

Making a Long Story Short: Can a Single Verb be Called a Sentence? A Cognitive Study of Sanskrit Conversational Data

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Abstract

The sentence-definition '*ākhyātaśabdaḥ*' in the '*Vākyapadīya*' written by Bhartrihari attributes the status of the sentence to the single-verb expressions when they necessarily denote the complete implied meaning of the sentence. Although various ancient and modern scholars have addressed this notion from a theoretical point of view, there is a need to revisit it from an innovative and explorative perspective. We study this definition from an experimental outlook using Sanskrit conversational data. We found that the single verbs in the written data are certainly comprehensible, notwithstanding, in a few cases, they demand more mental exercise to process as compared to the complete sentences. Along with this cognitive vista, we also explore a sociolinguistic aspect of the definition by taking into consideration readers' demographical data. A statistical significance test is performed to validate this data. Finally, we present discussion, limitations and the possible future work of this study. This research aims at exploring the scope, working and the limitations of the definition to understand the nature of a single-verb sentence from a cognitive and sociolinguistic point of views.

Keywords: Sanskrit, *Vākyapadīya*, Bhartrihari, *ākhyātaśabdaḥ*, psycholinguistics, web-based experiment.

1 Introduction¹

Bhartrhari and his *magnum opus* ‘*Vākyapadīya*’ (VP) (*circa* fifth century C.E.) have been a topic of research for many decades for both Indian and western scholars alike. The text addresses various linguistic and philosophical issues in Sanskrit versified form in three chapters. At the beginning of the second chapter, the author provides eight definitions of a sentence.² These were held by various ancient Indian scholars belonging to different schools of thought such as *Mīmāṃsā* (i.e. the school of hermeneutics), *Nyāya* (i.e. Indian school of logic) and *Vyākaraṇa* (i.e. the school of grammar).³ Depending upon the mental dispositions laid by these schools, the definitions vary in their nature.

We are interested in the very first definition which is ‘*ākhyātaśabdaḥ*’ which gives the status of the sentence to the mere verb. The word ‘*ākhyāta*’ (participle of the verbal root ‘*ā + khyā*’ which means ‘to tell/communicate’) in literal sense means ‘said, told or declared’ and in the grammatical sense, it means ‘inflected or conjugated’, i.e. the verb (Apte 1965, 202). The grammatical analysis of the compound word ‘*ākhyātaśabdaḥ*’ can be illustrated in two ways, namely, ‘the mere verb’ (i.e. ‘*ākhyātaḥ eva śabdaḥ*’- *Karmadhāraya Samāsa*) and ‘the linguistic string in which there is a verb’ (i.e. ‘*ākhyātaḥ śabdaḥ yasmin tat*’- *Bahuvrīhi Samāsa*). Hence, the definition can be interpreted in both ways such as:

- (1) A *single verb* which can be regarded as a sentence, and
- (2) Any *linguistic string* which contains a verb (along with other words) can be regarded as a sentence.

¹Henceforth in the manuscript: Rk Prā refers to the ‘*Rk Prāṭīśākhya*’, VP refers to the ‘*Vākyapadīya*’, P. refers to *Pāṇini*’s ‘*Aṣṭādhyāyī*’, Pu.Ms refers to the ‘*Pūrvamīmāṃsāsūtra*’ by *Jamini*, M_D refers to the Mean-Difference and P refers to the P-value.

²“*ākhyātaśabdaḥ saṅghāto jātiḥ saṅghātavartinī, eko ’navayavaḥ śabdaḥ kramo buddhyanusamhṛtiḥ | Padamādyam pṛthak sarvaṃ sākāṅkṣamityapi, vākyam prati matirbhinnā bahudhā nyāyavādinām ||*” (VP II. 1-2) (P. R. Sarma 1980, 1) (Meaning: ‘Theorists hold different views about the notion of a sentence. [Thus a sentence is defined as:] the verb, the close combination of the words, the universal which resides in that close combination of the words, an utterance which is one and devoid of parts, the sequence [of the words], the meaning principle which lies in the speaker, the first word itself, any word in the sentence having mutual expectancy of each other’.)

³ Even before *Bhartrhari*, Sanskrit literature offers the sentences definitions such as ‘*saṃhitā padaprakṛtiḥ*’ (Rk.Prā.2.1) (Vyasa 1894, 60) (Meaning: a sentence is a group of the words) or by Kātyāyana, the commentator on Pāṇini’s ‘*Aṣṭādhyāyī*’ has given two definitions of a sentence viz. ‘*ākhyātam sāvyayakāraḥ kaviśeṣanam vākyam*’ (Meaning: A sentence is chiefly the action-word, accompanied by the particle, nominal words, and adjectives) and ‘*eka tiṅ vāyam*’ (V.10-11 on P.2.1.1) (Meaning: a sentence is that [cluster of words] containing a finite word as an element). All these definitions look at the sentence from the structural point of view i.e. taking into consideration the form or the syntactic structure of the sentence.

