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Taking a Road Not Travelled: A Cross-lingual Study of *Kāraka*-Cognition

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Abstract

The *Kāraka* theory in the Pāṇinian grammatical tradition in the Sanskrit studies stands as a benchmark to understand the confluence of Sanskrit syntax and semantics. The theory has been explored from syntactico-semantic and philosophical perspectives till date by ancient and modern scholars in India and beyond. Relying on the earlier theoretical discussions, the current report, the first of its kind, tries to investigate the cognition of the *kāraka*s in real-life human communication by carrying out experimental research on a total of 900 readers of Sanskrit and Marathi. The study argues that (1) the ontological classification of the verbs affects the cognition of the *kāraka*s, (2) while *kartā* (agent) and *karma* (object/ destination) of the verb are more accurately cognized, *adhikaraṇa* (location/ substratum) of the verb is not, unless it adds to the main semantic component of the sentence, (3) the first language of the readers affects their comprehension of the *kāraka*s in the second language, provided if the second-language is not used in daily life conversations. The novelty of the research lies in the experimental methodology that is still in its infancy in Sanskrit studies.

Keywords: Single-verb, *Kāraka*, Psycholinguistics, Sanskrit studies, Experimental Research

Introduction[1,2]

Kāraka (pronounced as *kaaraka*) is a syntactic category or a non-linguistic item that participates in an action. A sentence usually consists of two main parts: verb (*ākhyāta*) and argument/s or complement/s (*kāraka*). Thus, *kāraka* serves to bring an action to accomplishment (*kriya-sādhana*) and is always connected with the action (*kriya-viśeṣayukta*). It is a constituent of the main action (Cardona, 2008, p. 107).

The *kāraka* theory is one of the centrepieces of Pāṇinian syntax that is dealt by Pāṇini, a 5th C BC Sanskrit grammarian, in great detail in his monumental work '*Aṣṭādhyāyī*' (Joshi & JAF, 1999, p. 95). Nonetheless, Pāṇini has never defined the term *kāraka*. Etymologically speaking, the term *kāraka* has been derived from the verbal root *'kṛ'* ('to do') and an agentive suffix *'ṇvul'*. Hence, *kāraka* signifies the agent of the action or something that accomplishes

[1] The abbreviations used in the manuscript are as follows: P.- Pāṇini's Aṣṭādhyāyī.
[2] The transliteration system used in the manuscript for both Marathi and Sanskrit sentences follows IAST-International Alphabet of Sanskrit Transliteration system.

an action. A similar view is emphasized by Patañjali under the rule *'kārake'* (P.1.4.23), that the *saṁjñā 'kāraka*' means '*karoti kriyāṁ nirvartayati*' (that which does or accomplishes an action) (Bhatta, 1988, p. 16).

According to the Pāṇinian grammatical system, a verb can have a maximum of six arguments, viz.,

(i) *Kartā* (one who is independent, the agent) (P.1.4.54),
(ii) *Karma* (what agent seeks most to attain, object) (P.1.4.49),
(iii) *Karaṇa* (the main cause of the effect, instrument) (P.1.4.42),
(iv) *Saṁpradāna* (the recipient of the object) (P.1.4.32),
(v) *Apādāna* (that which is fixed when departure takes place) (P.1.4.24), and
(vi) *Adhikaraṇa* (the basis or location) (P.1.4.45).

*Kāraka*s are 'generally' the words that play thematic roles in the sentence and are roughly translated as an agent, object/ patient/ goal/ destination, instrument, beneficiary, source of action, and location. However, Bharati (2007, p. 2) have rightly pointed out that from a linguistic string only kāraka relations can be known, and not thematic roles.[3] Generally, they take nominative, accusative, instrumental, dative, ablative, and locative suffixes, respectively.[4] Although, the connection between the *kāraka* and the case-endings is not one-to-one, as it is a well-known facț In a certain circumstance, more than one *kāraka* can equally apply to a single entity (Cardona, 2008, p. 109).

It is stated by Faddegon as quoted by Staal that

> "By karakas Panini understands the logical or ideational relations between a noun and a verb, or more precisely between an object or anything conceived after the analogy of an object and an action or anything conceived after the analogy of an action…" (Staal, 1967, p. 18).

*Kāraka*s do not always correspond with the nature of an action; therefore, it is said that the *kāraka* theory is only a *via media* between grammar and reality. Pāṇini's system is based on the meaning, rather than the conventional method to string together the words (Kak, 1987, p. 124). The attestation of the arguments with that of the verb as regards which role it plays in bringing about a certain action is governed by the speakers' wish/ intention ('*vivakṣā*'). When some words/ arguments are left out and not used explicitly in the sentence, listeners infer and fill in the 'missing' argument/s. (Traxler, 2011, p. 170).

The current research addresses the question about how different *kārakas* are cognized by the readers when they are missing from the surface level of the language.

[3] In a given sentence, different thematic roles can be played by a single *kāraka*.
[4] The following Pāṇinian rules link a case-ending with a specific kāraka, such as P. 2. 3. 2, links *dvitīyā* with *karman*, P. 2. 3. 13, links *caturthī* with *saṁpradāna*, P. 2. 3. 18, links *tṛtīyā* with *kartṛ* and *karaṇa*, P. 2. 3. 28, links *pañcamī* with *apādāna*, and P. 2. 3. 36, links *saptamī* with *adhikaraṇa*.

The Emergence of the Idea of the Research

The research has taken its shape as a peripheral research objective of the doctoral dissertation of the author when she was a PhD student at the Indian Institute of Technology Bombay in late 2019. The primary study was to investigate the role of the single-verbs in the conversations in Sanskrit using experimental research. The obtained data suggested that a few *kāraka*s or arguments of the respective verbs are mapped more accurately than the other by the readers across all age, gender, and other spectrums. The attention was, then, paid to the several *kāraka*-specific aspects in the process of verb-argument mappings, such as the type of the linguistic string, the coded information, the reality or the ontology of the verbs and *kāraka*s, etc.

Aim and Research Questions

The research aims at exploring the cognitive aspect of the *kāraka*s in Sanskrit conversational data. It probes into the human mechanism of sentence processing to investigate which *kāraka* is easily assumed or inferred by the readers on encountering upon a single-verb in the conversations by considering the ontological classification of the given verb. Thereby, it tries to explore the third angle of the semiotic triangle of the verb that stands for the 'referent' or the '*vastv-artha'* (external-object) and its role in the verb-argument mapping. Research questions are as follow:

(i) Does the ontology of the verb affect the process of verb-*kāraka* mapping?
(i) Which among the six *kāraka*s is easier to map with its verb?
(ii) What can be the possible reason behind it?

Literature Review

Due to the sophisticated presentation in Sanskrit grammar, the *kāraka* theory has managed to retain the attention of linguists and grammarians alike for the past several hundreds of years. In the last more than 40 years, computer scientists and computational linguists have also started their quest into the applicability of the *kāraka* theory with a fresh perspective to harness the insights in the fields of natural language processing, machine translation, data retrieval, and such. However, surprisingly, and interestingly, the cognitive role played by the *kāraka* in real-life human communication has not been explored till date.

