

Psychometrics of Perspective Taking in Writing: Combining Manual Coding and Computational Approaches

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Abstract

Perspective taking, one's knowledge of their own mental and emotional states and inferences about others' mental and emotional states, is an important higher order cognitive skill required in successful writing. However, there has not been much research on the identification and examination of the psychometrics of perspective taking. To fill in this gap, I reviewed the psychological and cognitive frameworks of perspective taking including theory of mind, audience awareness, development of epistemological understanding, and argumentation schema. I also reviewed various methods of examining the psychometric properties of perspective taking in written composition, including both manual and computational approaches. The review of literature yielded suggestions on the development of manual coding scheme for perspective taking as well as the selection of indexes to draw from natural language processing tools. Challenges and affordances of combining the manual and computational approach are discussed along with future research directions to advance the field of psycholinguistics.

Keywords: Psychometrics, Perspective Taking, Writing Evaluation, Manual Coding, Computational Approaches

1. INTRODUCTION

Developing writing skills is not an easy task. Writing and careful thinking go hand in hand, as writing plays a role in reasoning and vice versa [1]. With the inevitable connection between writing and cognition, it is imperative that quality writing draws upon one's analytical and reasoning skills. In fact, the skill to express complex reasoning in writing is important for college and career readiness as well as engaging in civil discourse within a society. Specifically, the skill of considering others' viewpoints and critically examining one's own is important in this era where there are almost no limits to information we can access. This calls for our developing children and adolescence to become vigilant and knowledgeable readers and writers, who know how to engage in healthy discussion and argumentation [2, 3].

According to the Direct and Indirect Effects Model of Writing, one relevant higher order thinking skill relevant to literacy development is perspective taking, one's knowledge of and inferences about others' mental and emotional states [4]. Recent studies have shown that perspective taking was positively related to writing quality in secondary students writing [5, 6]. There are various ways that perspective taking is manifested in writing. Perspective taking is considered important in writing because writers need to understand the needs of

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their audience and adjust their language accordingly [7]. Moreover, perspective taking is necessary when writers bring their understanding of a source text, with careful consideration of the perspectives of the author and the characters in the source material [4, 5]. Previous literature has also examined perspective taking through concepts such as discourse stance and markers as well as complex reasoning skills in argumentative writing [8-10]. Likewise, perspective taking has been discussed to draw upon various cognitive or discourse skills, and diverse approaches have been taken to examine the higher order cognitive skill of perspective taking in writing [6, 11]. Nonetheless, the identification of perspective taking has oftentimes been done through human examination of the written texts and manually coding them.

Expanding upon prior research, this study explores the affordances of not only manual coding approaches but also computational linguistics approaches such as the use of natural language processing tools to identify perspective taking in written composition. To this end, this study reviews extensive literature on psychological frameworks of perspective taking which serve as the basis for the creation of a manual coding scheme of perspective taking and the selection of indexes in the natural language processing tools relevant to perspective taking. This study makes theoretical contributions regarding the methodological approaches to examining a higher order cognitive skill such as perspective taking and practical implications on generating an index to represent perspective taking in writing.

2. THEORETICAL FRAMEWORK

With perspective taking identified as one of the higher order cognitive skills that contribute to writing [4, 5], there is a need for grounding the skill in theory-based cognitive and psychological framework. There are four frameworks that perspective taking in writing draws upon – theory of mind, audience awareness, development of epistemological understanding, and argumentation schema [5].

