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# Main Concepts for Two Picture Description Tasks: An Addition to Richardson and Dalton, 2016

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# Main Concepts for Two Picture Description Tasks: An Addition to Richardson and Dalton, 2016

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## Abstract

**Background**: Proposition analysis of the discourse of persons with aphasia (PWAs) has a long history, yielding important advancements in our understanding of communication impairments in this population. Recently, discourse measures have been considered primary outcome measures, and multiple calls have been made for improved psychometric properties of discourse measures.

**Aims:** To advance the use of discourse analysis in PWAs by providing Main Concept Analysis checklists and descriptive statistics for healthy control performance on the analysis for the Cat in the Tree and Refused Umbrella narrative tasks utilized in the AphasiaBank database protocol.
**Methods & Procedures**: Ninety-two control transcripts, stratified into four age groups (20–39 years; 40–59; 60–79; 80+), were downloaded from the AphasiaBank database. Relevant concepts were identified, and those spoken by at least one-third of the control sample were considered to be a main concept (MC). A multilevel coding system was used to determine the accuracy and completeness of the MCs produced by control speakers.
**Outcomes & Results**: MC checklists for two discourse tasks are provided. Descriptive statistics are reported and examined to assist readers with evaluation of the normative data.
**Conclusions**: These checklists provide clinicians and researchers with a tool to reliably assess the discourse of PWAs. They also help address the gap in available psychometric data with which to compare PWAs to healthy controls.

## Keywords:
Aphasia, AphasiaBank, discourse analysis, main concept, normative reference

## Introduction
There is a rich history of proposition research in aging and aphasia with a variety of approaches present, since the birth of modern discourse studies in the 1970s (see Bryant, Ferguson, & Spencer, 2016). Main concept analysis (MCA) is one such proposition-level approach introduced in the early-to-mid-1990s (Nicholas & Brookshire, 1993a, 1995). A main concept (MC) checklist is a closed set of utterances that provides the gist of the narrative task, where each MC consists of a subject, one main verb, object (if appropriate), and any subordinate clauses (Nicholas & Brookshire, 1995). As reviewed in Richardson and Dalton (2016), MCA is highly reliable and ecologically valid, and can discriminate between control and clinical populations, and also within clinical populations. MCA may also have potential for tracking spontaneous and/or treatment-induced recovery.

We recently published MC checklists for selected semi-spontaneous discourse tasks included in the AphasiaBank protocol (Richardson & Dalton, 2016). These checklists were developed by examining discourse samples of control participants and identifying the essential content (i.e., gist) commonly conveyed to describe a picture sequence narrative (Broken Window; Menn et al., 1998), tell a story (Cinderella; Grimes, 2005), and describe a procedure (making a peanut butter and jelly sandwich; Lau, 2013). To further contribute to the important development of objective discourse measures, we reported preliminary normative information to complement AphasiaBank's standardized administration procedures. In this short report, we provide comparable information (i.e., checklists, normative information) for the remaining two semi-spontaneous discourse tasks in the AphasiaBank protocol – a picture scene narrative (Cat in the Tree, or Cat Rescue; Nicholas & Brookshire, 1993b) and a picture sequence narrative (Refused Umbrella; MacWhinney, Fromm, Forbes, & Holland, 2011).

Since our original publication, there have been notable developments and applications of MCA. For example, Kong, Whiteside, and Bargmann (2016) applied MCA to healthy aging individuals, individuals with Alzheimer's type dementia, and individuals with fluent and non-fluent aphasia to validate the use

of MCA in these groups, establish norms, and report on the sensitivity and validity of using MCA to distinguish between groups. They used a group of 60 healthy controls to first establish the MC lists, which were then used to score the discourse samples of the different groups. They found each group displayed significantly different profiles of performance, except individuals with fluent aphasia and individuals with dementia, indicating that MCA may be used to distinguish between individuals with a variety of communication deficits.

Fromm et al. (2017) included MCA among several analyses to examine the discourse of individuals with aphasia of the mildest severity. Specifically, they sought to compare performance on discourse measures for three groups – (1) control participants without aphasia, (2) participants with aphasia of anomic subtype, and (3) participants who report a history and/or presence of aphasia but who score above the diagnostic cutoff on the Western Aphasia Battery (WAB, WAB-R; Kertesz, 1982, 2007) and are therefore "not aphasic by WAB" (NABW). The production of MCs differed significantly between each group comparison, in the expected directions, with controls with the highest MC score, persons with anomic aphasia with the lowest, and persons NABW in between. These findings further demonstrated the sensitivity of MCA.

MC production in bilingual speakers (English/Spanish) has recently been investigated (Rivera, Hirst, & Edmonds, 2017). Authors recognized the limitations, and even potential harms (e.g., misclassification or diagnosis), of assuming that MCs identified in monolingual English speakers in North America would be identical to those expressed by bilingual populations that are more culturally and linguistically diverse. They reported on the development of MC checklists for selected Nicholas and Brookshire stimuli (2 picture scene narratives, 2 picture sequence narratives) based upon the discourse of bilingual speakers, a vital development for discourse assessment in culturally and linguistically diverse populations. They provided normative information for MCs for a sample of healthy bilingual young adults and examined relationships between MCs and several participant-reported variables (e.g., percent language use, self-rated proficiency, other demographics), object and verb naming performance on An Object and Action Naming Battery (OANB; Druks & Masterson, 2000), and discourse performance, specifically correct information units (CIUs; Nicholas & Brookshire, 1993b). Self-rated language proficiency measures strongly correlated with MCs, but the best predictors of MC production were CIU production and naming performance (verbs for English MCs, objects for Spanish MCs).

