Research Article

Semantic categorization in bilinguals: A typicality effect

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Abstract

Semantic categorization is mainly to understanding of concepts using meaning and based on sets of characteristics properties. Better exemplars of category are identified quicker compared to poorer exemplars, is termed as "typicality effect". Clothing and non-clothing stimuli (strong and weak exemplars) were used for semantic categorization on 10 monolingual and 10 bilingual normal participants. NeuroScan Inc. data acquisition system gentask program was used to measure reaction time. All participants were instructed to press the appropriate option in response pad for all stimuli. Comparison of reaction time between monolingual and bilingual groups and comparison between first language and second language in bilinguals was measured. Results showed that a typicality effect was observed in both monolinguals and bilinguals and no differences were observed between clothing and non-clothing stimuli except in one category. Also results showed significant difference between languages in bilingual groups.

Introduction

The term "bilingualism" is used by different people in different ways. For some, an equal ability to communicate in two languages and for others bilingualism means the ability to communicate in two languages, but only in one language observed greater skills. The definition of bilingualism is very much complex. Classifications of bilinguals in the research usually concede the complexity of defining bilingualism and are easily influenced by multiple factors such as the age of acquisition of the second language, continued exposure to the first language (L1), relative skill in each language and the circumstances under which each language is learned. Popular definitions of bilingualism view language knowledge as being a binary category-whether two languages are acquired or not (Brutt-Griffler & Varghese, 2004).

Researchers recommend that native-like proficiency in both languages, mentioned as "true" bilingualism, is rare (Cutler, Mehler, Norris, & Segui, 1992; Grosjean, 1982). Depending on the age of acquisition, types of bilingualism has been explained. Lambert (1974) explained bilingualism in other two types. They are additive and subtractive bilinguals. Additive bilingualism means acquires proficiency in a second language without loss of the first language whereas in subtractive bilingualism new language substitutes the first language.

Bialystok (2007) gave an additional consideration in the definition of bilingualism depending on the concept of language dominance. Most bilinguals have stronger skills in one language, their dominant language. However, their dominant language need not be their L1. In addition, it is possible to show language dominance in one language for one domain (e.g. L1 for home) and dominance in the other language for another domain (e.g. L2 for work).

Degree of separation of two languages in a bilingual brain (i.e. processing and using of more than one language) on bilingualism has been the important issue in cognitive research. There has been two thoughts, one is that mental representation of two languages are being shared and the second one is each language has its own representation. This has been attempted to clarify using neuropsychological studies in literature but mixed results were observed in behavioral studies (Paradis, 1990, 1992; Mendelsohn, 1988; Vaid, 1983). Recent times it is shown that semantic representations have been the main focus in cognitive research. Semantics is one of the components of language. Semantic categorization is basic to understanding and using the concepts in semantic memory, knowledge of facts and meaning. Semantic categorization is mainly based on meaning, knowledge facts (Grossman, Smith, Koenig, Glosser, & DeVita, 2002; Kutas & Iragui, 1998) and also on sets of characteristic properties (Smith, 1995). Better exemplars

of category were indentified more by children and adults (Jerger, & Damian, 2005; Fujihara, Nageishi, Koyama, & Nakajima, 1998).

Words as stimuli are most used testing tool in the field of both speech language pathology and audiology. A listener hears a word and responds with an appropriate response. This response measures the reaction time (in milliseconds) and accuracy (percent of correct responses. This concept is a basic pattern of auditory speech perception, and decision process after post-perception that may escort the perceptual task. There are three successive phases in information processing models that can be explained with the associated words; form, transform, and inform (Jerger, 2007).

Words processing involves both 'bottom-up' and 'top-down' processes. This processing involves the auditory signal and its sensory depiction by cognitive mechanism and linguistic information, for example attention and memory play a major role in it. Some theories suggest that attention is directly related to stimulus in processing (Reed, 2007; Wolfe, Levi, Kluender, Bartoshuk, Herz, Klatzky, Lederman & Merfeld, 2006). In higher level cognitive responses the post- perceptual decision and problem solving plays a vital role (categorizing particular words in to one category e.g. Sports). This can be termed semantic categorization i.e. the ability to use common properties and semantic knowledge of the group (Grossman, Smith, Koenig, Glosser & DeVita, 2002).