To begin with, perspective taking can be examined in relation to *theory of mind*, which is the ability to understand others' mental and emotional states and predict their behaviors [12, 13]. This is the case because many writing practices depend on reading and interpreting source texts where various agents such as characters and authors perspectives are portrayed [5]. Researchers measured perspective taking skills in writing by utilizing theory of mind scenarios, where students were tested on their ability to identify a story character's mistaken belief itself or about another character [4]. Theory of mind served as a psychological measure that taps onto a writer's ability to critically evaluate multiple perspectives portrayed in a source text and to further choose (not) to reflect the perspectives in their own writing. More recently, researchers have also developed the Social Perspective Taking Acts Measure (SPTAM) where participants are asked to provide recommendations for social conflict situation and their responses are coded for different levels of acknowledgement, articulation, and positioning of perspectives [14]. Research has shown that scores on SPTAM have shown positive relations to writing performance in adolescents [15]. Moreover, perspective taking can also be exhibited through writers situating themselves in a different context from their current own, by imagining themselves in the shoes of the author or the characters in the source text [5]. Therefore, perspective taking and theory of mind are two sides of the same coin, as they exhibit the writer's skill to understand the perspectives portrayed in the source text as well as to put oneself in the situational context of the source text.

In addition, perspective taking relates to how the writer is aware of whom they are writing for, from which they adjust their language accordingly [4, 16]. *Audience awareness* in writing is considered an important feature that distinguishes novice from expert writing, and studies have examined its importance during planning or revising processes of writing when writers set goals and evaluate their writing through such lens [17-19]. Audience awareness has been examined through experimental studies where interventions such as providing audience awareness goals or scaffolding to be aware of what the readers don't know, have shown statistically significant effect on improving writing quality [16, 20]. Changes in student writing before and after heightened audience awareness were measured in various ways. A researcher examined the suitability of fifth and ninth graders' writing to an intended audience by identifying the extent to which students' writing included background information necessary for the imagined reader who does not have prior knowledge [16]. Meanwhile, some others identified audience awareness through the degree of how well opposing reasons and

rebuttal are incorporated as well as through language that engages audience (e.g. how would you feel) and adjusts tones (e.g. purposeful use of politeness markers and respectful language) in fifth and eighth graders' persuasive writing [20]. Likewise, audience awareness informs how writers are cognizant of their readers when presenting their ideas in written format.

Perspective taking can also be examined with relation to one's development of *epistemological understanding*, which involves the incorporation of subjective and objective domains of knowledge [21]. The development of epistemological understanding is relevant because writing entails the ability to construct knowledge from multiple information sources that present diverse viewpoints [22]. Researchers outlined a systematic progression of epistemological understanding from *absolutism* (knowledge is objective, located in the external world, and certain) to *multiplism* (source of knowledge is the individual, so knowledge is multiple, subjective and uncertain) to *evaluativism* (knowledge is constructed and inevitably entails uncertainty, with the need for and value of evaluating knowledge production) [21]. In investigating the relation between learners' epistemic perspectives and their comprehension of authors' viewpoints, researchers found that *absolutism* and *multiplism* were negative predictors, whereas *evaluativism* was a positive predictor of multiple viewpoint comprehension [23].

Lastly, perspective taking is relevant to the different kinds of *argumentation schema* that is activated when composing a piece of writing. Researchers came up with the argumentation schema theory that points to the existence of elements such as statement of beliefs, reasons, counterarguments, and rebuttals [24]. It has been discussed that one's argumentation schema facilitates argument construction and repair by anticipating objections in one's own and other's arguments. In a similar vein, researchers operationalized argumentation schema as a learned, culturally derived set of expectations and questions about argumentative texts [25]. Moving further, argumentation schema has been separated into two: fact-based and balanced [26]. For those with a fact-based argumentation schema, argumentation is simply a matter of presenting facts, while for those with balanced argumentation schema, there is preference for arguments that acknowledge more than one side. A study has found that college students with more fact-based argumentation schema had higher likelihood of displaying *myside bias*, which was operationalized as the state of excluding other-side arguments entirely [25]. Therefore, different types of argumentation schema may trigger students to take single-sided or balanced perspectives when putting forth one's argument in written form.