The current section presents the earlier research on the *kāraka*-theory in Sanskrit grammar in brief. An abundant amount of literature in Sanskrit studies has resorted to the theory of *kāraka* in their discourse on the process of *śābdabodha* or verbal cognition. A scholarly article by Bhatta (1988, pp. 15-17) presents the theory of *kāraka* in the light of ancient and modern research where the author has considered the views of Patañjali, Nāgeśa, Bhartṛhari and other later grammarians along with logicians and ritualists such as Jagadīśa, Giridhara, and the Bhāṭṭas stating that how scholars from different *śāstra*s have approached the theory of *kāraka* from syntactic and semantic levels. Scholars have also pointed out the comparison between the notion of *kāraka* as held by Bhartrihari versus Bhaṭṭojī Dīkṣita (Kudo, 1995, p. 482). A few articles have focused on the *pada-śakti* while discussing the theory of *kāraka*,

suggesting that the *yogyatā* is universally accepted in the theory of *kāraka* (Ogawa, 1997, p. 503). A few types of research have followed the comparative analysis of the *kāraka* theory in the east, especially that of Bhartrihai with some western concepts such as Ferdinand De Saussure's signs, Lucien Tensniere's the Actantial Paradigm, Rene Thom's Catastrophe theory (Manjali, 1995, pp. 87-91).

The issue of the cognition of *kāraka* is dealt by some modern scholars while discussing the process of *pratyakśa jñāna* in the framework of Indian logic or *Nyāyaśāstra*. Dash (1999, p. 334) explains that in *jñāna-lakṣana-pratyāsattī*, where all types of *sannikarṣa*s become inapplicable, the perception of the *kāraka*-relations function as perceptual relations. For example, in '*surabhi candanam'*, the mind brings the prior knowledge of the fragrance of the sandalwood after the *sannikarṣa* between the sandalwood and the eye takes place.

The *kāraka*-theory is also being dealt with in terms of the knowledge representation scheme. The knowledge of *kāraka* roles plays an important part in the process of *śābdabodha* since the sentence is defined as an action or *kriyā* in which *kāraka* function as actors (Dash A. , 1992, p. 43). Vacaspati Mishra (C. 9th A.D.) the author of Nyayavartika-Tatparya-Tika says, "*pradhāna-kriyā-sādhane hetau avāntara-kriyā-viśeṣayukte kāraka-śabdaḥ pravartate*" ('the term *kāraka* is used (in the context) with an entity which possesses a specific auxiliary action by which the causal factors participate in accomplishing the main action') (Dash A. , 1992, p. 51). In other words, one *kāraka* depends upon another *kāraka* with the help of its auxiliary activity to participate in the accomplishment of the main action.[5] Dash points out Bhavananda's view as presented in the text 'Kārakacakram' that only *karaṇa kāraka* is the most efficient means of any action that is directly effective. *Adhikarana* is dependent on both agent and object, while as *apādāna* and *saṁpradāna* are dependent on agent. Dash modifies the view stating that *apādāna* should be considered as effective through both agent and object, *saṁpradāna* is effective not via an agent, but through an object, and *kartā* is directly *caritārtha* in the main action (Dash A. , 1992, pp. 54-55). But the author adds that the effectiveness of the *kāraka*s should be considered when more than one *kāraka*s are stated explicitly in the same sentence and not in the case where the *kāraka*s are implied. The author concludes that while *kartā*, *karma* and *karaṇa* are the prominent *kāraka*s, the *saṁpradāna*, *apādāna*, and *adhikaraṇa* are dependent *kāraka*s (Dash A. , 1992, p. 56). The importance of *kartā kāraka* among all is also accented by (Artemij, 2010, p. 36).

Kak (1987, p. 117) uses *kāraka* theory for computational sentential parsing of the sentence. It is used by several later scholars as well for segmentation and tagging of Sanskrit

[5] For example, in the main action of cutting (action of '*avayavaviśleṣanukūlavyāpāra*' denoted by the verbal root 'chid'), the other actions such as *unnamana* and *nipātana* performed by the agent ('taking up' and 'putting down') and an instrument ('going up' and 'falling down') play auxiliary functions. In other words, the agent is effective or *cartitārtha* with instrument kāraka to accomplish the action. Similarly, the *saṁpradāna kāraka* is *caritārtha* via *karma kāraka*, because *saṁpradāna* is connected with the object.[5] Furthermore, the *adhikaraṇa kāraka* is dependent on the agent or object to participate in the accomplishment in any action[5] (Dash A. , 1992, p. 52).

data (Huet, Lexicon-directed segmentation and tagging of Sanskrit, 2003, p. 321), and to develop computational sentential shallow parsers (Huet, 2006, pp. 6-7).

A few kinds of recent research have started using the ancient Indian theories of *kāraka* to apply the knowledge in creating some computational tools such as (1) Anusāraka tool, which is a computational tool for accessing the material from unknown languages that contain different levels of processing such as word-splitting, morphological analysers, sentential parsers, and compound word analysers etc, which finally gives the translation as an output for a given sentence (Bharati, 2007, p. 3), (2) OntoSenseNet, can be used to derive *kāraka*-verb sense type distribution (Jha, 2018, p. 1), (3) Hindi-English parser, that uses Stanford dependency parser for the best solution for fixed-word order languages and maps it with *kāraka* relations by capturing the syntax and the senses of the verbs using VerbNet to parse English and Hindi sentences (Kumar, 2015, p. 363), (4) Yogyatā tool that captures the *kāraka-yogyatā* of the *apādāna kāraka* (Salaskar, 2019), and a few parsers for Sanskrit sentences as well.

Apart from Sanskrit, other languages have drawn a lot of insights from the kāraka theory. The following works give a short account on it. (1) Bagchi (2007, p. 8) has used the *kāraka* relation in Sanskrit, English and Bangla and studies the functional role played by the postposition in the Bangla, (2) Trandabat (2011, p. 1062) has proposed a semantic role labelling system for Romanian texts, (3) Sharma (2012, p. 239) has developed a Punjabi text clustering system by creating a *kāraka* list to use syntactic and semantic relationship among the words (Sharma, 2012, p. 395; Sharma, 2012, p. 33; Sharma, 2013, p. 180), (3) Radhika (2013, pp. 27-31) proposes a system to build a semantic structure from a given Malayalam text using *kāraka* role extraction from the sentence, (4) Jindal (2014, pp. 2-4) has used the syntactic and semantic cues provided by *kāraka* rules to analyse the sentence and converting the Hindi (natural language) sentence into database query language, (5) Bhaskar (2015, p. 847) proposes shallow form of semantic parsing for Malayalam language to derive semantic roles of the words formulating computational algorithms, (6) Kataria (2015, p. 41) has proposed an architecture for an interface that converts Hindi (natural language) sentence into the equivalent SQL (Structured Query Language) query, (7) Archana (2016, p. 1540) has developed a rule-based question-answering system for Malayalam, (8) Kishore (2016, pp. 196-197) proposes a method for abstractive document summarization that builds a suitable semantic representation of a Malayalam sentence, (9) Jain (2017, p. 134) has used *kāraka* theory and syntactic-semantic relation of the post-positions in Hindi to perform automatic scene generation from a linguistic string, (10) Jayan (2017, pp. 240-243) has created a VerbFrame model for Malayalam language, (11) Chakma (2018, p. 748) identifies and annotates predicates and semantic roles (arguments) in English language tweets by presenting a simpler approach i.e., 5W1H (five Ws and one H= who, what, when, where, why and how) adhering to the domain of journalism. The approach extracts the required information from a natural language, (12) Ajusha (2019, p. 1194) has generated a tree-bank for the Malayalam language based on the syntactic and semantic information provided by the *kāraka* relations, (13) Anuranjana (2019) proposes an automatic question generation model for Hindi by formalizing question transformation method based on kāraka theory of dependency, (14) Ojha (2019), in his doctoral dissertation, has used

Pāṇinian *kāraka* model to create an English-Bhojpuri machine translation system, to name a few.