Categorization of groups can be done by two important functions (Barrett, Abdi, Murphy & Gallagher, 1993). These are linguistic knowledge (e.g. food, fruit, & banana), similarities and differences. Categorization based on characteristic properties is the classical view in semantic categorization (Smith, 1995). Better exemplars of category were identified more quickly compared to poorer exemplars in both children and adults (Jerger & Damian, 2005; Fujihara, Nageishi, Koyama & Nakajima, 1998; Ellis & Nelson, 1999). This type of pattern is termed as the 'typicality effect' i.e. the performance advantage of faster reaction time and fewer errors for better exemplars and less in poorer exemplars.

The category typicality and out-of category relatedness effect ("yes" if pictured object is clothing) on typically developing 4-14 years-olds and adults were studied by Jerger and Damian (2005). Stimuli were typical and atypical category objects (e.g., pants, glove), related and unrelated out-of-category objects (e.g., necklace, soup). Errors were infrequent by all participants. In typicality effect, children's performance on category verification task was significantly influenced by within-category typicality. Replicated results were observed in adults indicating that typicality and relatedness effects reflected organizational principles of the semantic system, not picture-related processes. Results of the study explained the significance of typicality and relatedness in semantic categorization on all ages.

Fujihara, Nageishi, Koyama, and Nakajima (1998) recorded the Event-related brain potentials (ERPs) on 14 normal participants during a category verification task. Stimuli were selected from 17 semantic categories (e.g. 'vegetables'). Half of the words were typical category members (e.g. 'carrot', 'spinach') and the other half were atypical (e.g. 'parsley', 'asparagus').The participants were asked to judge whether each word presented was belongs to target category or non-target category. They responded more quickly to target words compared to non-target category in reaction time and more negativity was observed for target words compared to non-target category (typicality effect). It shows that target for typical words were more processed than for atypical words.

Electrophysiological correlates of word comprehension using behavioural and electrophysiological measurements were experimented by Mehta, Jerger, Jerger, & Martin (2009). Thirty-four young adult men and women in the age range from 18 to 33 years were included in the study. Semantic category was chosen for the study was 'clothing'. All the stimuli were concrete words. Clothing and non-clothing item were taken from various resources. Strong and weak exemplars were divided depending on the typicality effect. Stimuli were audio recorded using Cool Edit Pro software. It was presented through auditory mode. For behavioural measurements participants were instructed to press appropriate button on response pad for different stimuli. In electrophysiological measurement, Neuroscan electrophysiological data acquisition system was used and nine electrode sites (F3, Fz, F4, C3, C4, Cz, P3, Pz, & P4) were used in the study. Behavioral results showed that average accuracy scores were higher for strong exemplars compared to weak exemplars. The average reaction time was 200msec longer for weak than strong exemplars. Electrophysiological results found that significant latency differences were observed compared to weak and strong exemplars; clothing and non-clothing items.

Ellis and Nelson, (1999) examined the categorization of prototypical (target) and non-typical (non-target) items using event-related potentials (ERPs) and reaction time. Adults and 6-year-old children were taken in the study and presented the stimuli in picture mode of prototypical and non-prototypical dogs and cats. Instructions were given to press a button for members of one of the categories. Behavioral data results indicated that adults responded more quickly than children and prototypes were identified very quickly by both

adults and children than the non-prototypes. In event related potentials, for children, peak amplitudes were greater to prototypes than to non-prototypes whereas the latency-to-peak was shorter to prototypes than to non-prototypes in adults. These data highlight the importance of prototypicality in categorization of stimuli and point out age differences.

