect to see an object, but then he/she is faced with an adverb. It is more likely that any effect seen on the adverb will be a spill over from the verb though since the participant, in theory, should experience difficulty right after the verb, where the trace would theoretically be.

2.2.2.4 PROCEDURE

After obtaining informed consent, participants were seated in front of an Eyelink 1000 eye-tracking system, which has an average accuracy of 0.5º, a resolution of 0.05º RMS and a saccade resolution of 0.25, real time data access of 3 milliseconds (SD < 1.2 milliseconds) at 500 Hz, and a Multi Sync LCD 2070VX 20" LCD computer monitor. Participants were then asked to complete a personality test (NEO PI). This personality test is to be used along with the data obtained from the filler sentences for an alternative study. Instructions were provided to the participants both verbally and in writing on the computer monitor. In the alternate study where the stimuli were used as fillers the NEO PI was not executed.

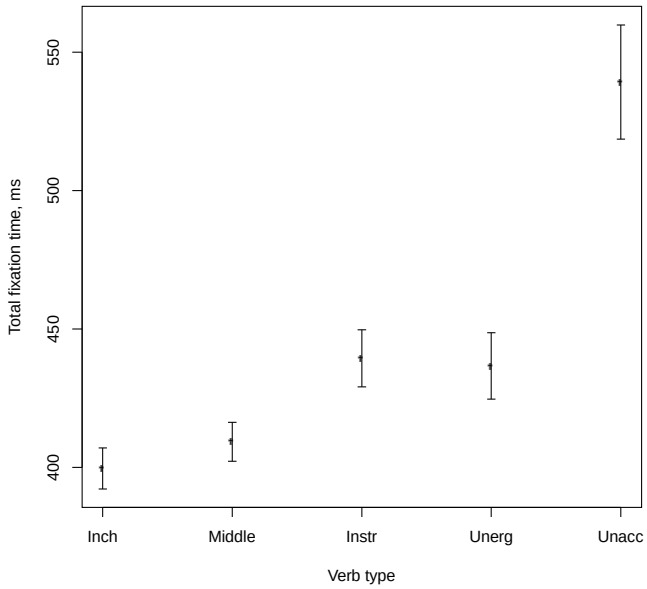
The participants were calibrated in accordance with eye-tracking procedures based on a series of three dots that appeared in known locations. This is done to ensure accuracy of the tracking of the eye-movements. The participants were presented with an instruction screen that provided key instructions for completing the study and then were instructed to press any key to continue. The stimuli were presented to participants one sentence at a time on the computer monitor at a distance of approximately 70 cm from the participant. The stimuli appeared in black Courier New Font size 24 against a white screen. While participants silently read, the Eyelink 1000 eye-tracker tracked their eye movements. If the stimulus presented was a sentence, the participant read the sentence once for comprehension and pressed any key on the keyboard to move to the next sentence using any finger. Conversely, if the stimulus presented was a question, the participant read the yes/no question and pressed "A" for Yes and ";" for No using any finger. Participants were provided with a debriefing sheet when they completed the study.

3 RESULTS

The critical verb region and the critical adverb region were analyzed for the present study. The total fixation time, gaze duration, second run duration and regression rate, specifically regression into the verb, were analyzed for the critical verb region. The total fixation time and regression rate, particularly regression from the adverb, were analyzed for the critical adverb region. Certain trials were excluded from the data analysis if they appeared to be outliers in the analysis of the total fixation time and gaze duration. These trials were eliminated if the fixation times for that trial were less than 50 ms or greater than 1500 ms for total fixation time on the verb or adverb and less than 50 ms for the gaze duration on the verb. The removal of these outliers resulted in a decrease in the total number of variables being examined. In both the verb and adverb data sets there were originally 4221 observations. The removal of the outliers resulted in 3716 observations for the total fixation time and 3716 observations for gaze duration on the verb region and 3667 observations for the total fixation time on the adverb region.