Apart from linguistic studies, the theory of *kāraka* is also taken up in the discourse on medicine (Khanna, 1988, p. 130). Referring to the Caraka Saṁhitā, the author argues that there is a strong possibility that the *kāraka* theory can be traced back to the ten-fold relations posited in the medical texts, viz. *kartā*, *karma*, *karaṇa*, *kāraṇa*, *kāryayoni*, *kāryaphala*, *anubandha*, *deśa*, *kāla*, and *pravṛtti*.

The current research is a novel contribution to the field of Sanskrit linguistics that tries to find the cognition of the arguments in the humans resorting to the verbs' ontological categories, which has remained a borderline twilight area. It is noted by two scholars, Cindy Fisher and Leila Gleitman that in early childhood, noun-meanings are easily learned than the verb-meanings since nouns refer to concrete and observable properties, as against verbs that stand for some action or event intended by the speaker, that sometimes have no physical appearance (Traxler, 2011, p. 349). Considering this fact, the research also examines the question of whether verbs' ontological categories impact the process of mapping the required arguments with it.

Methodology

Experiment Setup

The experiment was set up using two different techniques, viz. web-based experiment, and classroom-controlled experiment. Web-based experiments are conducted online via the internet where there is no need for the supervisor to be physically present while participants perform the task, and classroom-controlled experiments were conducted in an offline format where the investigator was present while readers read the texts. Hence, the former is knowns as a non-supervised technique, while the latter is known as a semi-supervised technique in which a supervisor can observe readers' reading behaviour, but no reaction time was measured as it is done in supervised methods. A total of eight experiments were conducted over the span of more than two and half years in two cities in Maharashtra (viz. Solapur and Pune). The reason behind choosing Solapur and Pune lies in the distinct variety of regional Marathi in the respective regions. While a majority of speakers in Pune uses the standard variety of Marathi, a majority of the population is Solapur uses the vernacular variety that is influenced by the nearby Kannada- and Telugu-speaking population. All readers were given the consent form, the experiment that contains the conversational paragraphs followed by questions, and a feedback form.[6] They were assured about the confidentiality of their personal information, and of no misuse or fabrication of the data. Each participant was acknowledged after the experiment for the time and effort.

Data Set Description

[6] Please refer to Figure 10 (Appendix).

A total of four data sets in Sanskrit and six data sets in Marathi consisting of conversations are selected manually and then finalised by a group of three linguists, one among them being a native speaker of Marathi. The conversations belong to both classical and modern literature. Sanskrit data sets are collected from different online resources and Marathi data sets are chosen from a large repository developed by CFILT laboratory, IIT Bombay[7] along with some other online blogs. The data sets are validated by an expert annotator with his 100% agreement that no paragraph is incomprehensible, which forms the ground truth for our work. The researcher has taken care that the content of the paragraph is neutral, and it would not lead to any kind of emotional outburst in the readers which would affect their reading behaviour.

The conversations run from a minimum of 8 to a maximum of 22 sentences.[8] Each conversation consists of at least one single-verb, having its arguments (*kāraka*s) dispersed across the text.[9] Furthermore, the number of the paragraphs in each experiment is kept optimum i.e., less than six paragraphs per data set, adhering to readers' attention span, that avoids mental fatigue and boredom on the readers' part. Each paragraph was followed by at least two questions referring to the single-verb sentence and complete sentence in it.

Fundamentally, comprehending any verb entails comprehending an event, state, or action it denotes. The ontological categories of the verb necessarily refer to this semiotic analysis of that verb. The question related to the single-verb sentence addresses the fact that readers assume a desired and most appropriate argument to comprehend the single-verb to have complete cognitive experience out of it. In each data set, six different single-verbs require one of the six *kāraka*s to denote the complete desired meaning. The question is formed in such a way that the correct answer to this question emphasizes the fact that readers have correctly mapped the respective argument with the verb.

Table 1 and Table 2 (Appendix) present the description of the data sets with single-verbs, the argument in the question, the kāraka category and the ontological classification of the verbs.

Participant Description

A total of 489 readers, belonging to the age-group of 13 to 84 years old have taken part in all eight experiments conducted on the Sanskrit language. They belong to Hindi, Gujarati, Saurashtri, Marwari, Bengali, Telugu, Marathi, Malayalam, and Konkani languages. All of them, except for six readers, are second-language speakers of Sanskrit having learned the language after the age of seven years. A few of them have daily exposure to both written and spoken Sanskrit, and the majority of the readers read Sanskrit regularly. A total of 447 readers, both native and non-native readers have participated in 12 experiments on the Marathi language. They belong to the age group of 21 to 54 years old. Almost all of them have regular exposure to both written and spoken Marathi. All participants are neurologically healthy, i.e.,

[7] I thank Mr. Gajanan Rane (CFILT, IIT Bombay) for providing me with the Marathi data sets.
[8] A sample paragraph is presented in Figure 8 (Appendix).
[9] Please refer to a prototype conversation in Figure 7 (Appendix).

they do not show any reading disability in their previous life. Readers are literate and well-acquainted with Devanāgarī script in which paragraphs were presented.[10]

Participants were given complete information about the experiment design, annotation input method, need for attentive reading, and ethical behaviour before the experiment. Written consent is sought from all readers. It was a self-paced and silent reading method.[11]

Results and Analysis

The subjective reports of more than 900 Sanskrit and Marathi readers, obtained from ten different data sets using more than 57 different verbs suggest that not all arguments of the verbs have a similar role in the comprehension of single-verbs, viz., some arguments are easily inferred and mapped with the verbs while some are not. Overstepping the physical limitations of the samples that control the manoeuvre of bridging the arguments with the verbs (such as difficulty level of the texts, familiarity with the texts, etc.), this section looks primarily at the internal viz. language-specific, and secondarily, at the external i.e., reader-specific factors that control the mapping of the required arguments with the single-verbs.

A *kāraka*-wise analysis of single-verb comprehension is presented in this section based on the available data. The potential factors that may influence the process of mapping some arguments effortlessly as against some others are mentioned by presenting the possible reasoning behind them.

Data Analysis- Step 1

(i) Considering all single-verb sentences in all four data sets, the *kāraka*-wise analysis is performed. Sample Figure 1 andFigure 2 show the results obtained from almost 100 Sanskrit readers and 69 Marathi readers, respectively.

Figure 1 depicts (image at the left) the percentage-wise accuracy vis-à-vis the comprehension of each *kāraka* in question. A total number of readers that have marked correct answers is also presented (image at the right). The results indicate that *kartā* and *adhikaraṇa* have obtained the highest accuracy, followed by *karma*, *karaṇa*, and *apādāna*. The *saṁpradāna kāraka* has obtained the least accuracy. In other words, while the readers could infer and map the agent and location of the respective verbs easily and more accurately, the recipient or the beneficiary of the action was demanding for the majority of the readers to be mapped with the verb. Figure Figure 2 states that in Marathi, *karma* and *saṁpradāna* were easier to process as compared to the *adhikaraṇa kāraka*.