Table 1: Participants of the study

Groups	No. of Participants
Monolinguals	10
Bilinguals	10
Total	20

In recent times the main focus in cognitive research was semantic representations. Semantic categorization is one of the main focus, it is mainly based on meaning, knowledge facts (Grossman, Smith, Koenig, Glosser & DeVita, 2002; Kutas & Iragui, 1998) and also on sets of characteristic properties (Smith, 1995). Studies showed that better exemplars of category were identified more by children and adults (Jerger & Damian, 2005; Fujihara, Nageishi, Koyama & Nakajima, 1998; Ellis & Nelson, 1999). This type of pattern is termed as the 'typicality effect'. In both behavioural and electrophysiological studies explained the significance of typicality and relatedness in semantic categorization on all ages (Jerger & Damian, 2005; Mehta, Jerger, Jerger & Martin, 2009; Fujihara, Nageishi, Koyama & Nakajima, 1998; Ellis & Nelson, 1999). Need of the present was to see the typicality effect in bilinguals as most of the studies were done on monolinguals. The main purpose of the study was to explore the semantic categorization of words based on their typicality effects. This study gives an exclusive use of the typicality effect for semantic categorization.

Method

Participants: Twenty neurotypical male participants were considered in the present study. They were divided into 2 groups. Group one consists of 10 native Kannada (L1) speaking monolinguals; group two consists of 10 bilinguals whose native language (L1) is Kannada and second language is English (L2). Table 1 depicts the details. The participants were selected based on the following points those are, all the participants were native speakers of Kannada language (L1) and second language was English (L2) in Bilingual group; no significant history of current or past hearing difficulties, or any history of neurological diseases. All participants were right handed. To assess the language proficiency in participants L1 and L2 the Language Proficiency Questionnaire- is an adaptation of The Language Efficiency and Proficiency Questionnaire (LEAP-Q) in the Indian context (Maitreyee & Goswami, 2009) was used. All the monolinguals were taken from the rural areas of Karnataka, India and their education levels were below fifth standard.

Stimulus Preparation: The category used in the study was 'Clothing' (Strong & Weak exemplars), refers to any covering for the human body vs. non- clothing (Strong & weak exemplars), refers to other than clothing items'. The type of clothing worn depends on functional considerations. The items will be concrete nouns representing clothing and non-clothing items selected from various resources (daily natural conversation, news papers, etc). The clothing items were selected to correspond a strong exemplar along with a weak exemplar to represent a range of goodness-of-example ratings, e.g. shirt vs. belt (Jerger & Damian, 2005). Non-clothing items were selected to represent a range of other categories (e.g. food, animals, furniture, etc). A total of 100 items in each category was rated by 10 speech language pathologists (native Kannada speakers and L2 as English). They were instructed as follows:

"The purpose of this study is to find out how well each of the following items represents your idea or image of clothing. Your task is to rate how good an example of clothing each item is, a scale ranging from 0-3. A rating of 0 means you sense the item is non- clothing (e.g. table). A rating 3 means, you feel that the item is a very good example of clothing (e.g. shirt)." The rating scale given to speech language pathologists for familiarity depicted in table 2.

A total of 20 items in each category was considered into the study. The same above mentioned procedure was used for preparation stimuli in both Kannada and English stimuli.

Recording of Stimuli: The collected stimuli were audio recorded on a personal computer using Adobe Audition 3.0 by an adult Kannada- English bilingual speaker. Recording was done by unidirectional microphone kept at a distance of 10cm from the speaker's mouth. Recording is done with a resolution of 32-bits and a sampling rate of 44.1 kHz. The recorded stimulus was normalized so that all the test items have the same intensity. The intensity of the stimulus was calibrated according to the intensity levels in the NeuroScan Inc. data acquisition system.

Instrument: NeuroScan Inc. data acquisition system was used to record the reaction time measurement. This consists of two monitors, one is used for stimulus presentation i.e. Stim2 and the other

Table 2: Rating scale used for clothing vs. non-clothing (strong & weak exemplars) sub-categories

Sub-category	0-3 rating scale			
	0	1	2	3
Clothing vs. Non-clothing (strong and weak exemplars)	Non-clothing (strong exemplar)	Non-clothing (weak exemplar)	Clothing (weak exemplar)	Clothing (strong exemplar)

Table 3: Mean reaction time, accuracy of response and standard deviation (SD) for Kannada stimuli in monolingual and Kannada and English stimuli in bilingual groups

