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Anaphora Resolution in English Ambiguous Sentences by ESL Learners

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ABSTRACT

The present study investigated the anaphora resolution in English ambiguous sentences. The study focused on the automatic anaphora resolution process in English ambiguous sentences by ESL learners in the natural language through anaphora resolution strategies. The aim of this research study was to know whether the ESL learners used anaphora resolution strategies. The study further explored the most frequently and least frequently used strategies by the ESL learners. A proficiency test was used as a research tool to collect data. The questions were about ambiguous English sentences containing both inter-sentential and intra-sentential anaphora. The learners had no significant difficulty in the use of most of most of the strategies. The strategies of gender and number agreement, syntactic knowledge and real-world knowledge were the most frequently used strategies; while, the least frequently used strategy for anaphora resolution was discourse knowledge. The study also found out that one of the strategies known as discourse was used commonly by the ESL learners. The findings of the current study are more fruitful for the ESL learners. They will aware the ESL learners and the instructors to include anaphora resolution strategies in teaching English ambiguous sentences.

Introduction

Ambiguity in natural language processing is difficult for a computer to understand but easily understood by human beings (Anjali, & Babu, 2014). Ambiguity in English is the reference to a word or sentence, which expresses more than one meaning **(**Crystal, 1988). It is the construction, which admits more than one interpretation (Hartmann & Stock, 1976). The ambiguity could be syntactic, semantic, lexical, pragmatic, morphological, phonological discourse and anaphoric in nature

(Anjali & Babu, 2014; Salih, 2015). The two main types of ambiguities are *genuine* and *computer* ambiguities (Davis, 2016). Semantic ambiguity occurs when the meaning of a word itself is misinterpreted, even after the syntax and the meaning of the individual words have been resolved (Franz, 1996). Lexical ambiguity occurs when a word in a sentence has ambiguity to its syntactical class (Schwartz, 2015). It is the presence of two or more than two possible meanings within a single word in a sentence (Nordquist, 2018). Pragmatic ambiguity arises in a situational phrase having multiple interpretations in a context because of the missing information in sentences (Franz, 1996). Morphological ambiguity occurs when affixations are added to a word causing ambiguity for the readers to interpret (Oaks, 2010). Phonological ambiguity, a sub type of lexical ambiguity occurs when the same sound can be interpreted in more than one way. This type of ambiguity arises at the level of surface structure rather than at deep structure. For example, in English, *I scream* and *ice-cream* cause ambiguity for the listeners (Tang, 2016). Discourse ambiguity resolution demands the processing of the needs of a shared knowledge or a shared world and its interpretation is carried out according to the context (Tang, 2016). Anaphoric ambiguity occurs when an expression has more than one possible interpretation (Tang, 2016). In the sentence, '*Telly tried on the dress over her skirt and ripped it*', the pronoun *it* is co-referent to the word "*dress*" because the word "*dress*" has got centre of attention and this can be resolved through the process of salient entity.

Anaphora

Anaphors are the phrases or words which refer to entities that have been mentioned in the sentences previously and co-referential to an antecedent in the noun phrase (Oaks, 2010). Anaphor in context of the natural language processing is a reference, which points back to an object that has been mention previously antecedent (Nand, 2012). It is the relationship between the 'anaphor and the antecedent' (Huddleston, 2010a). There are different possible realizations of anaphors and antecedents. The anaphor can work as a noun/pronoun, adjective, adverb, infinitive marker, ellipsis and verb phrase. The antecedent can be a word, a phrase (especially noun phrase), clause or one or more than one sentence. "Anaphors derive their interpretations from the expressions, it refers to, because their own meaning is often rather general" (Trask, & Stockwell, 2007). Anaphora is a linguistic phenomenal device which refers back to an entity, and which has been introduced to a more fully descriptive phrase earlier in the text; the entity may be a concept, an object, an individual or a state of being (Samuel et. al, 2007). Anaphora is a gadget which makes a truncated reference, in the desire that the collector of the talk will have the capacity to expand the reference and make the personality of the specified substance in a sentence. The anaphora contains fewer bits of disambiguating information, being lexically or phonetically shorter. The reference is thus called an anaphor and the referred entity is called antecedent of the anaphor, so the reference and its referred is called referential (Hirst, 1981). The pronoun that refers to a previously mentioned entity in a sentence is consider as anaphoric reference (backward reference) while a

pronoun that point ahead to later noun or noun phrase in a sentence is called cataphoric reference (forward reference) (Hacker, & Sommers, 2012).

Forms of Anaphora

Anaphora has been categorised in many forms. Tense anaphora is a form of anaphora that consists of one or more reference temporal perspective times, speech time action time and location time (Reichenbach, 1947; Partee, 1973). In English, tense anaphora basis the co-reference between the tense bearing element in the main clause, and that of the compliment clause (Higgingbotham, 2006). In the following example, Sameer at some point in the past had done an action, whose content is *got drunk* as of the time of that very statement. The complement action is thus relative to past participle *got*.