[10] It would be more exhaustive and all-encompassing study to consider the social, economic, and education background of the families from which the participants belong. I thank the reviewers for this insight.
[11] Please refer to Figure 9 (Appendix).

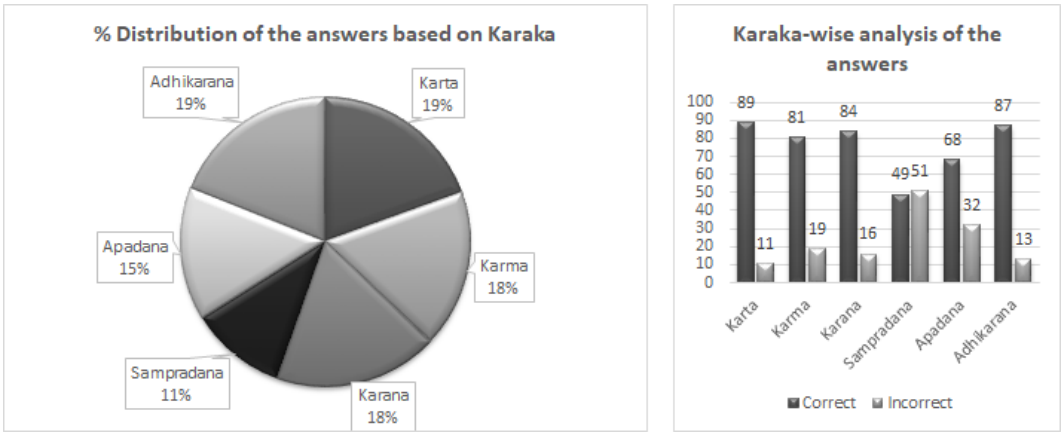

Figure 1: Kāraka-wise Analysis of the Sanskrit Conversational Data

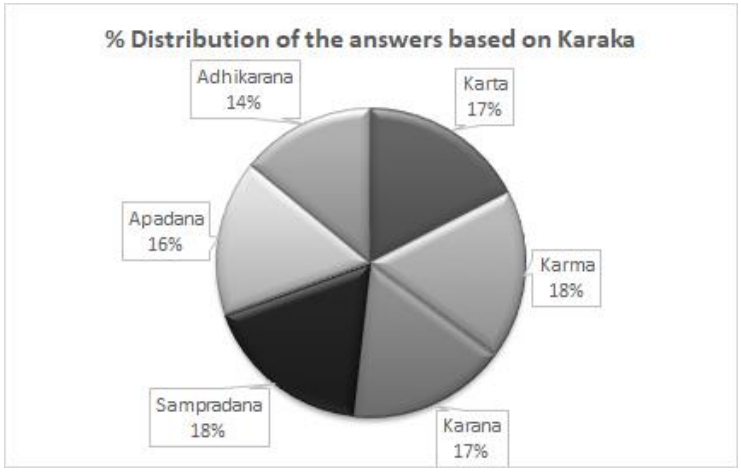

Figure 2: Kāraka-wise Analysis of Marathi Conversational Data

(ii) Similarly, along with the single-verb, the correct answers marked for the complete sentences is also taken into consideration to perform the comparative analysis. Figure 3 presents the number of readers that have marked correct answers to all six paragraphs (image at the left side) along with paragraph-wise analysis that gives the details about the accuracy obtained on each separate paragraph (image at the right side). The results presented in the image show that Para4 that was related to the *saṁpradāna kāraka*[12] has obtained the highest accuracy as against Para2 and Para6 that were related to the *karma* and *adhikaraṇa kāraka*s. It can be deduced that while the beneficiary of the action was easily cognized, the object and the location of the action were not.

Figure Figure 4 depicts the paragraph-wise accuracy for all readers. It can be observed that Para4 has obtained the highest number of correct answers while Para6 has the lowest number of correct markings. The verb in Para4 corresponds to the *Kartā kāraka*, while the verb in Para6 corresponds to the *Karma kāraka.* In other words, readers have inferred and mapped the *kartā* easily, but not *karma* of the action denoted by the respective verbs.

[12] Please refer to Table 1 and Table 2 in the Appendix for the respective *kāraka* in question.

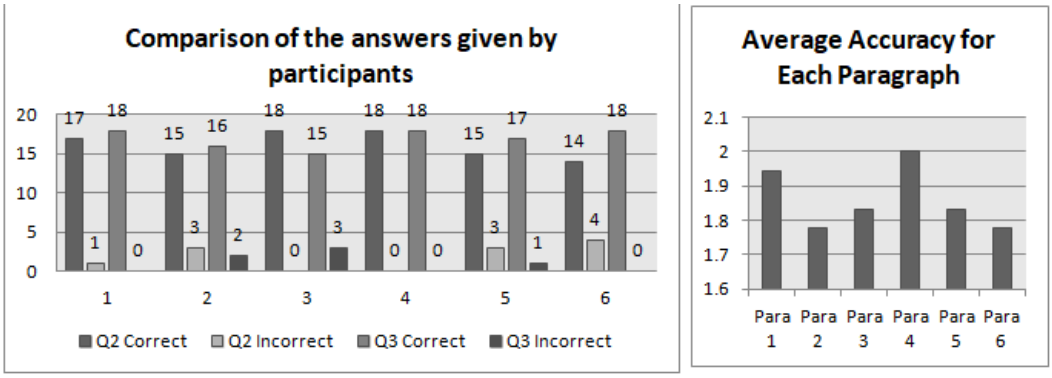

Figure 3: Paragraph-wise Analysis of both Single-verb Sentences and Complete Sentences in Sanskrit

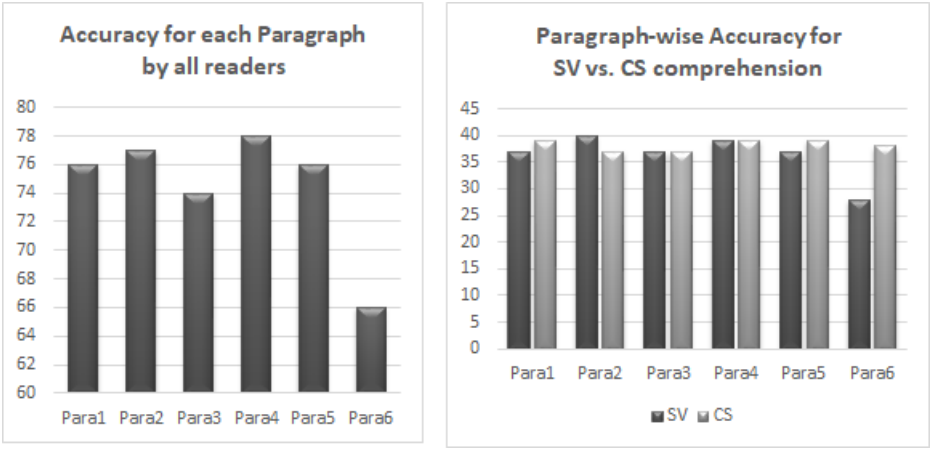

Figure 4: Paragraph-wise Analysis of both Single-verb Sentences and Complete Sentences in Marathi

Both types of analyses presented above are taken into consideration and reflected upon accounting for the inconsistency that is visible concerning the accuracy obtained for each *kāraka*.