Groups	Language	Stimulus		Mean reaction time	Accuracy (%)	SD
Monolinguals	Kannada	Clothing	Strong	388.3	98	29.2
			Weak	463.2	95	54.6
		Non-clothing	Strong	392.3	98	24.1
			Weak	497.04	97	49.8
Bilinguals	Kannada	Clothing	Strong	383.5	99	22.1
			Weak	440.1	95	62.9
		Non-clothing	Strong	374.6	98	27.06
			Weak	493.6	97	48.09
	English	Clothing	Strong	411.9	99	35.7
			Weak	489.7	96	52.4
		Non-clothing	Strong	373.9	97	31.5
			Weak	510	96	46.7

were used for response and data storage i.e. Scan 4.4. ER-3A insert ear phones for auditory stimulus and response pad for participant's response were used.

Table 4: Mixed ANOVA for Kannada stimuli between monolingual and bilingual groups

Source	Df	F	Sig.
Groups	1	2.27	0.14
Clothing vs. Non-clothing	1	4.13	0.057
Strong vs. Weak	1	73.4	0.00

Procedure: Participants were seated comfortably in a quiet room. NeuroScan Inc. data acquisition system was used to elicit reaction time. Gentask Synamps2 program was used in NeuroScan for presentation of stimuli. Recorded stimuli were randomly presented through auditory mode using ER-3A insert ear phones. Instructions were given to the participants to press the button "1" if the presented stimulus is clothing and to press "2" if the presented stimulus is non-clothing. Response was measured in milliseconds and elicits the response for each stimulus. The reaction was measured for Kannada stimuli in both monolingual and bilingual groups and for English stimuli in bilingual group was measured.

For the analyses, comparison of reaction time between monolingual and bilingual was measured and also within each group between types of stimuli was measured. In bilingual group, first language (Kannada) and second language (English) comparison and within types of stimuli were also analyzed.

Results and Discussion

There was difference in means for strong and weak exemplars in all categories. Weak exemplars took longer time compared to stronger exemplars. There was slight higher accuracy rate for stronger exemplars compared to weak exemplars. There were not many differences between languages through means of reaction time. Mixed Analysis of variance (ANOVA) , three way repeated measures ANOVA and paired t test was used to find out the differences between languages, type of stimuli. Response accuracy and reaction time measurements in monolingual and bilingual groups for different types of stimuli (Clothing vs. Non-clothing) using Kannada stimuli and English stimuli are depicted in Table 3.

Table 5: Paired t-test between clothing and non-clothing items

Pairs	fT	Df	Sig.
KCS-KCW	4.18	19	0.00
KNCS-KNCW	10.04	19	0.00
KCS-KNCS	0.32	19	0.74
KCW-KNCW	2.48	19	0.02

Abb: KCS - Kannada clothing strong, KCW - Kannada clothing weak, KNCS- Kannada non-clothing strong, KNCW- Kannada non-clothing weak.

Results of Mixed ANOVA indicated main effect of exemplars (F= 73.4, p<0.001) but not groups and categories (clothing vs non-clothing). There was no interaction effect found between groups and clothing - non-clothing stimuli; same was observed between groups and strong-weak exemplars but there was interaction found between clothing - non-clothing stimuli and strong-weak exemplars (F= 6.272, p<0.05). Since there was an interaction found the paired t-test was administered and depicted in Table 5.

Results of Paired t-test suggested significant difference for KCS-KCW (Kannada clothing strong-Kannada clothing weak), KNCS-KNCW (Kannada non-clothing strong- Kannada non-clothing weak), and KCW-KNCW. Only in KCS-KNCS pair there was no statistical significant difference. Thus, difference was observed between strong and weak exemplars of a category. The difference was observed between clothing and non-clothing categories for weak exemplars but not was seen for strong exemplaes. The mean reaction times between mono and bilingual groups for Kannada stimuli are also shown Figure 1.