3. MANUAL CODING OF PERSPECTIVE TAKING

Perspective taking is identified as one of the higher order cognitive skills that contribute to writing [4, 5]. Extensive literature review has found four cognitive or psychological concepts that underlie perspective taking in writing—theory of mind, audience awareness, development of epistemological understanding, and argumentation schema. Theory of mind is exhibited by how writers incorporate the perspectives of the author and the characters in the source text. Perspective taking also relates to how the writer is aware of the audience they are writing for, from which they adjust their language accordingly. It can also be examined in association with one's development of epistemological understanding, as writing entails the ability to construct knowledge from multiple information sources that present diverse viewpoints [22]. Lastly, perspective taking is relevant to the different kinds of argumentation schema that is activated when composing a piece of writing [24].

Based on these frameworks, researchers have come up with a coding scheme to identify the level of extent of perspective taking portrayed in writing. Detailed analytic scoring methods can provide information about how cognitive skills are portrayed within a piece of writing [24]. For one, researchers have applied the development of epistemological understanding to argumentative writing context. Specifically, researchers matched the levels of epistemological understanding to *complex reasoning skills* manifested in argumentative writing [10, 11]. For example, an essay was segmented into T-units and coded based on four levels: non-argument (e.g., repetitive, irrelevant, descriptive, or unclear ideas), own-side only argument (i.e., incorporating positives of the favored position), dual perspective (i.e., offers negatives of the opposing position), and integrative perspective (i.e., considers for negatives of the favored position and positives of the opposing position). Own-side only argument corresponded to the *absolutism* stage of development; dual perspective was in line with *multiplism*; and integrative perspective was relevant to *evaluativism*. In this coding scheme, dual

and integrative perspectives were regarded as exhibiting complex reasoning. This coding scheme portrays how the writer exhibits one or more sides to an issue, which taps onto perspective taking skills. The coding scheme is well-developed in how it reflects the stages of epistemological understanding by assessing levels of argumentative sophistication and how it addresses counterarguments through dual and integrative perspectives. However, it was limited in the ways that the coding scheme was developed with a binary prompt assumed (e.g. Do you agree or disagree with the following statement?) and the primary focus was on the cognitive framework of epistemological understanding and argumentation schema. Given that perspective taking also draws upon cognitive and psychological skills such as theory of mind and audience awareness, there was a need for refining the previous coding scheme to account for these missing but important aspects.

In response, another group of researchers adapted the previous coding scheme and further developed an analytical coding manual for perspective taking [5, 6]. Specifically, the authors retained the four hierarchical categories but specified them to reflect a broader range of underlying psychological mechanisms for perspective taking portrayed in various genre of writing including argumentative and text-based analytical writing. To illustrate, in the coding scheme presented below (Table 1), each new, different, and relevant idea unit is assigned a score for its corresponding perspective (0-3). Own-side perspective was given to units that were written from exclusively the writer's own perspective. On top of that, the identification of dual perspective was specified more to comprehensively account for the four relevant psychological concepts. For example, units were coded as dual when they portrayed how the writer accounted for the perspectives of authors or the characters in the source text (e.g. He [the author] wants you to keep in mind that ...), when the writer situated oneself in a different context from their direct own (e.g. You ask yourself why does he [author] use those words?), and when they bring counterarguments or alternative perspectives (e.g. They had courage instead of sitting, crying and doing nothing). Integrative perspective was designated to units that considered for both perspectives and chose one over the other after reasoning or offered a third option. In addition, the criterion for not being coded for any perspective taking are specified into four categories: descriptive, repetitive, unclear, or irrelevant statements. For example, if the writer brought direct quotes from the source-text that is purely descriptive and does not portray the writer's perspective in any way, it is given a score of 0. Repetitive and unclear statements were not coded because they are already accounted for or are incomprehensible. Irrelevant statements are those that were totally off-topic or stranded.