On the other hand, *Jamini*’s definition given in the ‘*Pūrvamīmāṃsāsūtra*’, ‘*arthaikatvādekam vākyam sākāṅkṣam ced vibhāge syāt*’³ (Pu.Ms.2.1.46) (Sandal 1923, 54) (Meaning: so long as a single purpose is served by a number of words, they form one single unit called a sentence) deal with the semantic aspect of the sentence.

Various definitions of a sentence can also be seen in works on poetics by ancient Indian rhetoricians such as *Bhojadeva* (1010-1055 CE). In his treatise ‘*Sṛṅgāra Prakāśa*’, the author has defined a sentence in eleven different ways based on the presence of the verbal form in it. (Josyer 1955, 103)

Bhartrihari himself is seen to have resorted to the former explanation while explaining the definition in the later verses of the same chapter. According to him, if the single verb when necessarily denotes the means of action i.e. agent, instrument, etc. it should be considered as a sentence. Both *Mīmāṃsakas* and grammarians take the action as the central meaning of an expression and offer a verb-centric definition of a sentence. The meanings of the other words attested in the expression qualify the meaning of an action conveyed by the verb. Many ancient and modern commentators on the '*Vākyapadīya*' such as Puṇyārāja⁴ and Pt. Raghunatha Sarma⁵ have investigated this sentence-definition in the light of *Bhartrihari*'s own explanation and mainly from theoretical approaches. Sarma⁶ gives a specimen of daily-life conversation to elucidate the essence of the definition viz. when someone utters the mere verb '*pidhehi*' ('close' [imperative]), the listener necessarily understands the *karma* or the goal of that action which is '*dvāraṃ*' ('the door'), in which case, the mere verb '*pidhehi*' conveying complete intended meaning, can be regarded as the sentence.

Fundamentally, a notion of a sentence materializes with the fact that the particular linguistic string should convey the whole meaning or idea, or concept as intended by the user. Etymologically, a 'sentence' expresses what is felt or thought ('*sentir*') (Manjali 1995, 87). When a speaker, for effective and speedy communication, uses a single verb during the daily conversations, in most of the cases, the listener understands the complete meaning of the sentence from the mere verb i.e. the meaning of the particular verb which is of a nature of an action along with the meanings of its necessary means. When such a verb is uttered, that single-verb can be regarded as a sentence as it conveys the whole intended idea. In other words, meanings of other words in the sentence which are explicitly not expressed on the surface level of the language are inherited by the verb itself. The listener or the reader has to process these meanings in accordance with the meaning of the verb itself (i.e. based on the agreement of the verb concerning the particular *kāraṅkas* in the sentence⁷) or with the help of previously given

⁴ While commenting on the verse "*kriyā kriyāntarādbhinnā...*" (VP.II.414), *Puṇyārāja* explains that when the verb is heard, a particular action connected with all the necessary complements such as agent, object, instrument are understood. Hence, the nature of the sentence is essentially of the nature of an action. Other words in the sentence emphasize that particular understanding of the action. ('*kriyāiva viśiṣṭā sarvatra prathamatarameva vākyārthatvenaprakrāntā...*')

⁵In his '*Ambakartrī*' commentary, Pt. Raghunatha Sarma, explains the scope of this definition by stating that the sentence cannot exclusively be defined only in one way which is '*ākhyātaśabdaḥ*'. However, sometimes it can be. When the complete meaning of the sentence is derived out of the single-verb which is devoid of any *kāraṅkas* (not attested in the expression), then a mere single-verb can be regarded as a sentence. ('*tatrākhyātaśabdō vākyamiti vādinaāṃ ākhyātaśabda eva vākyamitinābhiprāyaḥ... kintu, kvacid ākhyātaśabdō'pi vākyam, yatra kāraṅkaśabdaprayogaṃ vinā kevalākhyātaśabdaprayoge'pi vākyārthāvagatiḥ...*' i.e.) (P. R. Sarma 1980)

⁶ '*yatrākhyātaśabde kevale pidhehityādirūpe prayujyamāne sati dvārādirūpaṃ niyataṃ sādhanam gamyate, ekaṃ kevalam pidhehityādirūpaṃ samāptārtham...*' (*Ambakartrī* on VP.II.1-2) (P. R. Sarma 1980, 4)

⁷According to Paṇinian grammatical system, a verb can take one or more of the six *kāraṅkas* viz. *kartā*, *karma*, *karaṇa*, *saṃpradāna*, *apādāna* and *adhikaraṇa* which are roughly translated as agent, goal, instrument, beneficiary,

context, subject matter and overall discourse. Successful bridging of these meanings with the verb leads to the successful comprehension of that single-verb.

The rest of the paper is divided into 6 sections. Section 2 gives the literature survey, hypothesis and research objectives. We present the experimental design in Section 3, followed by the results, analysis, and discussion in Section 4. In Section 5, limitations and the possible future work are presented followed by the conclusion in Section 6.