With regard to the two picture-elicited semi-spontaneous discourse tasks addressed in this investigation, there are readily retrievable proposition checklists for the picture scene Cat in the Tree (Capilouto, Wright, & Wagovich, 2005; Hameister & Nickels, 2018; Wright, Capilouto, Wagovich, Cranfill, & Davis, 2005) but not for the picture sequence Refused Umbrella, which was recently commissioned by AphasiaBank (MacWhinney et al., 2011). The Cat in the Tree picture was drawn to the investigator specifications for the landmark study that introduced CIU analysis (Nicholas & Brookshire, 1993b) and was included in the first study introducing MCA (Nicholas & Brookshire, 1995), though the MC list was not disseminated. Both the picture scene (Cat in the Tree) and analytic approach (MCA) were predated by a study including a conceptually similar Cat Story picture sequence and Rooster Story retelling narrative tasks, in which authors conducted a propositional analysis, alongside other microlinguistic and story grammar analyses (Ulatowska, Freedman-Stern, Doyel,

Macaluso-Haynes, & North, 1983; Ulatowska, North, & Macaluso-Haynes, 1981). A proposition was defined as a predicate followed by one or more arguments, and authors refer to closed sets of propositions, though neither how they were established nor the content of those propositions were presented. Authors observed that persons with aphasia (PWAs) produced discourse that was shorter and less complex than healthy controls.

Wright and colleagues (Capilouto et al., 2005; Wright et al., 2005) listed in their appendix four main events (MEs) for the Nicholas and Brookshire (1993b) Cat in the Tree scene. MEs are similar to MCs, but often are more complex and/or longer than MCs because the intent is to capture both the essential content *and* the relationships between ideas, agents, etc. These ME lists for Cat in the Tree (and other narrative tasks) were based upon lists created by three lead investigators, and the final list included those events produced by at least two of the three investigators. Differences in ME production by age have been reported (Capilouto et al., 2005; Wright et al., 2005), and PWAs produce fewer MEs than neurologically healthy controls (Capilouto, Wright, & Wagovich, 2006).

The aforementioned Rivera et al. (2017) study included Cat in the Tree among their stimuli. They sampled 42 healthy bilingual (English/Spanish) young adults to generate an MC list of 12 concepts that met basic Nicholas and Brookshire criteria (1995) and that also could be related to the setting or to the expression of motivation, intent, and/or affect. Concepts were either (1) shared by 40% of speakers, or (2) if not shared by 40% of speakers, were salient and agreed upon by author consensus to be included, and (3) were produced in both English and Spanish.

More recently, Hameister and Nickels (2018) list 10 MCs for Cat in the Tree, sampling from 50 transcripts of healthy control speakers randomly selected from the AphasiaBank database. Authors generated a lengthy list of candidate concepts utilizing the Nicholas and Brookshire definition of an MC (1995) and then imposed a cutoff criteria of 60%, as well as some additional consensus decisions to finalize the list. Using this checklist, authors conducted an MCA using 50 transcripts of PWAs randomly selected from the AphasiaBank database. PWAs attempted significantly fewer MCs compared to healthy controls; accuracy and completeness were not assessed. Importantly, this significant reduction was observed even though both spoken and gestured recognizable attempts that corresponded to an MC on the list were included.

We sought to develop MC checklists drawn from a control population for the remaining two semi-spontaneous discourse tasks included in the AphasiaBank protocol and to report MCA results for control speakers, drawing from the sample used previously (Richardson & Dalton, 2016). To that end, we replicated methods to determine MC checklists for the two remaining picture-elicited narrative tasks. We then carried out MCA for the control sample and reported normative information for MC codes and overall score, including a secondary presentation of results by coarse age stratification.

# Methods

## Transcripts

Transcripts obtained from healthy controls were downloaded from the AphasiaBank database. Individuals included in this database do not have a history of neurological illness or damage, and self-report normal cognitive status. All participants in the database are asked to complete a standardized

protocol that includes conversation and semi-spontaneous tasks. Ninety-two transcripts (contributed by Capilouto, Kempler, Richardson, and Wright laboratories) were retrieved in order to establish an MC list for the picture scene narrative, Cat in the Tree, and a picture sequence narrative, Refused Umbrella. For both tasks, the picture stimulus was placed in front of the individual. They were instructed to look at the picture(s), and when ready, tell a story with a beginning, middle, and end (aphasia.talkbank.org/protocol/; Forbes, Fromm, & MacWhinney, 2012; MacWhinney et al., 2011). Participants were able to look at the pictures as they told the story.