Sameer had a party last night and Sameer got drunk.

Both the main predicate (*had)* and the compliment predicate *(got)* report events. The tense expresses the binary relation of time and event (Higginbotham, 2002a). Noun anaphora or nominal anaphora represents a particular case of identity of sense-anaphora and identity of reference-anaphora. In such cases, the anaphor and the antecedent do not correspond to the same referent in real world but to one of a similar description. Noun anaphora (nominal anaphora) should not be confused with noun phrase.

Nominal anaphora arises when a referring expression (pronoun, definite noun phrase or proper name) has a non-pronominal noun phrase as its antecedent. The *one* in the following example is a noun anaphora. *One* points to a noun *pretzel* not to noun phrase *sweet pretzel* (Mitkov, 2002).

I don't think I will have a sweet pretzel, just a plain one.

The verb too has anaphoric use by mentioning the previous entity in a sentence or noun phrase. In the following example, the verb *did* has an anaphoric relation to an antecedent in the proceeding clause/phrase.

Romeo, the Canadian general in charge, begged the reinforcement; so did Boutros.

The adverb can also function as locative and temporal anaphora. In the following example, the locative adverb *there* refers to the *garden* in the noun phrase.

Will you walk with me to the garden? I have got to go down there.

Zero anaphora (ellipsis) is an 'invisible' anaphora in a sentence and is signalled by (Ø) 'gap'. It is a phenomenon associated with the linguistic form without damaging the coherence of the discourse segment (Mitkov, 2002) presupposing something, what is left out in the discourse. It also contributes to the semantic structure of the discourse. According to Halliday and Hasan, (1976), ellipsis is the omissions of an item and designates this kind of cohesion mechanism as ellipsis. In the following example, the

word *Ali* is omitted in the second clause to avoid the same entity be mentioned twice within the same sentence through pro-nominalization.

Ali went to university and Ø to department.

The sentence structure determines whether the second mentioned entity will be named again or will be referred to by a pronoun or by Ø. Zero anaphora has some common forms such as, zero pronominal anaphora, zero noun anaphora and verb phrase ellipsis (Pereira, 2010). Zero pronominal anaphora occurs when the anaphoric pronoun is omitted but is however understood. This phenomenon however occurs in English in restrictive environment (Maio, 2011). Zero noun anaphora occurs when the head noun is omitted and the reference is realised by the 'non-omitted' overt modifiers (Maio, 2011).

Ali ordered three copies of thesis and Saleem ordered several Ø too.

Zero verb anaphora occurs when the verb in a clause or in a sentence is typically omitted and the zero points to the previously mentioned verb.

Take catch or Ø wicket in match.

Types of Anaphora

Anaphora has been classified into two types according to its location such as intra-sentential (sentence) anaphora and inter-sentential (discourse) anaphora. Intra-sentential anaphora occurs when the antecedent and the referent anaphor are located in the same sentence. Reflexive pronouns are the examples of intra-sentential while possessive pronoun is often used in the same clause of intra-sentential sentence. Personal pronoun and noun phrase in intra-sentential anaphora have their antecedents in the subsequent clause of the same ambiguous sentence. Inter-sentential anaphora happens when the anaphor and the antecedent are located in different sentences. In the following example, the reflexive pronoun *himself* refers to *Naveed* in the preceding clause as intra-sentential anaphora (Maio, 2011).

Naveed bought a car for himself.

Anaphora Resolution

The process of connecting antecedent and the anaphor in a discourse is called anaphora resolution. Anaphora resolution is a complex process that is lately acquired and not fully addressed in the classroom. This process is concerned with identifying which pronouns, proper names and noun phrases refer to the same objects or individuals. The process of anaphora resolution is based on some strategies or techniques, through which the EFL learners can resolve the anaphor (Ferrández *et al.*, 2000). The factors for eliminating and preferring anaphora resolution in English ambiguous sentences are called *constraints* and *preferences* (Carbonell & Brown, 1998),

constraints and *proposers* (Rich & LuperFoy, 1988) or *factors/attributes/symptoms* (Mitkov, 1995b) that encourage recognizing the antecedent of an anaphoric articulation are the separation between an anaphoric articulation and its precursor, lexical limitations (for example, gender and number understanding that are utilized to take out some antecedent competitors) and syntactic jobs which can show inclination for specific forerunner hopefuls among other factors.

Literature Review

According to Anjali & Babu (2014) ambiguity in natural language processing is an area of research which shows how a computer can be used to disambiguate or understand a discourse or speech to do more useful things. It is the phenomenon inherited in natural language processing and so occurs when an expression is understood in more than one different way. The anaphoric ambiguity could be nocuous anaphoric ambiguity and in-nocuous anaphoric ambiguity. Nocuous ambiguity arises when a discourse can be interpreted differently or in different way by the readers, while in-nocuous ambiguity arises when it is interpreted the same by different readers (Yang et al., 2011). Annotating and resolving adverbial anaphoric ambiguity was investigated by Knees (2008). The participants had no difficulty in naming the referent but they didn't know about the annotation conventions because they had no systematic method for marking the antecedent. Artstein and Poesio (2005) investigated the annotation of anaphoric ambiguity, in which they identified ambiguous expression in human language dialogue. The result of the study showed that there was perfect agreement among the annotators.