Data Analysis- Step 2

This sub-section presents the possible reasoning behind the discrepancy that is seen in the cognition of different *kāraka*s. For example, the results presented in (ii) above stand in contrast with the earlier results presented in subsection (i) in respect to the cognition of the *saṁpradāna kāraka*. The current section tries to view this problem from linguistic, cognition and sociolinguistic point of views considering different variables that play their part in human cognition processes. The following are the possible reasons behind the inconsistency among the kāraka-cognition:

(a) First possible reason: Readers' First Language

Interim Conclusion:

The first language of the readers, if spoken in daily life, may affect the kāraka-cognition in the second language, if not used for speaking regularly.

Reader's first language is considered to account for the disparity that can be seen in the comprehension of all arguments. It is found that Marathi native speakers have marked the greatest number of incorrect answers to the question related to the *saṁpradāna kāraka* in Sanskrit experiment which is their second language. The single-verb in this paragraph '*niryātaya*' ('[Please] return', Figure 5) uttered by *Sītā* to her maid *Avadātikā* asking her to return the clothes to *Āryārevā*. Here, *Avadātikā* (object of the action 'telling') takes the accusative, and *Āryārevā* (beneficiary of the action 'to return') takes the dative case suffixes. These two words *Avadātikā* and *Āryārevā* also stand as two options for the question related to the single-verb '*niryātaya*', viz., 'whom should the clothes be returned is told by *Sītā*?'. The question consists of both verbs i.e., 'telling' and 'returning'. The fact that both accusative and dative case suffixes in Marathi are similar, that is, '*sa*', '*lā*', '*te*', and '*nā*' might have confused Marathi native speakers leading to the inaccuracy while processing *saṁpradāna* of the Sanskrit verb. In other words, it is challenging for the Marathi speakers to construe the beneficiary of the action when it competes with the object.

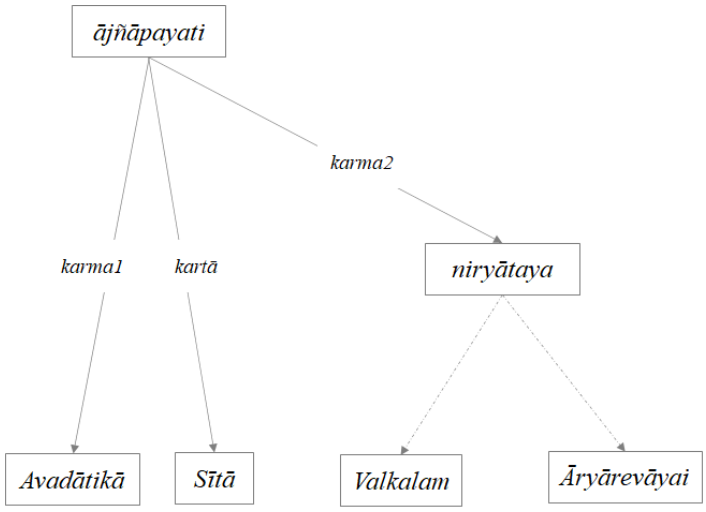

Figure 5: An Illustration of Cognition of Saṁpradāna Kāraka

There are two possibilities behind the inaccuracy. In the first case, Marathi readers may not have understood the message owing to the increased cognitive load due to the contest between the object and the beneficiary. In the second case, readers might have understood the message correctly, but have made mistakes in retrieving the message when the questions are asked in Sanskrit. The first possibility directly corresponds to the language-specific characteristics of two languages, while the second possibility taps into the cognitive paradigm of the readers. The second possibility, thus, poses a question, whether the message in a particular language is stored irrespective of that language, probably in some schematic representation that is independent of any grammatical categories or language-specific nuances, and the language merely helps in encoding and decoding of the message in the form of such a representation. Any failure either in encoding or in decoding may lead to unsuccessful comprehension. The point is, Marathi native speakers might not have correctly decoded the message when the question was asked in Sanskrit. There is no way the research can address

this issue owing to the limitations of the experiment design however, such teething problems make the subject matter for future studies.

Let us go back to the conclusion that the homophonous forms of the accusative and dative create confusion in the minds of Marathi readers. This claim is supported by other experiments where the single-verbs that demanded beneficiary were accurately comprehended by the Marathi native speakers, especially when the two options for the question do not compete with each other, i.e., when the object that takes the accusative is not presented with the beneficiary that takes the dative suffix which had led to the confusion in the earlier scenario. For example, the beneficiary '*tāpasāya*' ('to the ascetic') of the single-verb '*dadātu*' ('[Please] give') is correctly mapped when the other option (the incorrect one) was also in the dative case. Here, the beneficiary was easily understood by the native Marathi speakers where readers did not have to retrieve the grammatical categories from their mental matrix, but just the gist of the message. Hence, the interim conclusion can be derived that 'two languages may compete while processing the second language'.

Furthermore, in several Marathi experiments, both native and non-native readers have performed this sophisticated mapping of the beneficiary ('*bāīlā'*- 'to the lady') and its verb '*vikalāsa*' ('sell [it]') quite skilfully that adverts it is not *saṁpradāna*, but readers first language that interferes the process of bridging the verb-argument pair.

However, two instances do not agree with this claim. Firstly, in the same experiment that presents the classical Sanskrit texts, similar behaviour is shown by the Telugu native speakers[13] who got confused between two options presented in accusative and dative case suffixes. Even though Telugu uses distinct case suffixes for both accusative and dative,[14] the reason behind the least accuracy is not transparent. Similarly, the difficulty with the comprehension of the *saṁpradāna kāraka* is unanimous in another experiment for Gujarati, Hindi, Kannada, and Tamil speakers. Only Gujarati has similar case suffixes for both accusative and dative,[15] while the other languages have distinctive markers. Thus, the first language might be an incommensurable measure to derive conclusions. This brings us to explore other reasons for the incorrect marking of the answer.

(b) Second possible reason: Increased Cognitive Load

Interim Conclusion:

Kārakas are easily inferred and mapped with their verbs in easy texts as compared to the difficult texts owing to the imposed cognitive load.

[13] Telugu is one of the official and classical languages in India that belongs to the Dravidian language family and is predominantly spoken in the southern parts of India along with some east coastal regions in India.
[14] Accusative case suffixes in Telugu are '*nu*' and '*ni*', while dative suffixes are '*ku*' and '*ki*' (Andronov, 1976, pp. 716-721).
[15] Gujarati uses '*ne*' for both accusative and dative. [Personal Communication with Dr. Chinmay Dharurkar (Central University of Kerala) dated September 9, 2020, 19:00 IST]

The single-verbs that obtained the highest inaccuracy appear in the classical Sanskrit texts, while the single-verbs that were processed effortlessly appear in modern writings. The unquestionable fact that the classical Sanskrit texts make the high-load task for the readers, especially for the teenager readers having the least exposure to Sanskrit directly corresponds to the least accuracy in the processing.[16]

(c) Third possible reason: Verb's Selectional Restriction and Ontology

Interim Conclusion:

The ontology of the verbs affects the process of verb-argument mapping. While cognizing any kāraka, readers perform the incremental processing of going from the abhidhā meaning of the verb to the lakṣaṇā meaning. Based on verb's ontological categories, and imposed selectional restrictions, suitable kārakas are inferred and mapped.