The transcripts used to establish MC lists and normative data for these two stories were contributed by the same individuals as those utilized in Richardson and Dalton (2016), except for five transcripts for the Cat in the Tree narrative (see Table 1). The Cat in the Tree picture stimuli was not initially a part of the AphasiaBank database protocol, so some early contributions by the Wright lab do not include this narrative. Five transcripts were identified to replace the normative samples lacking the Cat in the Tree narrative, and they were matched for age, gender, years of education, and performance on the Broken Window task (i.e., MC composite score and number of utterances). This was done in an effort to ensure that samples and subsequent results for all semi-spontaneous tasks in the AphasiaBank protocol are maximally comparable. Using the GEM command from the Computerized Language Analysis (CLAN) tool, we isolated the selected discourse tasks from the rest of the transcript using this command (for Cat in the Tree as an example): + g + sCat + d1 + fCat + t * PAR * .cha. The GEM command created files with the Cat in the Tree and Refused Umbrella transcript segments for each participant.

Table 1. Demographic information for the 92 transcripts selected as the normative sample from the AphasiaBank database.

| | | *N* | Age (years) | Gender | Education (years) | Race/Ethnicity |
|---|---|---|---|---|---|---|
| Cat in the Tree | All | 92 | 58.8 (±21.7) | 55 Female<br>37 Male | 15.6 (±2.4) | 89 Caucasian<br>1 African-American<br>2 Hispanic/Latino |
| | 20–39 | 23 | 28.8 (±5.4) | 14 Female<br>9 Male | 15.5 (±1.8) | 21 Caucasian<br>1 African-American<br>1 Hispanic/Latino |
| | 40–59 | 23 | 48.4 (±6.4) | 15 Female<br>8 Male | 15.7 (±2.5) | 22 Caucasian<br>1 Hispanic/Latino |
| | 60–79 | 23 | 71.6 (±4.7) | 13 Female<br>10 Male | 15.7 (±2.4) | 23 Caucasian |
| | 80+ | 23 | 83.9 (±2.9) | 13 Female<br>10 Male | 15.3 (±2.8) | 23 Caucasian |
| Refused Umbrella | All | 92 | 58.3 (±21.6) | 55 Female<br>37 Male | 15.6 (±2.5) | 88 Caucasian<br>2 African-American<br>2 Hispanic/Latino |
| | 20–39 | 23 | 29.6 (±5.8) | 14 Female<br>9 Male | 15.9 (±2.5) | 20 Caucasian<br>2 African-American |
| | | | | | | 1 Hispanic/Latino |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 40–59 | 23 | 48.4 (±6.3) | 15 Female<br>8 Male | 15.7 (±2.5) | 22 Caucasian |
| | 60–79 | 23 | 71.6 (±4.7) | 13 Female<br>10 Male | 15.7 (±2.4) | 23 Caucasian |
| | 80+ | 23 | 83.9 (±2.9) | 13 Female<br>10 Male | 15.3 (±2.8) | 23 Caucasian |

## Relevant concepts (RCs)

We first identified the RCs produced during each discourse task. RCs were defined as any statement consisting of a main verb and its subject, object, and subordinate clauses (as appropriate) that related to the story (Nicholas & Brookshire, 1993a, 1995). RCs were statements that could be considered MCs if enough of the normative sample produced them. To determine RCs, each transcript was examined utterance by utterance, and each novel utterance that related to the story topic was added to a running list. The first time an RC was produced, it was added to the list of RCs for that story. The speaker who produced that RC received a score of "1", and any following speakers who did not produce the RC received a score of "0" for that concept. If a speaker produced an utterance that was comparable in content to the RC, they received a "1" for that RC, regardless of the specific words that were used to produce the utterance. Any transcripts that had been examined prior to adding an RC received a score of "0" for that RC, since they had not produced it. In this manner, each participant received either a "1" (present) or "0" (absent) for each RC. We then summed the number of participants who produced each RC, and determined a frequency count of the number of times an RC was produced. After completing RC coding of all transcripts for each discourse tasks, authors examined the RC lists and used forced choice agreement to determine if any should be merged.

## Main concepts

Frequency plots of the RCs for each discourse task were generated, where the x-axis represented the RCs and the y-axis represented the number of speakers ($N$ = 92) who produced each RC. A 33% threshold was applied to all discourse tasks such that any RC produced by 30 of the control speakers was considered an MC; we also report which MCs would survive 50% and 66% thresholds (see Appendices 1 and 2), as in Richardson and Dalton (2016). For each MC, essential elements (e.g., the subject, verb, object, etc.) were identified based on how many times each element was produced for a given MC. For example, the concept "The dog was barking up the tree" consists of two essential elements ("the dog" and "barking") and one non-essential element ("up the tree") that was said by less than 33% of the sample. Non-essential elements are included in the list in order to aid researchers and clinicians in identification of MCs produced by their participants or clients.

MCs were then coded for accuracy and completeness. If an MC is not produced, it is coded as absent (AB). If an MC is present, a multilevel coding system is applied, as follows: Accurate/Complete (AC) – all essential elements have been produced and are accurate; Accurate/Incomplete (AI) – one or more essential elements is omitted, but those produced are accurate; Inaccurate/Complete (IC) – all essential elements are produced, but one or more are inaccurate; Inaccurate/Incomplete (II) – one or more essential elements are omitted, and one or more essential elements are inaccurate. Each code receives a numerical score from 0–3, and scores are summed across MCs in a narrative to yield an MC

composite score using the formula: MC composite = (3 × AC) + (2 × AI) + (2 × IC) + (1 × II) (but see Kong, 2009 for alternative scoring).