The processing of ambiguous sentences by children and the adult L2 learners was compared and findings showed that the participants were sensitive to English at the age of 10 and the second language learners performed better in the grammar part of a standardised proficiency test (Falser et al., 2003). The processing of scope ambiguity in English passive sentences by L2 speakers of English was investigated and result confirmed the discrepancy between the processing of scope ambiguity in English active and passive sentences. The result of the study also provided the evidence for shallow processing and good reading in online scope ambiguity processing (Xu, 2015). Anaphora resolution in Portuguese corpora identified semantically similar words by automatic lexical acquisition techniques. The key nouns of the anaphor were different from the key nouns of the antecedent, i.e., an indirect anaphora (Gasperin & Vieira, 2003). The longitudinal survey on anaphora resolution (forty years of research) covered the issues related to not only the linguistics and psycholinguistics area but also the theories of the interpretation of anaphora expressions. The survey was based on data-driven methods for co-reference resolution. Extracting lexical and encyclopaedic knowledge features required for anaphora resolutions were also explored. The study concluded that one of the most fundamental expressions of language interpretation is interpreting anaphora (Artstein & Poesio, 2005).). Pronominal anaphora creates problems because the identified noun referents are difficult to identify with the help of pronominal (Singh et al., 2014) or with the help of pronoun anaphora because of the existence of more than one candidate for the pronoun antecedent (Leffa, 2003). According to Mathieu (2016), the

positions of the antecedent between null and overt pronoun were different. In null subject languages, the null and overt pronouns positions differ with respect to antecedent choice in ambiguous constructions. The base for sentences with null pronoun might have acquired with null pronoun and this might not be strong for the anaphora with overt pronoun. Subject is preferred in German and object in French as anaphora resolution because speakers take into account of the alternative in ambiguous construction (Colonna et al., 2012). Anaphora resolution is the predicted between the interaction of cohesion relation and information structure. The discourse representations are constructed based on the utterances and can trigger the expectations about the upcoming discourse. The expectations depend on potentially missing or unspecified content. (Fuente & Hemforth, 2012).

Marques (2013) worked on anaphora resolution in Portuguese for developing a co-referential, pronominal anaphora resolution module. The strategy adopted was based on the identification of anaphora resolution and candidates through a system rule and in the selection of the most probable candidate for antecedent by a model built based on the (machine learning) algorithm Expectation-Maximization (EM). For anaphors' identification, relative pronoun and reflexive pronoun stand out as the best due to the greater proximity between the anaphors and their antecedents. Li (2010) investigated the use of the web for anaphora resolution with an absolute analysis of the relationship between anaphora and definiteness. The results indicated that given the well-designed questions, the system can give answer to linguistic questions besides the simple semantic relationship. The coherence of anaphora can be resolved by the use of syntactic and pragmatic strategy (Nand, 2012). A systematic survey was conducted on grammatical patterns to detect the linguistic situation where the NP omission occurs and the governing condition of its omission. Some errors were found out to be connected to (a) pos-tagging, (b) chunking (c) extraction of dependency, including zero anaphora rules (Pereira 2010).

An experimental study on statistical approach to anaphora resolution showed the relative contribution for all combined sources of information and the pronoun resolution method achieved good accuracy because the precision of the learning method can influence anaphora resolution (Hale et al., 1998). Gardiner et al. (2005) investigated a machine learning approach on interpretation and resolution of *one* anaphora. The machine first learned to distinguish multiple uses of instances the word *one.* The numeric, portative, anaphoric, generic, idiomatic and unclassifiable of *one* anaphor were identified. If the candidate antecedent is the correct antecedent of the anaphor, a pair is positive and if not, it is negative. Different meanings depend upon the context from the standpoint of natural linkage between sentences and the semantic relation among the sentences. The observation of the event depends upon the viewpoint, from which the event is observed (Yamamura et al., 1995). Due to gender mismatches in language, anaphora resolution is important in translation (Mitamura et al., 2001). Kamune and Agarwal (2015) conducted a study on hybrid approach on pronoun anaphora resolution in newspaper texts. In this study, the inter-sentential and intra- sentential *third person pronoun* and the pleonastic *it* were identified. Devi et

al. (2015) conducted a study on generic anaphora resolution engine for Indian languages. The similarities and variation between pronoun and their agreement with antecedent in Indian languages such as Tamil, Bengali and Hindi languages were found out. The results of study showed that the Indian language have similarities in person, number and gender distinction and similar resolution strategies are used for anaphora resolution. Anaphora is a complex and challenging task in natural language processing. Pragmatic knowledge, gender agreement and number agreement can be added to the factor in order to increase the accuracy of the overall system of anaphora resolution (Lakhmani et al., 2014).