Table 1. Manual coding scheme for perspective taking

Score	Perspective	Description
0	No perspective	T-units that contained no perspective or are repetitive, descriptive (without adding anything to the theme), unclear (language-wise not making sense or difficult to understand), or irrelevant (to the theme or supporting idea)
1	Own-side perspective	T-units that identified the writer's own perspective with or without explanation
2	Dual perspective	T-units that included both single and either opposing or an alternative to the single perspective OR included perspectives from the source text (author' or characters' perspectives) OR directly addressed the audience OR situated writer him or herself in a different context
3	Integrative perspective	T-units that considered for both perspectives (own-side and dual), and choose one over the other after reasoning, or offer a third option

Examination of secondary students' analytical writing using this coding scheme found that students wrote mostly from one's own perspective and that integrative perspective was not found in the essays [5, 6]. Reasons for this were attributed to the pervasiveness of myside bias in adolescent writing and how adolescent writers

are still developing their skills to think and write from diverse perspectives [25]. Another important finding was that dual perspective taking was related to writing quality over and above own-side perspective taking, which showed that essays written from multiple perspectives are more likely to be considered quality writing than those written only from the writer's own perspective [5]. In all, the identification of discourse-level thinking skills, such as perspective taking, has been done through manual coding based on theoretical frameworks. However, it is also worth noting that human coding has issues regarding reaching high interrater reliability [6]. Therefore, alternative approaches such as the use of computational methods to generate indexes of language and discourse features can complement human coding. In other words, the future direction of writing assessment and studies of the psychometrics of writing involve both manual scoring and computational approaches.

4. COMPUTATIONAL APPROACHES TO IDENTIFY PERSPECTIVE TAKING

Language is the means through which we externalize our thoughts and interact with the world [27]. Although language forms themselves are worthy of examination, understanding the psychological processes and cognitive skills underlying the use of language is as important. Various analytical methods can be used to understand the psychological processes and cognitive skills embedded in written and oral texts. Traditionally, the identification of higher order thinking skills or discourse level features were dependent on somewhat laborious human coding, such as segmenting texts into meaningful units and coding the units from an analytic framework [5, 11]. This was due to the nuanced nature of identifying psychological or cognitive skills, as they cannot be easily identified as linguistic features, such as the use of certain parts of speech. Instead, the identification of discourse level skills is more nuanced in that there are differences in one's personal style of communication that warrants some flexibility and there is no set equation to identify the workings of specific skills.

However, many limitations of human coding have been pointed out, including the difficulty of reaching high interrater reliability and the time-consuming nature of the practice. Nonetheless, in this world of big data, hand-coding large corpora became almost impossible. As a response, researchers increasingly incorporated language analysis software in analyzing larger data. Language analysis software such as Systematic Analysis of Language Transcripts (SALT) and Computerized Language Analysis (CLAN) have been frequently used in the analysis of oral texts as they are able to generate general linguistic indexes such as the total number of words, mean length of units, and type token ratio [28, 29]. They are also able to count the frequency of words that the user of the software program inputs. For example, a list of *mental state verbs* (e.g., think, know, believe, remember) can be input and counted in their frequency. In fact, the frequent use of mental state verb was discussed in relation to perspective taking, as the specific verbs provide information on one's ability to think and talk about one's own as well as others' mental and emotional states in various contexts [30]. Likewise, even the simplest functions done by language analysis software such as frequency counts can serve as an aid in identifying the relevant thinking skills such as perspective taking.

Moreover, computational linguistics approach including the use of Natural Language Processing (NLP) tools emerged as a feasible solution to automate the interpretation of human language input. However, much emphasis is put on grounding computational linguistics in educational theory, as using sophisticated technology without sound theoretical rationale can be void [31, 32]. Various tools have been developed to calculate linguistic indices that provide information important within educational contexts. In the assessment of writing, NLP tools such as Coh-metrix have been frequently used to generate indexes of language features (e.g., syntactic complexity, word concreteness) [33]. Another example is the development of automated essay scoring (AES) algorithms for writing assessment, based on NLP techniques and artificial intelligence [34]. In fact, AES technology has been highly successful, almost to a comparable accuracy rate as expert human raters [27].