### Data analysis

SPSS v25 (Statistical Package for the Social Sciences) was used for analysis. Characteristics of the RC and MC distribution are reported for both stories, including descriptive statistics, skew and kurtosis, and normality plots for the entire sample and for four age groups (20–39, 40–59, 60–79, and 80 and older). For each narrative, we also applied a Kruskal-Wallis (H) test and planned pairwise comparisons to determine and identify differences in performance across the four age groups. The Kruskal-Wallis test was selected as it is the non-parametric equivalent to a one-way ANOVA, and our data violated the assumption of normality for use of an ANOVA.

Previous investigations using this sample demonstrate that use of the standardized AphasiaBank protocol results in samples with a high degree of assessment fidelity, allowing for results to be collapsed across locations (Richardson & Dalton, 2016). Intra- and inter-rater reliability of MC coding was assessed using point-by-point comparison. For Cat in the Tree, inter-rater reliability was 88% and intra-rater reliability was 93%. For Refused Umbrella, inter-rater reliability was 92% and intra-rater reliability was 91%.

## Results

### RCs

For each task, the following descriptive statistics for the total number of RCs produced are displayed in Table 2: mean, standard deviation, median, range, skewness, and kurtosis. Mean and median were close in value, and skewness and kurtosis were within acceptable ranges (≤±2 and <±4, respectively). Overall, Cat in the Tree had less deviation from the normal distribution than Refused Umbrella. Supplemental Figure 1 displays Q-Q plots for RCs for the discourse tasks, with most data points clustered tightly around the straight line of the normal distribution.

Table 2. Descriptive statistics for relevant concept (RC) production on discourse tasks.

| | Cat in the Tree | Refused Umbrella |
|---|---|---|
| Mean | 10.7 | 13.4 |
| *SD* | 4 | 3.6 |
| Median | 10 | 13 |
| Range | 3 to 25 | 5 to 23 |
| Skewness | 0.662 | 0.458 |
| Kurtosis | 1 | 0.389 |

### MCs

MC checklists are presented in Appendices 1 and 2. There were 10 concepts shared by at least 33% of the sample for both Cat in the Tree and Refused Umbrella. Essential elements for each MC are listed with information about alternative word choices and sentence structures and in some cases, are accompanied by non-essential content that was commonly produced with that MC (but did not reach the 33% threshold). Also, identified are the concepts included when using the 50% and 66% cutoff

criteria. For both tasks, descriptive statistics for each MC code (AB, AC, AI, IC, and II) and MC composite scores are presented in Tables 3 and 4. See Appendix 3 for examples of statements that would receive each MC code. The maximum value for each MC code is the number of MCs for that story (i.e., 10) and the maximum MC composite score is 30 (i.e., 10 MCs × AC score of 3). Mean and median were close in value, and skewness and kurtosis were within acceptable ranges, indicating a sample distribution of acceptable symmetry for all variables except AC for the 60–79 age group on Refused Umbrella, where kurtosis was 4.243. Supplemental Figures 2 and 3 display Q-Q plots for AC codes for the discourse tasks, with most data points clustered tightly around the straight line of the normal distribution, except for the above-mentioned group. The AC code was selected for display because it predicts the distribution of both the *AB* code and the MC composite score and also because the other codes occur so infrequently.

Table 3. Descriptive statistics for each main concept code for the Cat in the Tree narration of the entire normative sample and each age group separately.

| | | ALL | 20–39 | 40–59 | 60–79 | 80–99 |
|---|---|---|---|---|---|---|
| Accurate- Complete | Mean | 6.1 | 5.5 | 6.4 | 6.5 | 6 |
| | *SD* | ±1.7 | ±1.7 | ±1.5 | ±1.7 | ±1.7 |
| | Median | 6 | 5.5 | 6 | 6 | 6 |
| | Range | 2 to 10 | 2 to 8 | 4 to 9 | 3 to 10 | 2 to 9 |
| | Skew | −0.184 | −0.226 | 0.183 | 0.086 | −0.579 |
| | Kurtosis | −0.218 | −0.416 | −1.117 | −0.024 | 0.058 |
| Accurate-Incomplete | Mean | 0.6 | 0.9 | 0.5 | 0.6 | 0.5 |
| | *SD* | ±0.6 | ±0.7 | ±0.6 | ±0.4 | ±0.7 |
| | Median | 1 | 1 | 0 | 1 | 0 |
| | Range | 0 to 2 | 0 to 2 | 0 to 2 | 0 to 2 | 0 to 2 |
| Inaccurate-Complete | Mean | 0 | 0 | 0 | 0 | 0 |
| Inaccurate-Incomplete | Mean | 0.01 | 0 | 0.04 | 0 | 0 |
| | *SD* | ±0.1 | | ±0.2 | | |
| | Median | 0 | 0 | 0 | 0 | 0 |
| | Range | 0 to 1 | 0 | 0 to 1 | 0 | 0 |
| Absent | Mean | 3.2 | 3.7 | 3 | 2.9 | 3.4 |
| | *SD* | ±1.7 | ±2 | ±1.4 | ±1.6 | ±1.7 |
| | Median | 3 | 3.5 | 3 | 3 | 3 |
| | Range | 0 to 7 | 1 to 7 | 1 to 5 | 0 to 6 | 1 to 7 |
| | Skew | 0.392 | 0.267 | 0 | 0.151 | 0.761 |
| | Kurtosis | −0.460 | −1.057 | −1.366 | −0.629 | 0.122 |
| Main Concept Score (30) | Median | 20 | 18.5 | 20 | 20 | 20 |
| | Range | 8 to 30 | 8 to 26 | 14 to 27 | 11 to 30 | 8 to 27 |
| | Skew | −0.336 | −0.270 | 0.124 | −0.062 | −0.727 |
| | Kurtosis | −0.337 | −0.843 | −1.382 | −0.427 | 0.152 |