Material and Methods

The present study has focused on linguistics knowledge of lexical, phonological, morphological, syntactical and semantic aspects of anaphora resolution. The current study was survey research for which a proficiency test was designed to collect the data containing twelve English ambiguous sentences. The questions in the test contained all type of anaphora including both inter-sentential and intra-sentential anaphora. The participants were selected from five post-graduate colleges and five universities in Khyber Pakhtunkhwa province. From each institute, ten BS level students learning each English as a second language through non-random convenient sampling technique were selected having equal number of male and female students. The students were asked to fill the blank which sound best to them having the omitted anaphora. After collecting the data, the researcher analysed the data through quantitative approach in order to find out whether the ESL undergraduate level students used anaphora resolution strategies and which of the selected six strategies were most and least frequently used by these ESL learners.

Results and Discussion

The results of the collected data in anaphora resolution tasks through test contained six anaphora resolution strategies. In the test, twelve English ambiguous sentences (two for each category) were included. The results of each constraint and possible preference are presented in the form of pair of sentences which are put according to those constraints and preferences.

Anaphora Resolution through Gender Agreement

The constraints were given in the test and each constraint contained two sentences. The first sentence below contains a constraint, while the second one has no constraints but the possible preference of anaphora resolution. The results for the two sentences are given below.

Table 1
Showing anaphora resolution for the constraint of gender agreement

Sentences	Correct resolution	Incorrect resolution
Ahmad slapped Sara when he was young.	100%	00%
Saleem slapped Ali when he was young	80%	20%

Total	90%	10%

The participants had responded to the first sentence with the constraint with 100% accuracy by anaphora resolution through gender agreement but the second sentence had 80% correct responses in the absence of the constraint. The students here could prefer any of the possible resolutions available. There was no significant difference found out in the results of the two sentences given for the same constraint meant to be resolved through gender agreement. Thus, there was no difference in the accuracy of anaphora resolution processing through gender agreement.

Anaphora Resolution through Number Agreement

There were two sentences for anaphora resolution through number agreement. The first sentence contained constraint of number along with the semantic property of the subject and objects nouns and the anaphor can only refer back to the object noun (concert's tickets) being sold. While the second sentence has a different verb phrase in the second clause (didn't get any) demanding the subject noun (Jamil and Jasmine) having the ability to buy tickets. The following table shows the results.

Table 2
Showing anaphora resolution for sentence 3 and 4 in (constraint) number agreement

Sentences	Correct resolution	Incorrect resolution
Jamil and Jasmine wanted to buy concert tickets but they were all sold out	100%	00%
Jamil and Jasmine wanted to buy concert tickets but they didn't get any.	82%	18%
Total	91%	9%

The selected participants correctly responded (100% correct responses) to processing anaphora resolution through number agreement in the first sentence below and 82% correct responses for the second sentence. The combined results for these two sentences show that students had no significant difficulty for the same constraint of anaphora resolution through number agreement.

Anaphora Resolution through Syntactic Knowledge

Anaphora resolution through syntactic knowledge was resolved by all participants. The results of anaphora resolution through syntactic knowledge in English ambiguous sentences are shown in the table.

Table 3
Showing result of Anaphora Resolution for sentence 5 and 6 through constraint (Syntactic Knowledge)

Sentences	Correct resolution	Incorrect resolution
Shams told Salman to start the business for him	90%	10%
Shams told Salman to start the business for himself	90%	10%
Total	90%	10%

The students resolved anaphora in both the sentences with 90% accuracy though syntactic knowledge correctly. There was no significant difficulty for students in resolving anaphora through syntactic knowledge and so to identify the correct anaphor and antecedent pair.

Anaphora Resolution through Semantic Knowledge

The anaphora is also resolved through semantic knowledge of the words used in sentences. The results of anaphora resolution through semantic knowledge in English ambiguous sentences by ESL learners are shown in the table below.

Table 4
Showing results of anaphora resolution for sentence 7 and 8 in constraint (semantic knowledge)

Sentences	Correct resolution Percentage	Incorrect resolution Percentage
The children ate biscuits. They were delicious	60%	40%
The children ate biscuits. They were delighted	70%	30%
Total	65%	35%

The students resolved anaphora with 60% correct accuracy for the first sentence above using their semantic knowledge that biscuit are eaten which can be delicious. The correct responses here were less than the responses for other resolution because the constraint here was semantic in nature and the students had no other clue except the inherent meaning of words. Almost the same results were found out for the second sentence (70% correct responses). The combined correct responses for these two sentences (65% correct responses) suggest that students have significant difficulty in resolving anaphora through semantic knowledge.