2 Literature Survey and Research Objectives

The text ‘*Vākyapadīya*’ is mainly explored from the philological (Matilal 1966, Raja 1968, S. K. Iyer 1969, Pillai 1971), linguistic (J. E. Houben 1989) and philosophical (H. Coward 1976, Loundo 2015) point of views, albeit, various modern scholars have critically established the text from psychological (G. H. Coward 1973) perspectives as well. In recent years a few scholars have pointed out the underlined cognitive aspect of the language presented in the text. Manjali (1996) studies the ‘*sādhanasamuddeśa*’ section given in the third chapter of the ‘*Vākyapadīya*’. Houben’s work (2003) has introduced Bhartrihari as a cognitive linguist by providing a theoretical background of modern cognitive linguistics while explaining the verses in the ‘*Vākyapadīya*’. Tiwari (2008), in his enormous work, has opted for the cognitive approach to observe Bhartrihari’s philosophy and his goal to analyse the cognition revealed by the language in usual communication.

Researchers have already provided the guidelines for translating the theoretical discussion on the sentence-definitions into an experimental outlook (Gajjam and Kulkarni, 2019b). In their earlier work (Gajjam, Kanojia and Kulkarni, 2018), authors have conducted the first pilot experiment to investigate the cognitive nature of the first sentence-definition using eye-tracking method and established the importance of the verb in the Sanskrit sentence semantics by providing the details of this visual verbal cognition (Gajjam and Kulkarni, 2019c). This research is extended by (Gajjam and Kulkarni, 2019a) which is focused on the comprehension of the verbs in Sanskrit prose and poetry. They found that the verbs in Sanskrit poetry demand more mental attention than those in the prose. In addition to the cognitive aspect, a sociolinguistic feature (i.e. gender) is also taken into consideration by the authors while analysing the data (Gajjam and Kulkarni, 2019d). Nevertheless, all these studies focus on the second explanation of the sentence definition.

The question of language comprehension has been addressed by the field of Psycholinguistics for last more than 20 years. Accordingly, psycholinguists have developed

a point of departure and locus (respectively) which generally take nominative, accusative, instrumental, dative, ablative and locative case (respectively).

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various methods to carry out this research.⁸ We, in this paper, utilise a well-established and widely used pen-paper method (also called as a web-based task (Carrol 1971)). This method comes under the purview of the offline method in which the tasks are solved with a delay in time and the comprehension is measured after the reader performs the task.

Hypothesis and Research Objectives

Our hypothesis is: ‘A single verb in Sanskrit conversations can convey complete implied meaning and hence can be regarded as a sentence itself.’ We try to understand the nature and scope of this definition which will highlight the point that the single-verb can carry the meanings of its means of actions as well. We aim to explore both cognitive and sociolinguistic aspect of the definition to understand its working and limitations in varied external conditions.

3 Experiment Setup

3.1 Data set description

We, a group of three linguists, have manually chosen and finalised six conversational paragraphs⁹ from modern Sanskrit writings selected from different issues of an online Sanskrit journal ‘*Sambhāṣaṇasandēśa*’¹⁰ which are published after 1990. The selected conversational data resembles the daily-life conversations. Due to the small sample size, we did not add any filler hence each paragraph is tested and observed to evaluate the data. Paragraphs are presented in *Devanāgarī* script. They have a minimum 8 to maximum 16 lines each which contain at least one single-verb in it,¹¹ the complements of which are dispersed in the paragraphs before the respective verbs.

A few variables have been taken care of such as eliminations of non-frequent, complex, long word etc. as they are not usually used in a daily life conversation but are present in the written data. A brief context regarding each sample is provided at the beginning of the paragraph in the brackets¹² e.g. ‘*sevaka-veṣadhārī rājā praviśati*’ (Meaning: ‘a king enters dressed as a servant’). We have chosen neutral and plain texts and avoided the content which would cause any type of emotional outburst in the reader which would affect their attention.

⁸Few are behavioural methods such as grammaticality judgment task, pen-paper method, thematic role assignment task, etc. while some are neuro-cognitive methods i.e. eye-tracking, EEG- electroencephalogram, ERP- Event-Related brain Potentials, etc. See (Gajjam, Kanojia and Kulkarni 2018) for detailed account on this.

⁹ The reason behind choosing not more than six paragraphs is to avoid mental fatigue and boredom that would betide during the eventual reading of the paragraphs and to eliminate the effect of inattentive reading caused by it.

¹⁰ The link to the online Sanskrit journal is: <https://sambhashanasandesha.in/> (Date accessed: July 05, 2019)

¹¹ Single-verbs such as ‘*paśyāmi*’ (lit. ‘[I] see’- Paragraph 1), ‘*dāsyanti*’ (lit. ‘[They] will give’ Paragraph 2), ‘*ucyatām*’ (lit. ‘[Please] tell’ Paragraph 3), ‘*jāne*’ (lit. ‘[I] know’ Paragraph 4), ‘*śruṇu*’ (lit. ‘[Please] listen’ Paragraph 5) and ‘*tvaryatām*’ (lit. ‘[Please] hurry up’ Paragraph 6) etc.