In a particular condition, the particular needs of the verb as regards its arguments are based on its selectional restriction. Verbs restrict some arguments to be mapped with them based on their subcategorization frames. Take, for example, the verb '*yeṇār*' ('come') restricts the arguments that are inanimate objects to be mapped with it in the role of an agent since the meaning of the verb '*yeṇār*' (from the 'bodily action' category) entails the 'movement' (i.e., '*pūrva-deśa-viyogānukūla apara-deśa-saṁyogānukūla vyāpāraḥ*'- going from one point to another) which inanimate objects are potentially incapable of performing. Readers could not map the agent '*pustaka*' ('book', here 'novel') as its agent since it lacks the ability to move. These restrictions of a verb are based on verbs literal meanings, rather than their idiosyncratic characteristics.[17] The argument 'book' can only be mapped with the verb '*yeṇār*', if the verb is taken in the secondary sense of 'publish' that does not entail any physical corresponding movement.

Nonetheless, in two experiments readers have correctly mapped the agent with the respective verbs irrespective of the fact that these verbs restrict the arguments from mapping. The agent '*vastūni*' ('utensils') with the verb '*mriyante*' ('die') [in the sense of 'The utensils are broken'], and the agent '*rogaḥ*' ('the disease') with the verb '*gataḥ*' ('has gone') [in the sense of 'The disease is cured'], even though these agents do not have the ability to perform the action denoted by the verbs that belong to the 'act' and 'bodily action' categories. Here, readers seem to go beyond the literal sense of the respective verbs.

These observations accent that adult readers first take the literal meaning ('*abhidhā*') of the words in the process of verbal understanding. When the primary meaning does not serve

[16] It is observed in the same research that that 'Ākhyātaśabdaḥ' in classical Sanskrit texts are comparatively more difficult to process than those in modern writings. Only 56% of the readers have successfully comprehended SV sentences in classical Sanskrit as compared to almost 92% of the readers comprehending SV in modern texts in the web-based experiments. In classroom-controlled experiments, SV sentences in classical texts were correctly comprehended by approximately 89% of the total population as against 95% of the population understanding SV in modern texts.

[17] (Fernandez, 2010, p. 63)

the purpose, readers resort to the secondary meaning ('*lakṣaṇā*') of the verb that is compatible with the message in the text. Any failure in implying the suitable secondary sense would usher the comprehension failure.

During this procedure of depending on the secondary sense of the verb, adult readers transcend their knowledge of the verb's ontological categories.

In a general linguistic episode, the interlocutors surpass the knowledge of the real referent or the *vasv-artha* of the word-meanings to have the integrated and coherent understanding of a discourse which leads to suave and polished communication. To conclude this is not to deny the relation between the word and the object in the external world, because the secondary sense of the single-verbs can only be implied when the literal sense, which refers to the object in the world, seems to be incompatible or contradicts readers' normal experience in the world.

(d) Fourth possible reason: 'Utthita' and 'Utthāpya'ākāṅṣā and the Arguement-Adjunct Dichotomy

Interim Conclusion:

Arguments of the verb that invite natural expectancy for the complete cognition are inferred and mapped easily, while the adjuncts that incur potential expectancy are not, in all cases.

Sanskrit literature, particularly the Advaita Vedānta school of philosophy, talks about two kinds of *ākāṅkṣā*, namely, *utthita- ākāṅkṣā* (actual and natural expectancy of one word for the other to make a complete sense), and *utthāpya- ākāṅkṣā* (potential expectancy which could be roused if necessary).

For example, in the sentence 'bring the cow', the attributes of the cow and other instruments helping in the accomplishment of the action of 'bringing' (such as black cow, the old cow, bring with a stick, etc.) and several such possibilities are potential expectancies.[18] But, the 'cow', the object of the action of 'bringing' is a natural expectancy. Based on this possibility, it can be deduced that the readers might have been more focused on actual or natural expectancies rather than the potential ones. construed with their respective verbs, indicating the requirement to have more knowledge about it showing the expectancy from the readers' part as against the location.

In the sentence consisting of SV '*ghe*' ('[Please] take'), it is more important for the readers to know the agent, direct and indirect object of the action, rather than the location. In this paragraph, the grandfather is offering his servant a reasonable amount of money so that he

[18] (Raja, 1968, p. 159)

can use it when the grandfather will be away to meet his son that stays in a different city. While the reader has to retain all this information that is necessary to understand the complete meaning of the single-verb 'take', s/he did not find it necessary to know the location of the action of 'giving', that is, '*aṅgaṇāta*' ('in the verandah') retiring their expectancy to know more. Although, it can be argued that, for action, the location or the substratum is an obligatory or fixed accessory to be accomplished, it is outshined by other arguments for a readers' part when the meaning of the action denoted by the single-verb has to be derived.

Similarly, while comprehending another paragraph where two friends were arguing with each other, the readers might have been more focused on the content of the fight, rather than the exact words. In this conversation, when a friend says that he will throw the other person on the big rock, it was the action of 'throwing', the possible reasons and consequences that were more important than its possible location '*śīlākhaṇḍe*' ('on the rock').

Although, when the location itself is a focus of the conversation, readers do map it with the respective verb, as it becomes the natural expectancy of that verb. For example, in the Sanskrit experiment, readers were asked the location of the single-verb '*sthāpyatām*' ('Put [it] to rest') uttered by Karṇa to his charioteer suggesting that 'Let us rest our chariot here for a while'. Since the location itself has been the main topic of the conversation, it has incurred the natural expectancy (*utthita- ākāṅkṣā*) among them, readers have mapped it with more accuracy.

In other words, while the readers try to fulfill the natural expectancies of the verbs to acknowledge its role in the conversation, the innumerable potential expectancies are paid less attention to, unless they are the focus of the topic of the conversation. In a modern linguistic parlance, they are known as arguments and adjuncts, respectively. While the arguments are invariably needed to derive the complete meaning, the adjuncts can be 'optional' that just gives more information about the event and is outmatched by the arguments while processing the verbs.74 In a nutshell, a particular kāraka can become either of both based on the theme of the topic. The experiments presented in the thesis suggest that the expectancy on a readers' part to know more about the verb is, usually, fulfilled by agent, instrument, etc. more than that of location, unless the location itself is the main theme of the topic. This rationale is asserted at least in short conversations, more particularly for the readers above age 15 years.

Summary

This section addresses the process of construing the arguments with the single-verbs and provides some linguistic, and possible cognitive reasoning behind it such as the first-language of the readers, the increased cognitive load, or the verb's ontological categories, and the natural or potential expectancies. Although no reasoning can be satisfactorily said as a general explanation or a valid interpretation or all-encompassing reasoning, this discussion presents a fresh method to look at the *kāraka*-mapping from different perspectives.

1. **Some Unanswered Questions: In retrospect**

The main characteristic of the research is it is left to the readers to infer, assume and map the suitable *kāraka* presented previously in the conversation with that of the respective verb. The question that which kāraka is effortlessly mapped with the verb when more than one *kāraka* are explicitly presented on the surface level of language is yet to be addressed. Furthermore, verbs from all ontological categories are not tested against all participants owing to the limitations posed by the experiment design. A more sophisticated and exhaustive experiment would furnish with more details and nuanced processing among the human beings vis-à-vis verb-argument mapping.