Anaphora Resolution through Discourse Knowledge

Anaphora resolution is also done through discourse knowledge. The discourse knowledge helps in resolving the anaphora which is assisted by other information available in the context of discourse. The results of anaphora resolution through discourse knowledge for the selected sentences are given below.

Table 5
Showing results of anaphora resolution for sentence 9 and 10 in constraints (discourse knowledge)

Sentences	Correct resolution Percentage	Incorrect resolution Percentage
Seema tried on the dress over her skirt and ripped it	10%	90%
Tuesday morning had been like any other. Samreen had packed her schoolbag, bossed her seven years old sister Nasreen. After breakfast at 8.25, she walked down the stair and said I am off to school now – bye Mom, bye Dad, I will see you later.	30%	70%
Total	20%	80%

All the participants responded to anaphora resolution process through discourse knowledge with 10% accuracy rate for the first sentence because there were two possible candidate antecedents *dress* and *skirt* for the anaphor *it*. The use of the same knowledge was improved in the case of second sentence (30% correct responses) as the students had recognized the centre of the discourse in spite of the two possible candidate antecedents. The results as whole (20% correct responses) suggest that there was significant difficulty for resolving anaphora through discourse knowledge.

Anaphora Resolution through Real-World Knowledge

Anaphora resolution through real-world knowledge with or without discourse knowledge is also used for anaphora resolution. The results of the same constraint are shown in the table below.

Table 6
Showing results of anaphora resolution for sentence 11 and 12 in constraints (real-world knowledge)

Sentences	Correct resolution Percentage	Incorrect resolution Percentage
The police shot at the thieves and they fell	85%	15%
The police shot at the thieves and they missed.	75%	25%

Total	80%	20%

Anaphora in the above table was resolved through real-world knowledge by the participants correctly with 85% accuracy for the first sentence where the anaphor refers back to the object because of the real-world knowledge that those who are shot, they fall on the ground. Similarly, the anaphora in the second sentence too was resolved with 75% accuracy rate in English ambiguous by the ESL learner where the anaphor refers back to the subject because of the real-world knowledge that those who shoot, they either hit or miss the targets. The results of anaphora resolution process through real-world knowledge (80% correct responses) suggest that ESL learners use real-world knowledge in anaphora resolution to a significant extent. Thus, there was no significant difficulty in the use of real-world knowledge in resolving anaphora resolution.

Most and Least Frequently Used Strategies for Anaphora Resolution

The strategy having above 70% correct responses was considered the most frequently used strategy while, the strategy having less than 50% correct responses was considered least frequently used strategy for anaphora resolution in English ambiguous sentences. The strategy having less than 70% and more than 50% correct responses was considered commonly used strategy. The most frequently used strategy for anaphora resolution had no significant difficulty for students while the least frequently used strategy had significant difficulty for students. The commonly used strategy on the hand had somewhat difficulty for students but not significant enough like the most frequently used strategy. The results of most frequently, least frequently and commonly used strategies for anaphora resolution are shown in the tables.

Table 7
Showing results of the most frequently used strategies for anaphora resolution

Anaphora resolution strategy	**Total percentage**
Gender agreement	100%
Number agreement	90%
Syntactic knowledge	90%
Real-world knowledge	80%
Semantic knowledge	65%
Discourse knowledge	40%

The table above showed the four anaphora resolution strategies were used most frequently by ESL learners for processing anaphora resolution. The most frequently among them is gender agreement, followed by number agreement and syntactic knowledge. The real-world knowledge was used less than the other most commonly used strategy for anaphora resolution. The strategy of semantic knowledge was neither most frequently nor least frequently used by the ESL learners. The discourse knowledge was the least frequently used strategy for processing anaphora resolution in English ambiguous sentences.

Discussion

The results of the current research study indicate that anaphora resolution strategies made the process of anaphora resolution easy but in spite this, it often created ambiguity in processing anaphora resolution especially in English ambiguous sentences. Anaphora resolution through the strategy of gender agreement was easy for the participants because of the presence of two different genders (Ahmad and Sara) in the same sentences. When the gender in the same sentence was changed to *Ahmad slapped Ali when he was young,* it was difficult for the participants to find the correct antecedent in the sentences. This difficulty was because of the pronoun *he* which is co-referential to both *Ahmad* and *Ali.* So, the constraint (gender agreement) helps the students to restrict them in finding the correct antecedent in the sentence. Without the gender agreement constraint, the students should have difficulty in resolving anaphora in English ambiguous sentences because the pronoun *he* in the second sentence refers to *Ali* which is the possible candidate through anaphora *recency* (nearest candidate) factor. The correct responses of students show that students have some idea about *recency* factor in the absence of other factors. Preferences (to give preference to one antecedent instead another) unlike constraints, are not obligatory conditions and therefore do not always hold. For instance, there is a general (but weak) preference for the most recent NP matching the anaphor in gender to be the preferred antecedent. There was no significant difference found in the results of the two sentences given for the same constraint.