¹²There are other aspects which aid in comprehension during the usual communication in a spoken form such as speaker’s gestures, intonation, and emphasis on the words among many other factors. Owing to this limitation of the written data, we have presented a brief context regarding each sample to ensure easier reading.

Two expert linguists have validated the data set with their 100 percent agreement that all paragraphs are comprehensible and easy while there is no incomprehensible word in it. This forms the ground truth for our work.

3.2 Participant description

A total of 56 participants took part in this experiment belonging to the age group of a minimum of 21 years to a maximum of 63 years. All of them are neurologically healthy and do not show any reading disabilities in their previous lives. Among them 23 were male and 30 were female readers having diversity with respect to the first language (Bengali, Hindi, Kannada, Marathi, Sanskrit¹³, Tamil, Telugu and Tulu), education (Bachelors, Masters' and Ph.D. in Sanskrit), exposure to the language (10 to 35 years) and period of language acquisition (before or after age 6). They belong to different parts of India and were randomly selected. A large number of participants were not familiar with the paragraphs. Each participant is asked to give his/her consent before starting the experiment and is provided with sufficient instructions regarding the necessity of attentive reading and the annotation input method however they were not aware of the purpose of the experiment beforehand. No participant was observed while performing the task hence it was a non-supervised task. All of them are properly acknowledged for their time and efforts.

3.3 Experimental Design, Methodology, and Measures to evaluate the data

The experiment starts with the introduction of the experiment and useful instructions to navigate through the experiment. We did not mention the purpose of the experiment explicitly as it would have posed a bias while reading the paragraphs. Participants were asked to give their personal information such as age, gender, etc. which is used to analyse the data from a sociolinguistic point of view. There was no time limit to perform the task hence it can be considered as a self-paced reading task.¹⁴ A Google form was created mentioning introduction, instructions, consent form, experimental paragraphs, feedback form and acknowledgment receipt which was floated across India through emails and social networks with the help of friends and colleagues.

One paragraph is presented at a time. Each paragraph is followed by three multiple-choice questions with two options. Although a reader can view the questions even before reading the paragraphs which would create a situation of 'reactive solving', we ensured that s/he is attentive throughout the task by asking them a question related to the overall semantics of the paragraph. The questions are designed in such a way that the investigator can measure

¹³ A few participants that have learnt speaking Sanskrit in their early childhood (before age 6 years) have annotated Sanskrit as their mother-tongue.

¹⁴The motivation behind this is taken from Arunachalam's work (2013).

generalized skills of comprehension along with how well the examinee comprehends the particular area of interest (i.e. single-verb sentence) concerning the other variable (i.e. complete sentence). The measure for evaluation is a subjective report regarding comprehension vs. non-comprehension and also the degree of comprehensibility. A participant is needed to perform the task in one sitting without a break. The average time taken by them to finish the task is 17 minutes.

The first question of each paragraph was related to the single verb in the paragraph. It is formed in such a way that the correct answer confirms the successful bridging of the verb with its means which in turn proves our hypothesis that the single verbs can convey complete implied meaning hence can be regarded as the sentence itself. The second question is related to the complete sentence in the paragraph. The twofold purpose of this question is to compare with the first question and to validate the readers' attentive reading. Answers marked to both questions are used to calculate the inter-annotator agreement to ensure that the readers were reading attentively. The third question of each paragraph was related to the familiarity of the paragraphs. If a subject's honesty with her attentive reading and annotation of the familiarity of the paragraphs are assured, subjective reports are valid and highly useful measurements of comprehension (Carrol 1971). After the participant is finished with the task, s/he was asked to fill up the feedback form which is then followed by the acknowledgment receipt.

4 Results, Analysis, and Discussion

We first analyse the overall data which offers the answer to our main research objective i.e. whether single-verb sentences in Sanskrit conversations are as comprehensible as complete sentences. Then we consider readers' demographical data to perform a sociolinguistic analysis to understand the scope and limitations of the sentence-definition which can unfold different facets of the same research objective.

4.1 Overall analysis

There are total of 56 readers who took part in this experiment, among whom we have eliminated three readers (P2, P23, and P38) from the data analysis as they have less than 33% of accuracy, assuming that they might have read the texts inattentively or have marked random answers without reading the questions carefully. Among the remaining 53 participants, 54% of the total population has 100% accuracy for Q1 and 67% of the population for Q2 as presented in Table 1. It seems that the complete sentences yield a large number of correct answers. To ensure the difference, we have performed a statistical analysis test based on the standard z-test

formulation for all participants. The p-value¹⁵ suggesting this difference is insignificant i.e. 0.07 which means readers comprehend both types of sentences with an equal amount of processing. It merits concluding that the Sanskrit sentences in the written conversations having only one word which is a verb can also convey the complete intended meaning.