Regarding the identification of underlying cognitive and psychological features embedded in texts, NLP tools such as Coh-metrix and Linguistic Inquiry and Word Count (LIWC) can be useful [35, 36]. For example, Coh-metrix generates indexes of mental representation such as intentional content (i.e., incidence of intentional actions, events, and particles) [35]. This has relations to the identification of perspective taking in the form of

agents’ intents and desires. In LIWC, linguistic indexes such as cognitive processes and social words can be generated [36]. Such indexes have relevance to perspective taking in that mental and emotional states are expressed through word signaling cognitive and social processes. Likewise, researchers can use their discretion to generate indexes from computational linguistics approach to identify the linguistic features that tap onto their psychological construct of interest such as perspective taking.

5. COMBINATION OF INDICES AND THEIR LIMITATIONS

Moving beyond the independent indices, there have also been attempts to create summary variables by extracting and combining a range of linguistic features. This approach to creating broader dimensions, by engineering the linguistic features based on theoretical and empirical background, can be beneficial for researchers and practitioners who have specific construct or concept of interest that they hope to gain insight into [35]. For example, Coh-metrix provides text easability principal component scores consisting of indexes such as narrativity, syntactic simplicity, word concreteness, referential cohesion, and deep cohesion [33]. These provide insights on the linguistic and discourse features of texts that help practitioners make decisions on which text to use for which purposes. Meanwhile, LIWC provided four summary variables – analytic thinking, authenticity, authority, emotional tone – created by combining various groups of words portraying linguistic forms and psychological states [36]. For example, as shown in Figure 1, a formal text such as a research article was inputted into LIWC-22 analysis, the summary variable showed that the text had higher analytic and authentic score than the average for formal language. Note that for the trial version of LIWC-22, there was a limit of 1000 words, but the more words the more accurate results will be. Also note that users have to classify the text into certain categories (e.g., personal, formal, commercial writing) to see where the text lies among all the texts that fall under the same category.

Traditional LIWC Dimension	Your Text	Average for Formal Language
I-words (I, me, my)	0.00	0.67
Positive Tone	1.47	2.33
Negative Tone	0.00	1.38
Social Words	5.49	6.54
Cognitive Processes	15.93	7.95
Allure	0.40	3.58
Moralization	0.00	0.30
Summary Variables		
Analytic	94.53	87.63
Authentic	43.86	28.90

Traditional LIWC dimensions reflect percentage of total words within the text you provided. The Summary Variables are composites derived from scientific research that have been converted to 100-point scales, where 0 = "very low" along the dimension and 100 = "very high." Analytic refers to analytical or formal thinking. Authentic is a property of language that reflects when someone is speaking in an unfiltered, off-the-cuff fashion.

Figure 1. Results of LIWC-22 analysis of a formal text sample

The summary variables in LIWC are highly relevant to the identification of higher order thinking skills such as perspective taking as they pertain to psychological and cognitive processes. First, the summary variable of *analytical thinking* was created by combining different function words that portray either categorical (abstract, academic style) or dynamic (time-based, narrative style) language [37]. Principle component analysis

of student essays found that articles and propositions were related to categorical language, whereas pronouns, auxiliary verb, conjunction, adverb, and negation were related to dynamic language. Consequently, the researchers found modest but highly significant correlations between usage of categorical language and academic performance. Similarly, some researchers identified the linguistic and discourse features (e.g., elaborated noun phrase, proportion of proper character introduction) that second graders used more often in decontextualized or more sophisticated discourse context [30]. The hypothesized characteristics of decontextualized language were similar to that of categorical language, which signaled analytic thinking and has potential for extending to perspective taking.