Number Agreement feature turns correct if the antecedent and anaphor agree in number (either single or both plural), else turns incorrect. The participants resolved anaphora through number agreement constraints because they had learnt the rules for number agreement. Finding correct antecedent for anaphora through number agreement is all based on the nature of the object in the verb phrase. The students were given the sentence: *Jamil and Jasmine wanted to buy concert tickets but* ***they*** *were all sold out.* In this sentence, the pronoun (*they)* had two possible candidates (*Jamil and Jasmine, and tickets)* in the sentence. The pronoun *they* is used for both animate and inanimate plural nouns. The pronoun here refers to the antecedent (*tickets)* due to the semantic meaning of the object of verb phrase (were all sold out). If the verb phrase in the same sentence in the object position is changed (did not get any), e.g. *Jamil and Jasmine wanted to buy concert tickets but they did not get any,* the pronoun *they* does not refer to the noun *tickets* but refers to the plural noun (*Jamil and Jasmine).* The students resolved anaphora through number agreement but still they found it a bit difficult due to the change of verb phrase (did not get any) in the object position. With the change of verb phrase in the second sentence, the accuracy of anaphora resolution reduced. Thus, there was a slight but not significant difficulty in the accuracy of anaphora resolution processing through number agreement.

Antecedents must have the same grammatical function as that of the anaphor. This constraint is particularly useful when other constraints or preferences do not point to unambiguous antecedent. Anaphora was resolved through Syntactic

knowledge by participants resolving the pronominal anaphora through the preference factor given to noun phrase that had the same syntactic function as the anaphor. The sentence given for the process of anaphora resolution was *Shams told Salman to start the business for him.* In the given sentence the pronominal anaphora *him* referred to *Shams,* which was syntactically co-referential to *Shams,* not to *Salman.* The same sentence was given to participants with the change of pronoun in the object position and which changed its antecedent accordingly i.e. *Shams told Salman to start the business for himself*, here the pronoun *himself* was co-referential to *Salman* through the syntactic function of the pronoun in the sentence. Syntactic knowledge was a preference and not a constraint as it was relatively easy to find an antecedent through its co-referential connectivity with the pronoun. Some anaphora resolution approaches give preference to the candidate that is the subject of the sentence. However, the subject preference in the sentence *Shams told Salman to start the business for himself,* is not strong enough and could be easily overruled by common-sense constraints or preferences. There was no significant difficulty found in the results of the two sentences given for the same constraint, meant to be resolved through syntactic knowledge.

In the complexity of natural language understanding anaphora resolution offers an ideal illustration: the difficulties involved in resolving anaphors, the reader must already have perceived, but there is yet another difficulty to consider. An anaphora resolution system supplied with extensive morphological, lexical, syntactic, and semantic and discourse knowledge may still find itself helpless when confronted with examples such as: *the police shot at the thieves and they fell.* And the second one is *the police shot at the thieves and they missed.* Many real-life examples of anaphors require world knowledge for their resolution. Anaphora resolution through real-knowledge requires the information about the target antecedent. By considering the above two examples one can clearly understands that those who get shot can fell. So, the anaphor '*they*' refers to the antecedent *thieves* in the first sentence while in the second sentence, the pronoun '*they*' refers to the *police*, and which is resolved through the Real-world knowledge and again those who shot can miss.

For anaphora resolution through Semantic knowledge, the identification of anaphors may depend on the ability of a system to undertake semantic processing in order to identify the discourse entity that is connected with the antecedent, for example, the sentence *Each child ate a biscuit. They were delicious.* In the given example, the anaphor agrees with the number of the discourse entity associated with the antecedent *biscuit* (the biscuit that the children had). This plural discourse entity can be deduced from the quantifier structure of the sentence containing the antecedent. To this end, translation into logical form is important. Semantic knowledge as to the permissible semantic attributes of the concepts *child* and *biscuit* would also be necessary in order to identify the discourse entity as the antecedent of *they* in the first sentence (e.g. the children cannot be delicious) and the discourse entity as the antecedent of *they* in the second sentence i.e. *Each child ate a biscuit. They were delighted.* Thus, the ESL learners were able to resolve anaphora through semantic knowledge due its complex rules for anaphora resolution. Thus, there was a slight but not

significant difficulty in the accuracy of anaphora resolution processing through semantic knowledge.