Table 6: Three way repeated measures ANOVA for both Kannada and English stimuli within bilingual group

Source	**Df**	**F**	**Sig.**
Language	1	23.2	0.01
Clothing vs. Non-clothing	1	0.21	0.65
Strong vs. Weak	1	56.4	0.00

The above results support the results of the study done by Mehta, Jerger, Jerger, & Martin (2009). They found in behavioural result shows that average accuracy scores were higher for strong exemplars compared to weak exemplars. The average reaction time was longer for weak than strong exemplars. Fujihara et al (1998) reported that participants responded faster to target category than a non-target category. In the present study also it has been observed that the accuracy of response is higher for strong exemplars compared to weak exemplars and longer reaction time for weak exemplars.

Results of 3-way repeated measures ANOVA indicated main effect of languages(F= 23.2, p<0.01) exemplars (F= 56.4, p< 0.01) but no main effect of stimuli (F= 0.21, p=0.65). There was an interaction effect between language and clothing - non-clothing stimuli (F= 11.34, p<0.01), language and strong-weak exemplars (F= 8.65, p<0.05), and clothing - non-clothing stimuli and strong-weak exemplars (F= 9.23, p<0.05). Since there was an interaction found paired t-test was administered and depicted in Table 7.

Results of paired t-test indicated a significant difference between KCS-ECS (Kannada clothing strong- English clothing strong), KCW-ECW (Kannada clothing weak- English clothing weak),

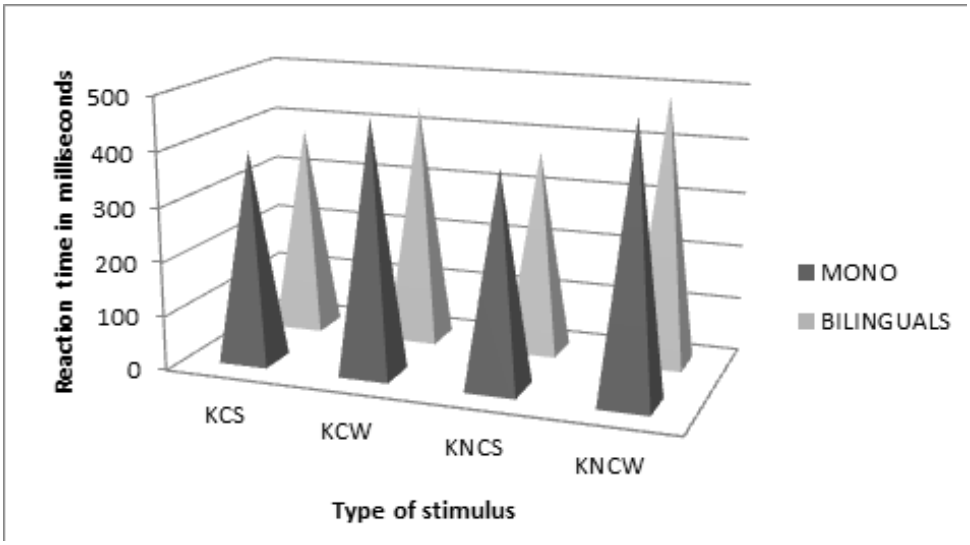

Figure 1: Mean reaction time values for Kannada clothing-non-clothing stimuli in monolinguals and bilinguals.