Table 1: Overall Analysis of all readers and Z-test results

	100% accuracy		M_D	P
	Q1	Q2		
Overall Analysis	54%	67%	0.17	0.07

As shown in the figure below (Figure 1), the single verb 'ucyayatām' ('Please tell') can convey more meanings apart from the meaning of the verbal root such as (1) the person who has uttered the verb ('bīrabala'), (2) to whom it is directed at ('akabara'), (3) the object of the action 'telling' ('svapnaḥ' - 'a dream') and (4) the location of the action 'telling' ('sabhā' - the court of the King) etc. It is the nature of a verb that it has a complement-taking property based on the 'valency'¹⁶ patterns depending on the voice of the verbal form. The single-verb sentences in Sanskrit have that capacity of accumulating the meanings of other related words, in a way it shortens the otherwise long linguistic string. These meanings reveal themselves as per the demand of the comprehender upon encountering the respective verb.

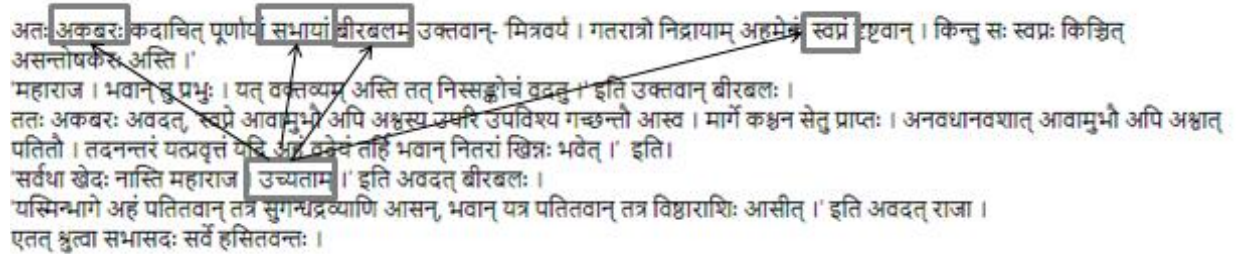


Figure 1: A hypothetical image: Meanings of other words are extracted upon encountering the single-verb sentence

¹⁵ M_D refers to the difference in the mean of two variables i.e. single-verb sentences and complete sentences and P is the p-value or the probability value, which if less than 0.05 rejects the null-hypothesis, which in turn proves one's claim or hypothesis.

¹⁶ Valency can be defined as the capacity of the verb to take the complements. Lucien Tesnière while introducing the concept of action as the base for the 'dependency grammar' states that the meaningfulness of the sentence is due to the central organizing role performed by the predicate verb, which is the highest node of the sentence, and which represents the action, on which the 'actants' participating in the action are dependent. He had introduced the notion of 'valency' to denote the number of actants carried by a verb. (Manjali 1995, 88)

To understand the intricacies underlying the comprehension of the single-verb sentences, we perform a detailed analysis of the data to discover the causes which beget or inhibit this comprehension.

4.2 Analysis based on readers' age group

Readers with a minimum of age 21 years to a maximum of 63 years have participated in the experiment. Among them 33 readers belong to the age below 30 years and remaining 20 readers belong to the age group more than 30 years old. The reading ability, attention-span, and accuracy differ in elderly adults. For readers above age 30, both Q1 and Q2 demanded a similar amount of processing as for both types of questions 60% of the readers have 100% accuracy. As against this, for readers below age 30, only 48% of the total population has 100% accuracy for Q1 and 69% of the population for Q2 which suggests easier comprehension of the complete sentences. This significant difference is validated by the t-test (Table 2).

Table 2: Analysis based on Readers' Age and T-test results

	<i>100% accuracy</i>		<i>M_D</i>	<i>P</i>
	<i>Q1</i>	<i>Q2</i>		
Below age 30	48%	69%	0.26	0.03
Above age 30	60%	60%	0	0.5

4.3 Analysis based on readers' gender

Among 53 readers, 23 were male and 30 were female. Comparing the comprehension of two types of sentences among male and female, we found that male readers have answered more correct answers to the complete sentences while female readers have given more correct answers to the single verb sentences as shown in Figure 2. Among the total population of male readers having 100% accuracy, 48% is for Q1 and 70% for Q2, while as 59% for Q1 and 66% for the Q2 among female readers.

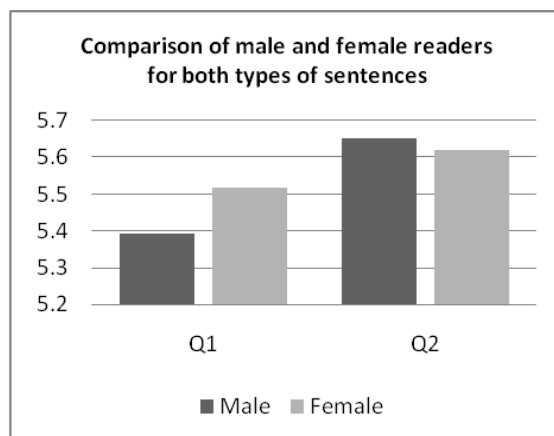


Figure 2: A Comparison of male and female readers for both types of sentences

Even though previous studies show that the women are better comprehenders (Kansaku, Yamaura and Kitazawa 2000, Keshavarz and Ashtarian 2008), few studies do not show a significant difference (Nemati and Bayer 2007). The t-test results (Table 3) for the difference between two types of questions are not significant i.e. 0.08 and 0.26 for males and females respectively suggesting no difference in the comprehension of the two types of sentences among them.