In spite of the fact that the morphological, lexical, syntactic and semantic criteria for antecedent's selection are extremely solid, they are still not generally sufficient to recognize among an arrangement of conceivable candidates. Additionally, they serve more as filters to dispose of unsatisfactory candidate than as proposers of the most hopeful candidate. On account of antecedent uncertainty, it is the most remarkable component among the candidate for antecedent that is generally the leader. This most salient element is referred to in computational linguistics as the focus (Grosz, 1977; Sidner, 1979) or centre (Grosz et al., 1983; Grosz et al., 1995) although the terminology for this can be much more diverse (Hirst, 1981; Mitkov, 1995a). Anaphora resolution through discourse knowledge strategy was the most difficult task. Neither machines nor humans would be certain in interpreting the anaphoric pronoun *it* in the sentence: *Seema tried on the dress over her skirt and ripped it.* If this sentence was part of a discourse portion, which would make it possible to identify the most salient element and the situation would be different: *Seema's mother had agreed to make her a new dress for the party. She worked hard on the dress for weeks and finally it was ready for Seema to try on. Impatient to see what it would look like, Seema tried on the dress over her skirt and ripped it.* In this discourse, *dress* is the most salient entity and is the centre of attention throughout the discourse. Anaphora resolution through discourse knowledge is the intuition behind the theories of focus or centre lies in the observation that is normally structured in around the central topic. This hypothesis affects the interpretation of pronouns because once the centre has been established; there is often a strong tendency for subsequent pronouns to refer to this centre. i.e., *Tuesday morning had been like any other. Samreen had packed her schoolbag, bossed her seven-year-old sister Nasreen. After breakfast at 8.25, she walked down the stairs of the family's first floor flat and shouted: 'I'm off to school now – bye Mum, bye Dad, I will see you later.* In this example, the established centre *Samreen* is referred to by the subsequent pronouns *her* and *she*. It is unlikely that any reader would associate *she* in the third line to her sister *Nasreen*, although this is the nearest potential antecedent.

It is now clear that when two or more candidates 'contend' for the role of an antecedent, the task of anaphora resolution can be shifted to the task of tracking down the centre or focus of the sentence or clause. Anaphora resolution through discourse knowledge itself has created ambiguity for the ESL learners for resolving anaphora in English ambiguous sentences. The ESL learners resolved anaphora through this strategy with the lowest accuracy rate and was used the least frequently among the six mentioned strategies. There was significant difficulty found in the results of the two sentences given for the same constraint, meant to be resolved through discourse knowledge. The results of the current study reveal that the task of anaphora resolution in English ambiguous sentences was made easy by the strategies that were used for anaphora resolution in English ambiguous sentences but in spite of this, it created ambiguity in the mind of ESL learners due to the co-relational restrictions and preferences between the antecedent and the anaphora used in sentences. They

correlate with each other in the natural way through these strategies in the natural language processing.

Conclusion

The present study investigated anaphora resolution in English ambiguous sentences by the ESL learners. The evidences from the current research study suggested that anaphora resolution strategies made the process of anaphora resolution in English ambiguous sentences easy but often the students were unable to resolve anaphora through the selected constraints. The students sometime got confused to resolve anaphora because they had not learnt the rules of resolving anaphora in English ambiguous sentences. Among the six mentioned strategies that were used for anaphora resolution, the researchers found four strategies (gender and number agreement, syntactic knowledge and real-world knowledge) most frequently used, while, discourse knowledge was the most difficult strategies not only computer but for humans in the interpretation of anaphora resolution in English ambiguous sentences. The results for the use of this strategy showed it neither most frequently nor least frequently. Because it created ambiguity in mind of the ESL learners during the process of anaphora resolution in English ambiguous sentences. The strategy of semantic knowledge for anaphora resolution was the least frequently used strategy by the ESL learners. They were confused in the change of semantically ambiguous words form one sentence to another. The main problem for the ESL learners for processing anaphora resolution was lack of semantic knowledge such as dictionary use and ontology. The findings suggests that anaphora resolution strategies should be used in teaching English as a second language.

References

Artstein, R., & Poesio, M. (2005). *Annotating (anaphoric) ambiguity*. Paper presented at Corpus Linguistics, England, United Kingdom.

Anjali, M. K., & Babu, A. P. (2014). Ambiguities in natural language processing. *International Journal of Innovative Research in Computer and Communication Engineering, 2*(5), 392-394.

Carbonell, J. G., & Brown, R. (1988). Anaphora resolution: A multi-strategy approach. In *Proceedings of the 12th International Conference on Computational Linguistics* (96–101). Budapest, Hungary.

Colonna, S., Schimke, S., & Hemforth, B. (2012). Information structure effects on anaphora resolution in German and French: A cross-linguistic study of pronoun resolution. *Linguistics*, *50*(5), 991-1013.

Devi, L. S. (2014). A generic anaphora resolution engine for Indian languages. In *Proceedings of COLING 2014, the 25th International Conference on Computational Linguistics: Technical Papers* (1824-1833). Chennai, India: MIT Campus of Anna University.

Felser, C., Roberts, L., Marinis, T., & Gross, R. (2003). The processing of ambiguous sentences by first and second language learners of English. *Applied Psycholinguistics*, *24*(3), 453-489.

De la Fuente, I., & Hemforth, B. (2013). Only and Even: Focusing effects on pronoun resolution in temporal clauses and explanations. Poster presented at Discourse Expectations: Theoretical, Experimental, and Computational Percpectives. University of Tübingen, Germany.