Table 4. Descriptive statistics for each main concept code for the Refused Umbrella narration of the entire normative sample and each age group separately.

| | | All | 20–39 | 40–59 | 60–79 | 80–99 |
|---|---|---|---|---|---|---|
| Accurate- Complete | Mean | 7.4 | 7.4 | 8 | 7.1 | 7.1 |
| | *SD* | ±1.6 | ±1.6 | ±1.1 | ±1.9 | ±1.6 |
| | Median | 8 | 8 | 8 | 7 | 7 |
| | Range | 1 to 10 | 3 to 9 | 5 to 10 | 1 to 10 | 3 to 10 |
| | Skew | −1.287 | −1.515 | −0.624 | −1.494 | −0.714 |
| | Kurtosis | 2.702 | 2.267 | 1.559 | 4.243 | 0.526 |
| Accurate-Incomplete | Mean | 0.3 | 0.5 | 0.09 | 0.3 | 0.2 |
| | *SD* | ±0.5 | ±0.7 | ±0.3 | ±0.6 | ±0.4 |
| | Median | 0 | 0 | 0 | 0 | 0 |
| | Range | 0 to 2 | 0 to 2 | 0 to 1 | 0 to 2 | 0 to 1 |
| Inaccurate-Complete | Mean | 0.09 | 0 | 0 | 0.4 | 0 |
| | *SD* | ±0.8 | | | ±1.7 | |
| | Median | 0 | 0 | 0 | 0 | 0 |
| | Range | 0 to 8 | 0 | 0 | 0 to 8 | 0 |
| Inaccurate-Incomplete | Mean | 0 | 0 | 0 | 0 | 0 |
| Absent | Mean | 2.2 | 2.0 | 1.9 | 2.2 | 2.7 |
| | *SD* | ±1.4 | ±1.6 | ±1.0 | ±1.3 | ±1.6 |
| | Median | 2 | 2 | 2 | 2 | 3 |
| | Range | 0 to 7 | 0 to 7 | 0 to 4 | 0 to 5 | 0 to 7 |
| | Skew | 0.969 | 1.511 | 0.187 | 0.422 | 0.807 |
| | Kurtosis | 1.334 | 3.182 | 0.230 | −0.851 | 0.821 |
| Main Concept Score (30) | Median | 24 | 24 | 24 | 23 | 21 |
| | Range | 9 to 30 | 9 to 29 | 17 to 30 | 15 to 30 | 9 to 30 |
| | Skew | −0.921 | −1.548 | −0.321 | −0.106 | −0.793 |
| | Kurtosis | 1.205 | 3.03 | 0.588 | −0.923 | 0.759 |

## MCs by age

Results of the Kruskal–Wallis test revealed no significant differences in MC codes or MC composite scores among the age groups for either narrative. Table 5 reports the results of the Kruskal-Wallis tests.

Table 5. Kruskal Wallis H test results for between age groups comparisons for each main concept code and main concept composite scores.

| | | MC Composite | AC | AI | IC | II | AB |
|---|---|---|---|---|---|---|---|
| Cat in the Tree | $\chi^2(3)$ | 1.827 | 2.894 | 5.697 | 3.0 | n/a | 1.24 |
| | *p* | .609 | .408 | .127 | .392 | n/a | .743 |
| Refused Umbrella | $\chi^2(3)$ | 4.428 | 5.17 | 6.978 | 3.0 | n/a | 4.12 |
| | *p* | .219 | .16 | .073 | .392 | n/a | .249 |

## Discussion

This study contributes to the research and clinical practice in aphasia and related disorders by generating MC checklists from a large control sample for the remaining two picture description tasks in the AphasiaBank protocol. As in Richardson and Dalton (2016), we describe the sample composition, provide normative information for the production of MCs, and evaluate the sample distribution relative to the normal probability distribution. With this information, readers can determine the adequacy of normative characteristics of the sample to inform their assessment. We established MC lists by identifying every relevant concept (or candidate MC) produced by a large sample of control speakers, followed by application of the 33% cutoff threshold used previously to determine which concepts populated our final MC lists (Richardson & Dalton, 2016). The procedures we report here exactly replicate those previously reported, with the same set of participants (except for the five participants previously discussed), and all samples were collected at a single time point for each participant, providing maximum consistency across the different tasks and manuscripts.