2. Conclusion

Based on the subjective reports of 489 Sanskrit non-native readers, and approximately 447 native and non-native Marathi readers obtained from a total of ten experiments conducted over the span of more than two and half years, it is argued that,

(i) *Kartā* and *karma* of the respective verbs are easily and more accurately mapped by the majority of the readers of both Sanskrit and Marathi while the *adhikaraṇa kāraka* is demanding to be mapped, unless *adhikaraṇa* itself the main topic of the conversation, in which case, it obtains the highest accuracy.

(ii) Verb's selectional restrictions based on its ontological classification affects the process of kāraka-mapping during the initial stages of processing, especially among the teenager readers,

(iii) The increased cognitive load that betides due to distinct vocabulary in the conversation adhering to the type of the text, such as classical versus modern literature, influences the process of verb-argument mapping,

(iv) The first language of the readers affects the *kāraka*-cognition in the second language when the second language is not spoken on daily basis, and

(v) While arguments that are necessary for a verb to denote its complete desired meaning are primarily inferred by the readers, the adjuncts of the verb that just provide some extra information may not be inferred and mapped with the respective verb.

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Appendix:

Table 1: Description of Sanskrit Data Set (Single-verbs, Arguments, Kāraka Category, and Ontology Classification of the verbs)

Single-verbs and their Arguments in Sanskrit Data Set				
Data Set	***Paragraph***	***Single-verbs and Argument/s***	***Kāraka Category***	***Verb Ontology***
D1	Para 1	*iccāmi* (‘[I] desire.’) *aham* (‘I’)	*Kartā*	Mental state
	Para 2	*praviśatu* (‘[Please] enter.’) *bharatam* (‘To Bharata’)	*Karma*	Bodily Action
	Para 3	*anugaccha* (‘[Please] follow [me].’) *tvareṇa* (‘immediately, with haste’)	*Karaṇa*	Bodily Action
	Para 4	*niryātaya* (‘[Please] return [it].’) *āryarevāyai* (‘To Aryareva’)	*Saṁpradāna*	Bodily Action
	Para 5	*paritrāyatām* (‘[Please] save/ protect [me].’) *svajanāt* (‘from own relatives’)	*Apādāna*	Act
	Para 6	*sthāpyatām* (‘[Please] deposit [it]/ put [it] to resṭ’) *devakulasamīpe* (‘near the temple’)	*Adhikaraṇa*	Act
D2	Para 1	*paśyāmi* (‘[I] see/ look.’) *aham* (‘I’)	*Kartā*	Perception
	Para 2	*dāsyanti?* (‘[They] will give/ Will [you] give?’) *rūpyakāṇi* (‘money/ dimes’)	*Karma*	Change
	Para 3	*ucyatām* (‘[Please] tell/ say.’) *akabarāya* (‘to Akabar’)	*Saṁpradāna*	Communication
	Para 4	*jāne* (‘[I do] know.’) *aham* (‘I’)	*Kartā*	Cognition
	Para 5	*ṣruṇu* (‘[Please] listen.’) No specific argumenṭ	-	Perception
	Para 6	*tvaryatām* (‘[Please] hurry up.’) No specific argumenṭ	-	Act
D3	Para 1	*udghāṭaya* (‘[Please] open [it].’) *dvāram* (‘door’)	*Karma*	Bodily Action
	Para 2	*svīkuru* (‘[Please] accept/ take [it].’)	*Kartā*	Bodily Action

		tvam (‘You’)		
	Para 3	*svīkurvantām* (‘[Please] accept/ take [it].’) *bhāṇḍāni* (‘utensils’)	*Karma*	Bodily Action
	Para 4	*mriyante* (‘[They] expire.’) *vastūni* (‘utensils’)	*Karma*	Act
	Para 5	*apasara* (‘Walk off! or Get away!’) *sahasā* (‘immediately’)	*Karaṇa*	Bodily Action
D4	Para 1	*gataḥ* (‘[Is it] gone.’) *rogaḥ* (‘the illness/ disease’)	*Kartā*	Bodily Action
	Para 2	*gṛhṇātu* (‘[Please] accept/ take [it].’) *suvarṇam* (‘gold’)	*Karma*	Bodily Action
	Para 3	*praveśaya* (‘[Please] enter.’) *gauraveṇa* [*saha*] (‘with respect/ dignity’)	*Karaṇa*	Bodily Action
	Para 4	*dadātu* (‘[Please] offer/ give.’) *tāpasāya* (‘to the ascetic’)	*Saṁpradāna*	Change
	Para 5	*pātayṣyāmi* (‘[I will] strike [someone] down.’) *vātāyanāt* (‘from the window’)	*Apādāna*	Bodily Action
	Para 6	*ānayatu* (‘[Please] bring [it].’) *rājabhavane* (‘to the King’s palace’)	*Adhikaraṇa*	Bodily Action

Table 2: Description of Marathi Data Set (Single-verbs, Arguments, Kāraka Category, and Ontology Classification of the verbs)

Single-verbs and their Arguments in Marathi Data Set				
Data Set	***Paragraph***	***Single-verbs and Argument/s***	***Kāraka Category***	***Verb Ontology***
D1	Para 1	*bheṭavato* (‘[I] introduce [you to someone].’) *mī* (‘I’)	*Kartā*	Bodily action
	Para 2	*mahītīye?* ([Do] you know?) *goṣṭa* (‘story/ fact’)	*Karma*	Cognition
	Para 3	*dila?* ([Have] you given?) *svahastāne* (‘with own hands’)	*Karaṇa*	Change
	Para 4	*vikalāsa?* ([Have] you sold [it]?) *bāīlā* (‘to the lady’)	*Saṁpradāna*	Change
	Para 5	*jā* ([Please] go.) *daravājyātūna* (‘through the door’)	*Apādāna*	Bodily action
	Para 6	*basa* ([Please] sit down.) *bākaḍyāvara* (‘on the bench’)	*Adhikaraṇa*	Physical State
D2	Para 1	*mhanalī?* ([Has] she said [so]?) *chingī* (‘Chingi’)	*Kartā*	Communication
	Para 2	*Baghaṇāra?* ([Will] you see/ look?) *nondī* (‘list’)	*Karma*	Perception
	Para 3	*milela* ([You] will get it.) No specific argument.	-	Change
	Para 4	*dyā* ([Please] [give it to someone].) *shiṁpīlā* (‘to the tailor’)	*Saṁpradāna*	Change
	Para 5	*thāmbśīla?* ([Will] you stay/ wait?) No specific argument.	-	Act