Grosz, B. (1977a). The representation and use of focus in a system for understanding dialogs. In *Proceedings of the 5th International Joint Conference on Artificial Intelligence* (67–76). Cambridge, Massachusetts.

Grosz, B. (1977b). The representation and use of focus in a system for understanding dialogs. *IJCAI*, *1*, 67-76.

Grosz, B., Joshi, A., & Weinstein, S. (1983). Providing a unified account of definite noun phrases in discourse. In *Proceedings of the 21st Annual Meeting of the Association for Computational Linguistics* (44–50). Cambridge, Massachusetts.

Grosz, B., Aravind J., & Weinstein, S. (1995). Centering: A framework for modelling the local coherence of discourse. *Computational Linguistics, 21* (2), 203–225.

Gasperin, C., & Vieira, R. (2004). Using word similarity lists for resolving indirect anaphora. In *Proceedings of the Conference on Reference Resolution and Its Applications* (40-46). Barcelona, Spain: Association for Computational Linguistics.

Gardiner, M., & Ng, H., Zhou, Y., Dale, R. (2005). A machine learning approach to identification and resolution of one-anaphora. *International Joint Conference on Artificial Intelligence, 19,* 1105-1110.

Hirst, G. (1981). *Anaphora in natural language understanding.* Berlin: Springer Verlag.

Hale, J. et al. (1998). A statistical approach to anaphora resolution. In Proceedings of the Sixth Workshop on Very Large Corpora (161-170). Quebec, Canada: University of Montreal.

Kamune, K. P., & Agrawal, A. (2015). Hybrid approach to pronominal anaphora resolution in English newspaper text. *International Journal of Intelligent Systems and Applications*, *7*(2), 56-64.

Knees, M. H. (2008). The German temporal anaphor danach—ambiguity in interpretation and annotation. *Research on Language and Computation*, *6*, 273-291.

Lakhmani, P., Singh, S., Mathur, P., & Morwal, S. (2014). Pronominal anaphora resolution in Punjabi language. *International Journal in Foundations of Computer Science & Technology, 4*(4), 99-105.

Li, Y. (2010). *Web-assisted anaphora resolution* (Unpublished doctoral dissertation). University of Alberta, Edmonton.

Leffa, J. V. (2003). Anaphora resolution without word knowledge. *DELTA, 19*(1), 181-200.

Mathieu, P. M. (2016). *The acquisition of the anaphora resolution by French-Spanish bilinguals* (Unpublished master's thesis). University of Ottawa, Canada.

Marques, J. S., Mamede, N., & Baptista, J. (2013). *Anaphora resolution in Portuguese: An hybrid approach* (Doctoral dissertation). University of Lisbon, Lisbon, Portugal.

Mitkov, R. (1995). An uncertainty reasoning approach for anaphora resolution. In *Proceedings of the Natural Language Processing Pacific Rim Symposium* (149–154). Seoul, Korea.

Mitkov, R. (2002). *Anaphora resolution studies in language and linguistics*. England, United Kingdom: Routledge.

Mitamura, T., Nyberg, E., Torrejon, E., Svoboda, D., & Baker, K. (2001). Pronominal anaphora resolution in KANTOO English-to-Spanish machine translation system. In *Proceedings of MT Summit,* (235-239). Dublin, Ireland.

Nand, P. (2012). *Resolving co-references anaphora using semantic constrains* (Doctoral dissertation). Auckland University of Technology, Auckland, New Zealand.

Pereira, S. C. (2010). *Linguistics parameters for zero anaphora resolution*. (Doctoral dissertation). University of Wolverhampton, Lisbon, Portugal.

Rich, E., & Luper Foy, S. (1988). An architecture for anaphora resolution. In *Proceedings of the Second Conference on Applied Natural Language Processing* (18–24|). Texas, USA.

Sidner, C. (1979). *Toward a computational theory of definite anaphora comprehension in English.* Cambridge, Massachussetts: MIT Press.

Singh, S., Lakhmani, P., Mathur, P., & Morwal, S. (2014). Analysis of anaphora resolution system for English language. *International Journal on Information Theory*, *3*(2), 51-57.

Vicedo, J. L., & Ferrández, A. (2000). Importance of pronominal anaphora resolution in question answering systems. In *Proceedings of the 38th Annual Meeting of the Association for Computational Linguistics* (555-562). Hong Kong: Association for Computational Linguistics

Xu, J. (2015). *Processing of scope ambiguity by Chinese L2 learners of English* (Unpublished master's thesis). University of Florida, Florida, United States.

Yang, H., De Roeck, A., Gervasi, V., Willis, A., & Nuseibeh, B. (2011). Analysing anaphoric ambiguity in natural language requirements. *Requirements Engineering*, *16*(3), 163-189.

Yamamura, T., Ohnishi, N., & Sugie, N. (1995). A method of anaphora resolution based on the concept of observation. *Systems and Computers in Japan*, *26*(1), 40-49.