Linear multiple regression models with a continuous dependent variable for log transformed fixation times were used to analyze the results of total fixation time, gaze duration and second run duration. A linear logistic regression model with a categorical dependent variable was employed for the regression rate. The regression rate, being regression into the verb or regression out of the adverb, is categorical as it is a yes/no variable, i.e. [1] if there was regression or [0] if there was no regression. The linear logistic regression model reports the estimate of the regression coefficients and associated standard error. Here a positive coefficient in the regression model is indicative of regression being more likely. The models report the contrast with a reference level, which is set to "Inch" (i.e. inchoatives) with the other levels being "Middle" (i.e. English middle), "Instr" (i.e. unergative instrumental), "Unacc" (i.e. unaccusatives) and "Unerg" (i.e. unergatives). Significance is set at $p \leq 0.05$.

Figure 7: Total fixation time on the critical verb region for all verb types



where Verb Type is the independent variable on the x-axis and Total Fixation Time in milliseconds is the dependent variable on the y-axis

Figure 7 illustrates that significantly more time was spent on the unaccusatives (mean = 539.2103) compared to all other types. Also, the unergatives (mean = 436.6770) and unergative instrumentals (mean = 439.3760) patterned similarly and were significantly faster than the unaccusatives but slower than the inchoatives (mean=399.6195) and the middles (mean=409.2062), which also appeared to pattern together. Results of the linear regression model indicate that in relation to inchoatives, unaccusatives were significantly slower (p=4.30E-08). Inchoatives and middles were the fastest, but they were not significantly different from each other. The contrasts between respective levels were established with the help of changing the reference (intercept) level of the factor reflecting the construction type.

Table 2: Results of multiple linear regression model for gaze duration on the critical verb region (intercept set to “Inch”)

Coefficients:					
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**	
(Intercept)	5.383377	0.053996	99.699	<2.00E-16	***
Instr	0.005148	0.025114	0.205	0.837595	
Middle	0.014164	0.020466	0.692	0.488947	
Unacc	-0.032507	0.035201	-0.923	0.355827	
Unerg	-0.057007	0.02528	-2.255	0.024188	*
WordLength	0.050395	0.005107	9.869	<2.00E-16	***
lN.FREQ	-0.001643	0.003755	-0.438	0.661667	
lV.FREQ	-0.011591	0.003319	-3.492	0.000485	***

Results of Table 2 indicate that there is in fact no significant difference between unaccusatives (p=0.355827), middles (p=0.488947) and unergative instrumentals (p=0.837595) from inchoatives. There was a significant difference between unergatives (p=0.024188) from inchoatives (intercept). This is further evidence for the notion that the effect seen in the total fixation on the critical verb region is not due to the first run. There was also a significant effect of word length (p=<2.00E-16) and logged verb frequency (p=0.000485), such that the shorter a word was the less time it was fixated on and the more frequency a verb was the less time it was fixated on in the first run. This result is expected.

Table 3: Results of linear regression model for second run duration time on the critical verb region (intercept set to “Inch”)

Coefficients:					
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**	
(Intercept)	5.502015	0.109403	50.291	<2e-16	***
Instr	0.024383	0.048646	0.501	0.6163	
Middle	-0.04931	0.04281	-1.152	0.2496	
Unacc	0.133307	0.059339	2.247	0.0248	*
Unerg	-0.036699	0.048348	-0.759	0.448	
WordLength	0.017416	0.009523	1.829	0.0676	.
lN.FREQ	-0.019155	0.007641	-2.507	0.0123	*
lV.FREQ	-0.005077	0.006462	-0.786	0.4323	

Table 3 indicates that in relation to the inchoatives, there was a significant difference in fixation time on the unaccusatives (p=0.0248), such that they displayed the longest fixation times. There was no significant difference for any of the other verb types. This further supports the claim that the effect seen in the total fixation time is not due to the second run duration. There

was also an effect of logged noun frequency (p=0.0123), such that the fixation time decreased as noun frequency increased. This result is as expected.