Table 3: Analysis based on Readers' Gender and T-test Results

	<i>100% accuracy</i>		<i>M_D</i>	<i>P</i>
	<i>Q1</i>	<i>Q2</i>		
Male	48%	70%	0.26	0.08
Female	59%	66%	0.1	0.26

4.4 Analysis based on readers' first language

Readers having their first languages such as Bengali, Hindi, Kannada, Marathi, Sanskrit, Tamil, Telugu, and Tulu have participated in the experiment. First language of the readers either has a facilitating effect on the comprehension of the second language or inhibits it based on which language family second language belongs to. After broadly dividing them into two categories such as Indo-European language family (readers having Hindi, Marathi, Bengali, and Sanskrit as their first language - total of 42 readers) and Dravidian language family (readers belonging to Tamil, Telugu, Tulu and Kannada as their first language - total 11 readers), we found that, IE readers have a large difference in Q1 and Q2 (Figure 3) while as DR readers have exact similar number of values for both questions. 52% of the total population of IE

speakers has 100% accuracy for Q1 and 67% for Q2, while as for DR speakers 73% population has 100% accuracy for both Q1 and Q2.

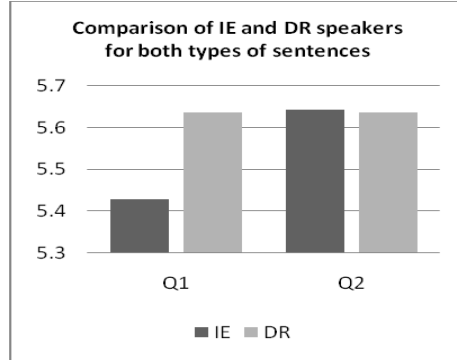


Figure 3: A Comparison of IE and DR speakers for both types of sentences

We performed a t-test and z-test for DR and IE speakers respectively and present the results in Table 4 and found the significant p-value i.e. 0.05 for IE readers which amount to say that these readers process both types of sentences differently, where complete sentences yield more correct answers showing easier comprehension than the single-verb expressions.

Table 4: Analysis based on Readers’ First-Language and T-test and z-test results

	<i>100% accuracy</i>		<i>M_D</i>	<i>P</i>
	<i>Q1</i>	<i>Q2</i>		
IE	52%	67%	0.21	0.05
DR	73%	73%	0	0.5

4.5 Analysis based on readers’ language exposure

Exposure to the language plays a major role in the comprehension as it forms the required background in the readers to comprehend the presented sentences. We take the language exposure in terms of education in Sanskrit and in terms of years spent learning Sanskrit. Since many readers have a Ph.D. in Sanskrit, they have language exposure from 20 to 35 years. The main purpose behind taking this feature is to investigate whether more language exposure facilitates the process of the comprehension.

4.5.1 Language exposure in terms of education:

We have divided the readers based on their education in Sanskrit into three categories: Bachelors (4 readers), Masters (32 readers) and more than post-graduation (17 readers) in

Sanskrit. It can be seen that all of them have answered more number of correct answers to Q2 (Figure 4) i.e. to the complete sentences as shown in the figure below. 100% of the readers having only graduation in Sanskrit have marked all correct answers to Q2 while as 75% population for Q1. Among the readers having post-graduation in Sanskrit, 53% and 59% of the total population has 100% accuracy for Q1 and Q2 respectively. Readers having more than post-graduation education answered more correct answers to Q2 i.e. 76% population, while as only 59% to Q1.

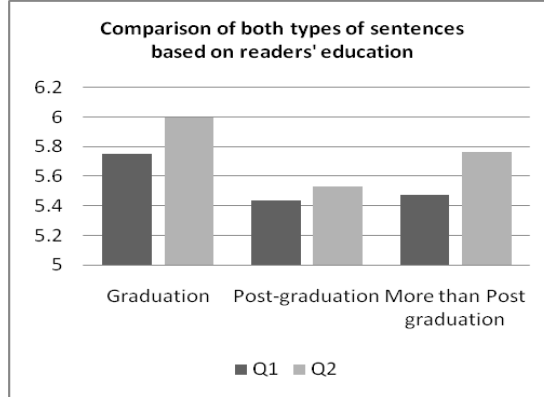


Figure 4: A comparison of both types of sentences based on readers' education

None of them show a significant difference (Table 5), as the p-values range from 0.8 to 0.28. To conclude, both single-verb sentences and complete sentences were comprehended effortlessly irrespective of readers' education in the language.