### Existing checklists

There are proposition checklists currently in existence for Cat in the Tree (Capilouto et al., 2005; Hameister & Nickels, 2018; Rivera et al., 2017; Wright et al., 2005) but not for Refused Umbrella. At first glance, the Capilouto et al. (2005) and Wright et al. (2005) ME list appears dissimilar because it contains only four events, but this divergence is largely due to the difference between the number of verbs allowed in an ME (multiple) versus MC (single), and also to the goal of the ME, which is to capture relationships between essential elements, characters, and/or events. For example, the ME, "The man tried to get the cat, but his ladder fell, and now he's stuck", includes MCs five and six from our list. While there is a great deal of overlap between these lists, there are several concept exclusions from the ME list (e.g., dog barking, the girl riding a tricycle, or someone calling the fire department) that may reflect the method of generating lists (investigator-generated) and/or the goal of the ME (relationships).

There are several MCs on the Rivera et al. (2017) list ($n$ = 12) and the Hameister and Nickels (2018) list ($n$ = 10) that either are not represented in our sample (e.g., "The girl is trying to get the cat back"; "The bird is singing") or do not map exactly onto our MCs (e.g., "The little girl was riding her bicycle" versus "Any plausible mention of the girl"). These differences could be related to several methodological factors, such as sample size, sample composition, cutoff threshold, and/or consensus decisions regarding inclusion, particularly those MCs that might be related to setting, motivation, etc. for the Rivera et al. list. There are also several MCs on our list that are further subdivided into separate MCs for other lists. For example, MC 9 from our list reads as "The fire department comes with a ladder", as over 66% of our sample produced all three elements as a single concept and within an utterance. However, both Rivera et al. and Hameister and Nickels divided these into two separate concepts, one in which the fire department (or brigade) comes or arrives, and the other in which the fire department (or brigade) has a ladder.

### Clinical use

The MC checklists presented in this report were written in such a manner to be used alongside Appendix 1 in Nicholas and Brookshire (1995), in which detailed instructions regarding accuracy and completeness decisions are provided to facilitate reliable scoring. We denote in our

appendices which elements are essential and we also include nonessential content when applicable to promote reliable identification of concepts. We also provide alternative wording whenever possible. These checklist aspects are necessary for accurate coding, and the coding system is perhaps one of the most important components of MCA, as several investigations suggest that the presence and frequency of error codes (e.g., AI, IC, and II) may be the critical information needed to distinguish between typical and clinical populations (e.g., Kong, 2009; Nicholas & Brookshire, 1995; Richardson & Dalton, 2016; Ulatowska et al., 1981). Accordingly, these codes may also be useful for tracking recovery and treatment-induced change.

Refused Umbrella is unique among the AphasiaBank semi-spontaneous discourse tasks because, of the five tasks, it frequently involved speakers assuming the role of one or both characters in the picture scene and/or using reported speech (e.g., "The mother said, '[insert quoted content]'" or "The mother said that [insert content]"). This often involved shifts in tense and of person that could lead to occasional difficulty with identification or coding. We include a statement about this in the appendix to alert readers as to how this might impact MC identification.

## Limitations and future directions

Because the methods used in this report are replicated from Richardson and Dalton (2016), the previously reported limitations are replicated as well. Chiefly, while the overall sample of 92 participants is large, each age group only contains 23 participants, which is smaller than the recommended sample of >50 per group for stratification (Mitrushina, Boone, Razani, & D'Elia, 2005). In addition, the sample is slightly skewed for the variable sex, with more females than males, and is not racially or ethnically diverse, indicating that these results may not be appropriate for all races and ethnicities. With regard to the latter, it will be exciting to monitor the continued work by Rivera et al. (2017) in bilingual speakers.

An interesting addition to MCs contributed by Hameister and Nickels (2018) is consideration of the order that MCs are introduced in the narrative, which could perhaps serve as a surrogate measure of story grammar, or as authors assert, might assist with identification of conceptualization deficits. They calculated a Difference-in-Order (DIO) ratio to determine differences in order of MC attempts between PWAs and healthy controls, but only observed differences in DIO in a small subset of PWAs (9/50) compared to typical speakers. MC order can be gleaned from the checklists presented here (and also in Richardson & Dalton, 2016), as the MCs are consecutively numbered and reflect the order in which the majority of our sample produced them. The utility of measures involving MCs, such as MC order or MC/min (Kong, 2009), for PWAs, as well as for other populations that might experience cognitive-communication deficits (as in TBI), should be explored further.

The MCA approach reported here reduces the amount of data to be analyzed in a given sample, critical for increasing clinical utility. However, this also means that some language output (e.g., relevant statements that are not MCs, "meta" utterances about the task or performance) is ignored. Relatedly, PWAs use more, and more varied, gestures than control speakers, often in place of spoken words; further, gesture use differs by aphasia type (Sekine & Rose, 2013). Complementing MCA with measures of coherence, story grammar, efficiency, and/or listener perceptions, and allowing for gestural productions, would tap into this ignored output and provide a more comprehensive understanding of an individual's communication ability.