Next, the summary variable of *authenticity* was generated by examining the linguistic characteristics of deceptive communications [38]. The researchers found that deceptive discourse had fewer first-person singular pronouns, more words reflecting negative emotions, and use more motion verbs (e.g. walk, move, go) and fewer exclusive words (e.g. except, but, without), as they were assumed to be less cognitively complex. In fact, the identified indexes were found to be well-aligned with human judgement of deception. With regards to the summary variable of *authority* or *clout*, it was found that people with higher status or position in hierarchy consistently used fewer first-person singular (*I*), but more first-person plural (*we*) and second-person singular pronoun (*you*), exhibiting how higher rank is linked with other-focus whereas lower rank is linked with self-focus [39]. Lastly, the summary variable of *emotional tone* puts positive and negative tone into a single summary variable to indicate the higher the more positive and the lower the more negative. Utilizing this index, researchers looked into online diary entries prior to and after the September 11 attacks, focusing on words displaying emotional positivity, cognitive processing, social orientation, and psychological distancing, and mapped out the changes in emotional tone by timeline [40].

However, there are some methodological concerns regarding the creation of summary variables in LIWC. To begin with, different statistical or analytic approaches were used in generating the four constructs, depending on researchers' decisions. For example, when creating *analytical thinking*, researchers used principal component analysis to identify which indexes went together, whereas for generating *authority*, researchers used multivariate analysis of variance and t-tests to distinguish the linguistic characteristics between groups and combined them together. In addition, the four constructs varied in whether they compared their summary indexes with human judgement of the same construct. For example, the variables of *authenticity* and *authority* were supported in its creation by comparing them against human judgements, while the two other variables relied primarily on the computerized tool to engineer the index. Lastly, it was unclear whether the researchers accounted for cultural differences when creating the variables. As one example, the definition of *authority* may be operationalized differently for different cultures such that in one culture, authority may mean leadership, whereas in another culture, it may translate to dictatorship. Therefore, it is important to mention the context in which the summary variables were generated so that the users have a better understanding of the assumptions behind the psychological and cognitive skills being identified.

In all, the key takeaway from the various approaches to generating summary variables is that researcher discretion is needed in creating an index grounded in theory, compared against human judgement, and reflective of the socio-cultural context. On top of that, future research may consider combining computerized indexes with human manual coding of the same construct to complement different methodological approaches. The convergence of manual coding and computational linguistics approaches can enhance our understanding of the psychometrics of cognitive or psychological constructs portrayed in written or oral texts. Some specific data analytic approaches to be considered include exploratory factor analysis, confirmatory factor analysis, and principal component analysis to derive the most representative index to represent the constructs. Once the operationalization of a psychological construct based on various methodological approaches has been set, the next step is to utilize such measures to address a wide variety of research questions.

6. CONCLUSIONS

This study reviewed theoretical frameworks on the psychological construct of perspective taking in writing and provided a literature review on manual coding and computational approaches to identifying perspective taking and relevant constructs. This study made theoretical contributions to the field of psychometrics and

psycholinguistics in that important issues regarding human and computer approaches to the measurement of construct have been discussed. In addition, practical suggestions have been made on the types of indexes to represent perspective taking in writing. Based upon this study, future research is encouraged to examine perspective taking in various genres of writing (e.g., narrative, expository) and context of writing (e.g., online discussion board) to examine its different patterns. In all, this study took an important step in operationalizing the skill of perspective taking in written composition, guided by psychometrics scrutiny in the manual coding and computational approaches.

The increasing affordances of technological tools have expanded the field's capacity to examine psychological constructs. However, it is important to understand that it is ultimately up to the researcher to make decisions on the best way to represent a construct in a psychometrics sense. Researcher decisions should be based on sound theoretical rationale and careful consideration of the practical implications of the construct of interest. Identifying a higher order thinking skill involved in written composition was not an exception to this rule. Researchers, as engineers of psychological constructs, are advised to go under rigorous decision-making processes in adapting various psychometrics approaches.

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