Table 4: Result of linear logistic regression model for the regression rate into the critical verb region (intercept set to “Inch”)

Coefficients:					
	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**	
(Intercept)	-0.388008	0.272761	-1.423	0.154876	
Instr	0.318522	0.123019	2.589	0.00962	**
Middle	0.004862	0.106614	0.046	0.963623	
Unacc	1.122846	0.158762	7.073	1.52E-12	***
Unerg	0.616263	0.122245	5.041	4.63E-07	***
WordLength	-0.051488	0.025336	-2.032	0.042134	*
lN.FREQ	-0.033991	0.019455	-1.747	0.080613	.
lV.FREQ	-0.060497	0.017012	-3.556	0.000376	**

Table 4 suggests that the unaccusatives in relation to the inchoatives ($p < 0.001$) are regressed into significantly more than all other construction types. The unergatives ($p < 0.001$) are regressed into less than the unaccusatives but more than the other construction types, followed by the unergative instrumentals (p=0.00962) and middles (p=0.963623) and inchoatives (intercept). There is no difference between inchoatives and middles. This result suggests that the reason for the pattern seen in the total fixation time is a result of the regression into the critical verb region, as these two measures pattern almost identically with each other.

Table 5: Result of the multiple linear regression model for the total fixation time on the critical adverb region (intercept set to “Inch”)

Coefficients:					
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**	
(Intercept)	5.669686	0.062843	90.22	<2.00E-16	***
Instr	0.094664	0.029057	3.258	0.00113	**
Middle	0.053555	0.023975	2.234	0.02556	*
Unacc	0.245992	0.040611	6.057	1.53E-09	***
Unerg	0.140891	0.029263	4.815	1.53E-06	***
WordLength	0.030344	0.006518	4.656	3.35E-06	***
log(N.FREQ+1)	-0.00499	0.004451	-1.121	0.26227	
log(V.FREQ+1)	-0.015222	0.003714	-4.098	4.25E-05	***

The results of Table 5 suggest that there is significant difference between all types in total fixation time on the critical adverb region. In relation to inchoatives, unaccusatives (p=1.53E-09) displayed the longest total fixation time, followed by unergatives (p=1.53E-06), unergative

instrumentals (p=0.00113), middles (p=0.00113) and inchoatives (intercept) respectively. This is indicative of a similar pattern seen in the total fixation times in the critical verb region, suggesting there may be spillover in the adverb region or that the difficulty has yet to be resolved at the critical adverbial region. There is also an effect of word length (p=3.35E-06), such that shorter words were fixated on less, and logged verb frequency (p=4.25E-05), such that as verb frequency increased, total fixation time decreased.

Table 6: Result of the linear logistic regression model for the regression rate out of the critical adverb region

Coefficients:					
	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**	
(Intercept)	-0.632827	0.323221	-1.958	0.050244	.
Instr	-0.008698	0.14658	-0.059	0.95268	
Middle	-0.044571	0.123357	-0.361	0.717863	
Unacc	1.035736	0.168398	6.151	7.72E-10	***
Unerg	0.512437	0.138473	3.701	0.000215	***
WordLength	-0.111515	0.033947	-3.285	0.00102	**
log(N.FREQ+1)	-0.021614	0.023056	-0.937	0.348514	
log(V.FREQ+1)	-0.038018	0.018855	-2.016	4.38E-02	*

Table 6 illustrates a pattern similar to that observed in Table 11. In relation to inchoatives, unaccusatives (p=7.72E-10) had the most regressions out of the adverb region. Unergatives (p=0.000215) had significantly fewer regressions than unaccusatives into the critical adverb regions, followed by unergative instrumentals (p=0.95268), middles (p=0.717863) and inchoatives (intercept) respectively. This provides some evidence for the notion that the effect seen for the total fixation time on the critical adverb region is due to the regression out of the critical adverb region, which coincides with the results for the critical verb region. There was also an effect of logged verb frequency (p=0.04438), such that as frequency of the critical verb increased, the number of regressions out the adverb decreased.

The effect of word length ($p < 0.001$) suggests that the shorter a word was, the less time it was fixated on. The effect of logged verb frequency ($p < 0.001$) indicates that the more frequent a verb was the less time it was fixated on. The more frequent a noun was the less time, it was fixated on it the pattern seen in the effect of logged noun frequency (p=0.014). The effects seen in word length, logged verb frequency and logged noun frequency are expected in normal reading.

4 DISCUSSION

In the present study, we examined the effects of five syntactic constructions, specifically the inchoative, unaccusative, unergative, unergative instrumental and English middle constructions, on processing difficulty. This was done in an attempt to survey evidence for NP movement in the unaccusative construction, as well as evidence for the NP-movement hypothesis in English middle constructions.