	Para 6	*khā* ([Please] have food/ eaṭ.) No specific argumenṭ.	-	Consumption
D3	Para 1	*dyā* ([Please] give [it to someone].) *Sara* (‘sir’)	*Kartā*	State
	Para 2	*saṅgā* ([Please] tell [me].) *nāva* (‘name’)	*Karma*	Bodily action
	Para 3	*ṭharala* ([It is] decided.) No specific argumenṭ	-	Communication
	Para 4	*kāḍhato* ([I (will)] draw.) *khaḍūne* (‘with chalks’)	*Karaṇa*	Change
	Para 5	*lāvūyā* ([We will] plant/ place.) *pārijātakāpāsūna* (‘from the Parijataka tree’)	*Apādāna*	Change
	Para 6	*ghe* ([Please] take/ accept [it].) *anganāta* (‘in the verandah’)	*Adhikaraṇa*	Action
D4	Para 1	*jamataya* ([It is] possible [for you].) No specific argumenṭ	-	Change
	Para 2	*bagha* ([Please] see/ look.) *gāḍī* (‘car’)	*Karma*	Communication
	Para 3	*cala* (Let us go!) No specific argumenṭ	-	Mental State
	Para 4	*dāhāpato* ([I] will steal.) *mī* (‘I’)	*Kartā*	Bodily action
	Para 5	*bolā* ([Please] speak up.) No specific argumenṭ	-	Bodily action
	Para 6	*yeṇāra* ([It will] come.) *pustaka* (‘book/ novel’)	*Karma*	Change
D5	Para 1	*sampavalasa?* ([Have you] finished?) *pustaka* (‘book’)	*Karma*	Communication
	Para 2	*yā* ([Please] come.) *mevhani* (‘sister-in-law’)	*Kartā*	Perception
	Para 3	*bolalā?* ([Has he] told [you]?) *patrāndvārā* (‘with letters’)	*Karaṇa*	Bodily action
	Para 4	*ghyā* ([Please] take [it].) *girīśalā* (‘to Girish’)	*Saṁpradāna*	Bodily action
	Para 5	*ghe* ([Please] take [it].) *ṭopalītūna* (‘from the basket’)	*Apādāna*	Communication
	Para 6	*sāpaḍala* ([It is] found.) *Fridge madhe* (‘in the fridge’)	*Adhikaraṇa*	Physical State
D6	Para 1	*yeīla* ([It will] come.) *mī* (‘I’)	*Kartā*	Change
	Para 2	*samajalo* ([I have] understood.) No specific argumenṭ	-	Cognition
	Para 3	*karatī* ([I (will)] do.) *mī* (‘I’)	*Kartā*	Bodily action
	Para 4	*thāmbā* ([Please] stay/ waiṭ.) No specific argumenṭ	-	Physical State

Figure 6: The illustration of deriving ontological classification of the Sanskrit Verb 'dā' using Sanskrit Wordnet

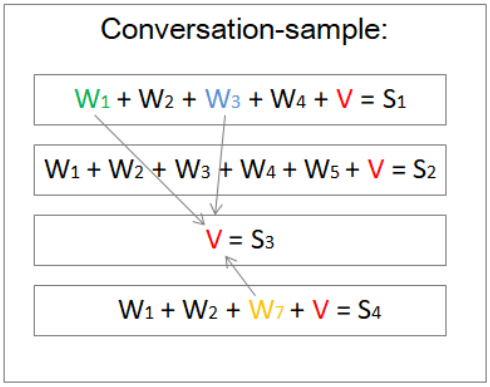


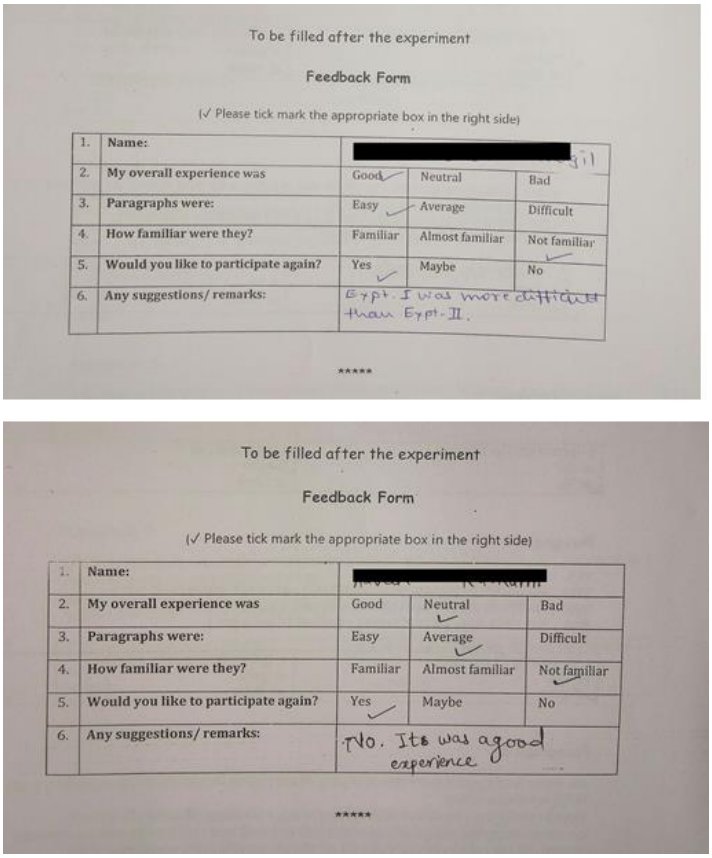
Figure 7: A prototype conversation depicting the single-verb and the required arguments dispersed across the conversation

अवदातिका- जयतु भट्टिनी !
सीता- अवदातिके, किमेतद् वामहस्तपरिगृहीतम् ?
अवदातिका- भट्टिनि । इदं वल्कलम् ।
सीता- वल्कलं कस्मादानीतम् ?
अवदातिका- शृणोतु भट्टिनी । नेपथ्यपालिन्यार्यरेवा निवृत्तरङ्गप्रयोजनमशोकवृक्षस्यैकं किसलयमस्माभिर्याचितासीत् । न च तया दत्तम् । ततोऽर्हत्यपराध इतीदं गृहीतम् ।
सीता- पापकं कृतम् । गच्छ, निर्यातय ।
अवदातिका- भट्टिनि । परिहासनिमित्तं खलु मयैतदानीतम् ।
सीता- एवं दोषो वर्धते । गच्छ, निर्यातय, निर्यातय ।

1. वल्कलम् कस्यै निर्यातय इति सीतायाः आदेशः? (1) अवदातिकायै (2) आर्यरेवायै	2. अवदातिकया आनीतं वल्कलं कस्य वृक्षस्य किसलयम्? (1) आम्रवृक्षस्य (2) अशोकवृक्षस्य

Figure 8: Sample Sanskrit Paragraph from Classroom-Controlled (Pen-paper) Experiment

Figure 9: A few participants performing the task (December 5-7, 2019, IST 10-11, Solapur, Maharashtra [The image is used with the vocal consent obtained from these participants for the use of academic purposes alone.])



To be filled after the experiment

Feedback Form

(✓ Please tick mark the appropriate box in the right side)

1.	Name:	[redacted]		
2.	My overall experience was	Good ✓	Neutral	Bad
3.	Paragraphs were:	Easy ✓	Average	Difficult
4.	How familiar were they?	Familiar	Almost familiar	Not familiar ✓
5.	Would you like to participate again?	Yes ✓	Maybe	No
6.	Any suggestions/ remarks:	Expt. I was more difficult than Expt. II.		

*****

To be filled after the experiment

Feedback Form

(✓ Please tick mark the appropriate box in the right side)

1.	Name:	[redacted]		
2.	My overall experience was	Good	Neutral ✓	Bad
3.	Paragraphs were:	Easy	Average ✓	Difficult
4.	How familiar were they?	Familiar	Almost familiar	Not familiar ✓
5.	Would you like to participate again?	Yes ✓	Maybe	No
6.	Any suggestions/ remarks:	No. Its was a good experience		

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Figure 10: Feedback form filled by the participants in classroom-controlled experiments

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