It is generally accepted that discourse measures are theoretically defensible; it is also generally accepted that they lean more subjective than objective and lack adequate psychometric data (e.g., Bryant, Ferguson, & Spencer, 2016; Dietz & Boyle, 2018; Linnik, Bastiaanse, & Hohle, 2016; Pritchard, Hilari, Cocks, & Dipper, 2017). There is recent and repeated emphasis regarding the need for psychometrically robust discourse measurements, especially as functional communication measures, including discourse, are viewed as primary outcome measures (Brady, Kelly, Godwin, Enderby, & Campbell, 2016) and some traditional surrogates may not correlate with discourse for all aphasia subtypes (e.g., Richardson et al., 2018). Further, to avoid exclusion from future versions of promising core outcome sets that will facilitate comparisons across studies (e.g., Wallace, Worrall, Rose, & Le Dorze, 2014), a speedy advancement of this fund of knowledge is critical. A viable plan would involve building upon standardized protocols such as the Nicholas and Brookshire protocol (1993b), AphasiaBank protocol (MacWhinney et al., 2011), and/or Curtin University Discourse Protocol (Whitworth, Claessen, Leitão, & Webster, 2015) to generate robust psychometric data for a restricted set of discourse measures most predictive of functional communication activities of daily living.

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## Disclosure statement

No potential conflict of interest was reported by the authors.

## Supplementary material

Supplemental data for this can be accessed here.

## Appendices

### Appendix 1. Main Concepts for Cat in the Tree

Essential information is ***italicized and bolded***. Each essential segment is numbered (superscript) with alternative productions (if any were produced) listed by number below. These alternative productions are not intended to be an exhaustive list but represent some of the more common productions of the normative sample and are included to aid in scoring. Additional, but non-essential, information often spoken to complete the main concept is in normal font.

1. [1]***The little girl*** [2]***was riding*** [3]***her bicycle***.
    - 1.1. She (if appropriate referent), the girl, the child, any girl's name
    - 1.2. Rode, rides, was on, is playing on, stopped riding, got off, was beside, has
    - 1.3. Bike, tricycle, trike, it (if appropriate referent)

†† 2. [1]***The cat*** [2]***was in*** [3]***the tree*** because the dog chased it.
    - 2.1. Kitty, kitten, it (if appropriate referent), any cat name
    - 2.2. Was up, was stuck in, got stuck in, climbed up, ran up, goes up, gets in, was caught in, ends up in, was on, was chased up, was scared up

2.3. The tree limb, limb

Note: Sometimes expressed as "The dog [2]***chased*** [1]***the cat*** [3]***up the tree.***" or "The girl [2]***saw*** [1]***the cat*** [3]***in the tree***."

† 3. [1]***The dog*** [2]***was barking*** up the tree.

3.1. It (if appropriate referent), puppy, pup, any dog name

3.2. Barks, is barking, barked, is yelping

Note: "The dog chased the cat" should not apply to this statement as it was a separate relevant concept that did not meet threshold but was occasionally combined with additional elements that could apply to MC2 above.

†† 4. [1]***The man*** [2]***climbed up*** [3]***the tree***.

4.1. The neighbor, the father, dad, daddy, someone older, big brother, he (if appropriate referent), any man's name

4.2. Was climbing, climbed, climbs, ran up, goes up into, got up on, crawls in/on

4.3. The branch, the limb, the ladder, it (if appropriate referent), there

† 5. [1]***The man*** [2]***tries to rescue*** [3]***the cat***.

5.1. See 4.1

5.2. Wants to help, wants to rescue, tries to get, attempts to get, tries to reach, goes to get, tries to retrieve, went up after, comes to rescue

5.3. See 2.1

Note 1: Frequently combined with MC 4 as in "The man climbed up the tree to get the cat."; a person who says this should receive full credit for MCs 4 and 5.

Note 2: Occasionally combined with MC 7 as in "He's stuck in the tree trying to get the cat."; a person who says this should receive full credit for MCs 5 and 7.

† 6. [1]***The ladder*** [2]***fell down***.

6.1. It (if appropriate referent)

6.2. Is down, falls, fell, has fallen, has fallen down, got away from him, is on the ground, has slipped away, has dropped away, fell off, has been knocked down

Note: Sometimes expressed with an agent that caused the ladder to fall, such as the wind or dog (e.g., "the dog knocked the ladder down").

† 7. [1]***The father*** [2]***is stuck*** [3]***in the tree*** with the cat.

7.1. See 4.1, the man and the cat, they (if appropriate referents)

7.2. Is up, is, is stranded, is caught, ended up, is marooned, is sitting

7.3. On the branch, on the limb, up there

Note: Sometimes expressed as: "[1]***The man*** [2]***couldn't*** [3]***get down***."

†† 8. [1]***Someone*** [2]***called*** [3]***the fire department***.

8.1. The mother, the neighbor, the lady next door, the girl, the father, a passerby, an onlooker, he/she/they

8.2. Notifies, alerts, got

8.3. The firemen, 911

Note 1: Sometimes expressed as a passive such as: "[3]***The fire department*** [2]***has been called***."

Note 2: For this concept, a pronoun without a preceding referent is scored as AC since this action is not depicted in the picture stimuli.

†† 9. [1]***The fire department*** [2]***comes*** [3]***with a ladder***.

9.1. The firefighters, the firemen, the fire truck, they (if appropriate referent or if includes ladder or other context so that the referent is not ambiguous)

9.2. Is on the way, is/are coming, came, have arrived, rushes out, brings

Note 1: Sometimes combined with MC 8 as in "The mother called the fire department to come with their ladder." A person who says this should receive full credit for MCs 8 and 9.