The results of the total fixation time on the critical verb region and adverbial region indicate that the unaccusative construction was processed with the most difficulty, followed by the unergative and the unergative instrumental construction, with the middle construction and the inchoative construction being processed most easily. It is important to note that the unergative and the unergative instrumental construction showed no significant difference between each other and the middle construction and inchoative construction displayed no significant from each other. The results from the regression into the critical verb region confirm the results from the total fixation time on the verb region, suggesting that the results of the total fixation time are due to the regression rate into the critical verb region. This is consistent with the view that the participant expects an object in constructions that involve a trace (e.g. middles), and so the participant would regress back to the verb to resolve the difficulty.

The middle construction and the inchoative construction were processed most easily in comparison to the other construction types. This may be a result of the fact that they are thought to involve no transformation and no movement. It is significant to note that the lexical approach is being employed to explain the processing ease of the English middle construction, hence – no movement. A typical property of themes is that they are thematically and lexically part of the verbal root and need to be included for the meaning of these type of construction types to be complete. In the inchoative construction, the thematic argument is the internal argument. As such, they are more tightly related to the semantics of the verb and should be processed more easily because more semantic information is available. In accordance with Ackema and Schoorlemmer's (1994) lexical theory on the formation of the English middle construction, the English middle construction would be processed more easily because it does not involve NP-movement and hence the processing of a trace. Although, according the Ackema and Schoorlemmer (1994), the English middle involves suppression of the highest argument in order to deliver the correct reading, this act of suppression does not exhibit a significant processing cost, especially since it is processed more easily than the unergative construction, which is a simple construction type.

Results indicate that the unergatives and the unergative instrumentals exhibit a processing cost that is less than the unaccusative construction, but more then the middle and inchoative constructions. The relevant properties of these constructions are such that they are thought to involve no transformation, no movement and only an external argument (e.g. an agent). A property of external arguments is that they are semantically and syntactically further from the verb than internal arguments and as such are less semantically tied to the verb due to their distance from the verb in the syntactic tree. This causes the construction to be slightly semantically harder to compose. As such, the extra processing cost we see in the unergatives and unergative instrumentals compared to the inchoatives and English middle construction may be due to this increased difficulty in semantic composition.

At all appearance, the significant extra processing cost associated with the unaccusative construction appears to be due to movement. The main difference between the unaccusative construction and the other construction types employed in this study is that it is theoretically agreed upon that the unaccusative construction involves NP-movement in English (Baltin, 2000). NP-movement is associated with traces and these traces impose a processing cost on the reader (Dickey & Choy, 2009). It seems then that the significant processing cost exhibited with the unaccusatives is due to the trace that the reader must process. As such, this result can be taken as psycholinguistic evidence for NP-movement in the unaccusatives.

Results of this data also present evidence against the NP-movement theory in the English middle construction. The immense processing cost associated with the unaccusative construction

can be attributed to the effect of NP-movement due to the notion that there is a processing cost affiliated with processing a trace. Had there been NP-movement in the English middle construction, a greater processing cost would have been expected. The English middle was also processed more easily than constructions that are known to not involve movement, which is further evidence for the claim that these results indicate that there is no NP-movement in the English middle construction.

5 CONCLUSIONS AND FUTURE WORK

The present study supports two conclusions. One is that there is evidence for NP-movement in the unaccusative construction. Significantly slower processing of the unaccusative construction in comparison to the other construction types that do not involve movement indicates this. The other conclusion is that there is likely no NP-movement in the English middle construction, while there is likely to be NP-movement in unaccusatives. The evidence that the unaccusatives, which are known to involve NP-movement, exhibit a processing cost associated with this movement supports this claim, but the fact that English middles do not exhibit this processing cost provides evidence for theories assuming there is no NP-movement in middles.

Potential aspects for future work include extending this study to other types of syntactic complexity. Another possible extension of this work could be to construct a cross-linguistic analysis of the analogues of the English middle construction to determine if the effect seen in the present study in English extends to other languages as well. Potentially, this research could be extended to languages that have explicit linguistic markers of argument structure, such as Slavic languages (e.g. Russian).

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