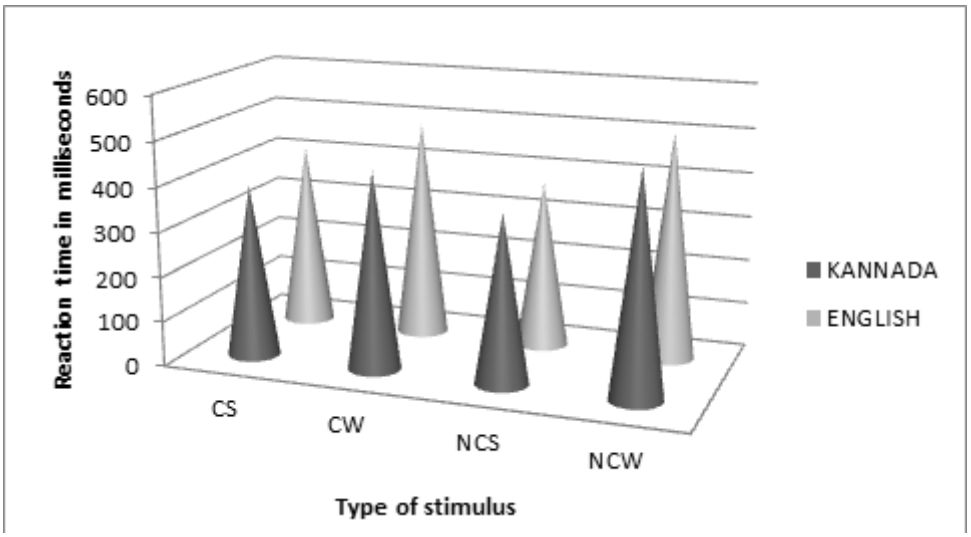

Figure 2: Mean reaction time values for Kannada and English (clothing and non-clothing) stimuli in bilinguals.

ECS-ENCS (English clothing strong- English non-clothing strong), KCS-KCW, KNCS-KNCW, ECS-ECW, and ENCS-ENCW (English non-clothing strong-English non-clothing weak). There was no difference observed in KNCS-ENCS, KNCW-ENCW, KCS-KNCS, KCW-KNCW, ECW-ENCW pairs.

A significant difference for clothing category items between languages (Strong and weak exemplars) and no difference non-clothing category was noticed. In strong-weak exemplar comparison there was a significant difference for all four pairs but in clothing-non-clothing comparison only for English stimuli (clothing and non-clothing strong pair) difference was observed. The mean reaction times of Bilingual group for Kannada and English stimuli also shown in Figure 2.

Table 7: Paired t-test between clothing and non-clothing items in bilingual group

Pairs	**t**	**df**	**Sig.**
KCS-ECS	3.12	9	0.01
KCW-ECW	6.62	9	0.00
KNCS-ENCS	0.13	9	0.89
KNCW-ENCW	1.405	9	0.19
KCS-KNCS	0.92	9	0.37
KCW-KNCW	2.07	9	0.06
ECS-ENCS	2.608	9	0.02
ECW-ENCW	0.99	9	0.34
KCS-KCW	2.61	9	0.02
KNCS-KNCW	7.79	9	0.00
ECS-ECW	4.81	9	0.00
ENCS-ENCW	9.01	9	0.00

Abb: ECS- English clothing strong, ECW- English clothing weak, ENCS- - English non-clothing strong, ENCW- - English non-clothing weak.

Results of the present study show that strong-weak exemplars (typicality effect) have shown significant effect in identification of stimuli. Strong exemplars were identified faster compared to weak exemplars. The results support those of previous studies. Adults and children responded better and faster for better exemplars compared to poorer exemplars (Jerger & Damian, 2005; Fujihara et al, 1998; Ellis & Nelson, 1999). Jerger and Domian (2005) explained that advantage of performance and fewer errors for better exemplars than poorer exemplars and results of the study explained the significance of typicality and relatedness in semantic categorization on all ages. In bilinguals, reaction time for strong exemplars of clothing and non-clothing categories was lesser than the weak exemplars of clothing and non-clothing categories. Reaction time for Kannada language (first language) was quicker compared to English language (second language), it suggests that processing of first language was faster than second language in bilinguals.

Prototypical (target) words and non-typical (non-target) words identification studies shows that adults responded faster to prototypical words (Ellis and Nelson, 1999; Fujihara, Nageishi, Koyama & Nakajima, 1998) and in children also (Ellis and Nelson, 1999). But in present study only in English stimuli (only for clothing and non-clothing strong pair) statistical significant difference was observed.

Present study highlights that typicality effect was observed in both the groups and for both the Kannada and English stimuli. There was no difference between clothing and non-clothing category except in one category i.e. English clothing strong-English non clothing strong. Also it shows that significant difference between languages i.e. Kannada and English languages was observed in bilingual

group. Thus, bilinguals responded quicker than monolinguals, reaction time was faster for first language (Kannada language) than second language (English language). This research has established usefulness of behavioural measurements and the appropriateness of typicality effect in semantic categorization tasks.

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