Table 5: Analysis based on Readers' Education in Sanskrit and T-test and z-test results

	<i>100% accuracy</i>		M_D	P
	<i>Q1</i>	<i>Q2</i>		
Grad.	75%	100%	0.25	0.18
Post-Grad.	53%	69%	0.09	0.28
Post-Grad. <	59%	76%	0.29	0.08

4.5.2 Language exposure in terms of years:

We asked readers when they started learning Sanskrit. 2 readers (P39 and P48) who have started it in the early years of their life i.e. between age 3 to 6 years show 100% accuracy for both types of questions (Figure 5). 11 readers started learning between the age of 6 to 10 years among whom 36% of the total population has 100% accuracy to both questions. A maximum

number of readers i.e. 24 readers started learning between age 10 to 14 years among whom 30% of the total population has 100% accuracy for both questions. Remaining 15 readers learnt later in their life i.e. after age 14. Nonetheless, they have the highest accuracy as 60% of the total population has 100% accuracy for both types of questions.

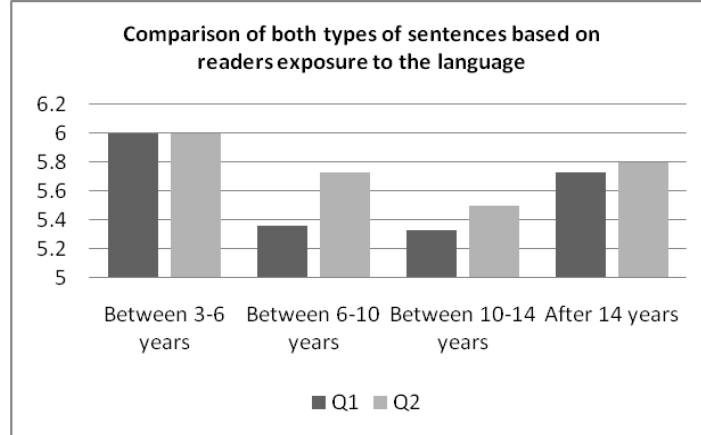


Figure 5: A Comparison of both types of sentences based on readers exposure to the language

Each of them has marked more correct answers to the complete sentences except for the readers have learned at an early age of their life i.e. 3-6 years showing no difference in both types of sentences. After performing the statistical significance test (

Table 6), we found no difference in both types of sentences for all readers. We cannot get the p-value for readers who learned between 3-6 years old as the sample size is too small.

Table 6: Analysis based on Readers’ Language Exposure and T-test results

	<i>100%accuracy to Q1&Q2</i>	<i>M_D</i>	<i>P</i>
Before age 6	100%	-	-
Between age 6-10	36%	0.36	0.08
Between age 10-14	30%	0.17	0.21
After age 14	60%	0.07	0.34

4.6 Analysis based on texts’ familiarity as annotated by the readers

Some textual features such as difficulty and familiarity have a facilitating effect on reading comprehension. 75% of readers of the total population were not familiar with any of the paragraphs. Among them, 50% of the population has 100% accuracy for both types of questions which suggests an attentive reading of the texts. 20% of the population was familiar

with only one paragraph in the whole experiment, among whom 27% of the population has 100% accuracy. Only two readers (P13 and P21) were familiar with 2 and 3 paragraphs presented, who have 83% and 90% accuracy respectively. Even though familiarity with the text enhances comprehension speed, it can be argued that it cannot be the reason for the accuracy in the comprehension.

4.7 Error Analysis

We have taken cross-sectional data such as readers' age, first language, gender, and language exposure together into consideration. Readers who show different kinds of processing for both single-verb sentences and the complete sentences belong to age below 30 as shown in section 4.2 above. Further analysis of these readers offers us some interesting results such as although they have the same first language, they differ in the distribution of their gender and language exposure (

Table 7). Readers below 30 have a large number of female readers and less than 30 years of linguistic exposure. On the other hand, readers in Group II have more male readers and more than 35 years of linguistic exposure. The reason behind the comprehension of the single-verbs in a more demanding manner for Group I readers either lies in the gender-wise distribution of them or in the linguistic exposure they have. To find out the answer, we consider gender-wise distribution and found that no female or male reader processed both types of sentences differently as stated in section 4.3 (p.57). Hence, the fact that the readers below age 30 have less exposure to the language requires them to process complete sentences in an undemanding manner than the single-verb sentences.

Table 7: Error Analysis (1)

	Gender	First Language	Linguistic Exposure
Group I Readers below 30	63% female 37% male	Marathi, Hindi	45% people- 10 years < 42% people- 20 years <
Group II Readers above 30	45% female 55% male	Marathi, Hindi	20% people- 35 years < 40% people- 15 years <

We also found that readers having Indo-European languages as their mother tongue (Group A) (

Table 8) struggled with the single-verb sentences as compared to those of Dravidian speakers. Cross-sectional data of these readers again tell us the difference in gender-distribution

and linguistic exposure they have. Again Group B readers have more language exposure as compared to Group A which facilitates their comprehension of both types of sentences.

Table 8: Error Analysis (2)

	Age	Gender	Linguistic Exposure
<i>Group A</i> IE Speakers	21 to 34	82% female, 18% male	10 years <
<i>Group B</i> DR speakers	36 to 63	50% female, 50% male	25 to 35 years <

To conclude, even though the single-verb sentences in Sanskrit conversations are as comprehensible as the complete sentences, in some cases they demand more mental processing especially for the readers who have less exposure to the language irrespective of their gender, age or first language.

4.8 Inter-annotator agreement table

To ensure the reliability and validity of the data, we calculated the Inter-annotator Agreement table using ‘Fliess’ Kappa’ for all questions of all paragraphs and present the results below (

Table 9). All readers seem to have an almost perfect agreement for Q2 which is related to the complete sentence in the paragraph, while for Q1 related to the single-verb sentence, paragraph 2 yielded less agreement i.e. 0.66 which is a substantial agreement. About familiarity with the paragraph, almost all paragraphs have almost perfect agreement except for Paragraph 3 which has a substantial agreement. Neither of the paragraphs has a poor or slight agreement which ensures our results since no reader has performed inattentive reading or has marked answers randomly.

Table 9: Inter-annotator agreement table

	<i>Q1</i>	<i>Q2</i>	<i>Q3</i>
1	0.86	0.89	0.8
2	0.66	0.86	1
3	0.74	0.96	0.69
4	0.86	0.93	1
5	0.96	0.83	0.96
6	1	0.86	0.96

4.9 Discussion

The results confirm the hypothesis that single-verb can be regarded as a sentence¹⁷ as it denotes the complete meaning of the sentence i.e. its own meaning along with the meanings of its means of action.¹⁸ Some results are strikingly complementary where there is a 100% similarity in the comprehension of both types of sentences such as readers above age 30, Dravidian speakers, and readers who acquired Sanskrit before age 10. Some inconsistencies can be seen in two cases where readers below age 30 and Indo-European language speakers process the complete sentences more effortlessly as compared to the single-verb sentences. However, it is the years of language exposure that comes into the play. More the exposure, easier the comprehension! Few more similar experiments on the texts with varying difficulty levels will offer some more insights regarding this.

5 Limitations and Future Scope

Limitations

The fundamental limitation of this research is that only written data is tested. The definition *might* have come into existence based on the observations of the spoken language. However, with our study, we try to employ some control measures so that we can bridge the gap between the written and spoken data. Similarly, the experiment is conducted on the second language speakers owing to the limitation that the first language speakers of Sanskrit are seldom found. The limitation concerning the methodology is that the investigator does not have any control over readers' reading speed, behaviour, and reaction time taken to annotate the answer. The foundation of this research lies in the assumption that readers are honest with attentive reading.

Future Scope

This study can further be extended to incorporate other languages, different kinds of samples, participants with varied backgrounds, several other techniques such as EEG, fMRI, etc. Different definitions given by Bhartriharii and other ancient Indian scholars can be studied by the same method to understand the hierarchy and correlation among them to explore the levels of sentence comprehension. If an abundant amount of data is gained from these researches, it can be used for machine learning¹⁹ and pedagogical purposes or for creating some language models for promoting easier comprehension in human beings having reading disabilities.

¹⁷ A few researched on the verb-less sentences can be found in authors other works (Gajjam and Kulkarni, 2020in press), (Gajjam and Kulkarni, 2020a).

¹⁸ Generally, Sanskrit verbs (roots and suffix) denote the meaning of the verb, tense, and number. Unlike other Indo-European languages (Hindi, Marathi etc.) the suffix is gender-neutral. Hence, the single-verb '*paṭhati*' expresses the action of 'reading', the present tense and the singular number and it is used for all types of gender.

¹⁹ Data received from the participants based on their Sentence-comprehensional skills is used for complex word identification (Wani, Mathias and Gajjam, 2018).

6 Conclusion

We have studied the first definition of a sentence ‘*ākhyātasabdah*’ mentioned in the first two verses of the second chapter of the text ‘*Vākyapadīya*’ written by *Bhartrihari*. The definition gives the status of a sentence to the single-verb as it can denote the complete intended meaning. By following an experimental perspective, we studied this definition conducting a web-based experiment on 53 Sanskrit readers using Sanskrit conversational data taken from modern Sanskrit writings. Based on a subjective report, we found that the single-verb in Sanskrit conversations not only denotes its own meaning, but also the meanings of means of action which is denoted by it. To conclude, even though the single-verb sentences in Sanskrit conversations are as comprehensible as the complete sentences, in some cases they demand more mental processing especially for the readers who have less exposure to the language irrespective of their gender, age or first language. By performing a sociolinguistic analysis of the data, we tried to understand the nature, scope, working and the limitation of the sentence-definition. With this research, we tried to shed some light on the cognitive aspect of the definition which has long been a twilight zone.

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