Note 2: While the first two essential elements met 66% threshold, the final element "with a ladder" was only produced by 33% of the sample.

†† 10. [1]***The fire department*** [2]***rescues*** [3]***them***.

10.1 See 9.1 (but not fire truck)

10.2. Saves, is going to get, helps, gets, will take

10.3. The man, the cat, the man and the cat

Note 1: Often combined with MC 9 as in "The fire department comes with a ladder to rescue them." A person who says this should receive full credit for MCs 9 and 10.

Note 2: Sometimes combined with MC 8 and MC 9 as in "The mother called the fire department to come and rescue the father with a ladder." A person who says this should receive full credit for MCs 8, 9, and 10.

† Indicates concepts produced by 50% of the normative sample

†† Indicates concepts produced by 66% of the normative sample

## Appendix 2. Main Concepts for Refused Umbrella

Essential information is ***italicized and bolded***. Each essential segment is numbered (superscript) with alternative productions (if any were produced) listed by number below. These alternative productions are not intended to be an exhaustive list but represent some of the more common productions of the

normative sample and are included to aid in scoring. Additional, but non-essential, information often spoken to complete the main concept is in normal font.

Healthy control speakers often used reported speech (e.g., one of the characters speaking to the other) in order to tell this story. Main Concepts that are produced as reported speech should be scored for the corresponding concept, even if the reported speech causes the concept to be stated in a different format than that reported below. Additionally, during interactions between the mother and boy, main concepts were often expressed from either character's perspective.

† 1. The mother says [1]***it's going to*** [2]***rain*** today.

1.1. It's supposed to, it might, it's predicted, it looks like, there's a chance

1.2. Sprinkle, drizzle, storm

Note 1: Occasionally produced as "[2]***Rain*** [1]***is in the forecast***."

Note 2: Statements that implied bad weather was on the way e.g. "the weather was looking gray and cloudy outside" do not count towards this MC as it was another relevant concept that did not meet threshold.

Note 3: The statement "It is raining." does not apply to this MC; see MC 5.

†† 2. The mother says [1]***you*** [2]***need to take*** [3]***the umbrella***.

2.1. He (if appropriate referent), the boy, (male name)

2.2. Carry, take, have, need, should have, might need, might want

Note 1: Sometimes produced as a command with the subject implied, e.g., "take this umbrella" these statements were considered AC since English allows the subject to be dropped in a command.

Note 2: Sometimes produced as "[1]***his mother*** [2]***offers*** him [3]***an umbrella***." or similar.

Note 3: Occasionally produced as a question "don't [1]***you*** [2]***want to take*** [3]***this umbrella***?"

Note 4: Sometimes produced "[2]***here is*** [1]***your*** [3]***umbrella***."

†† 3. [1]***The boy*** [2]***(does something to refuse)*** [3]***the umbrella***.

3.1. He (if appropriate referent), the boy, (male name), I (if reported speech)

3.2. Doesn't want, refuses, won't/is not going to take, declines, says no, says he'll be ok without

3.3. It (if appropriate referent)

Note: Occasionally this concept was stated as "He won't do it." in reference to the mother trying to make him take the umbrella, so the action he "won't do" is "take the umbrella" and this should receive an AC as long as the referent is produced.

†† 4. [1]***The boy*** [2]***walks*** [3]***to school***.

4.1. See 3.1, a child

4.2. Goes, leaves, heads, takes off, starts, sets

4.3. Outside, out of the house, out, to/for/towards [location], down the road, off, out of the door, further, forth, down, in the rain

Note: Sometimes the order of elements was switched, e.g., "***[3]Off to school [1]he [2]goes***"

†† 5. ***[1]It [2]is raining.***

5.1. The rain, the deluge

5.2. Starts to pour, starts coming down, is falling, is sprinkling, gets harder, gets heavier, is raining, begins to rain, starts to rain, starts falling, comes, is coming down, starts raining, started sprinkling, started, rained

Note 1: Sometimes produced as a colloquialism, "The sky opens up" or "We have a downpour."

Note 2: Occasionally produced as "Here ***[2]comes [1]the rain***."

Note 3: Do not count utterances about rain "increasing" in severity (e.g., "It starts to rain harder.").

†† 6. ***[1]The boy [2]gets [3]soaking wet***.

6.1. See 3.1

6.2. Is, looks, stands there

6.3. Soaked, drenched, dripping, very wet

Note: Sometimes speakers would use first person (e.g., "***[1]I [2]am [3]all wet***")

†† 7. ***[1]The boy [2]runs [3]back***.

7.1. See 3.1

7.2. Goes, heads, returns, turns around, races, rushes, comes, gets, arrives, shows

7.3. Home, inside

Note: Occasionally combined with MC 6 as in, "The boy runs back soaking wet." A person

who says this should receive full credit for MCs 6 and 7.

8. ***[1]The mother [2]is [3](negative emotional state).***

8.1. The woman, she, the lady, mom

8.2. looks, feels

8.3. unhappy, mad, angry, upset, annoyed, frustrated, concerned, cross, disappointed

Note 1: Sometimes reported as "his mother doesn't look happy."

Note 2: Statements about physical stance/nonverbal expression do not count, e.g., "She's scowling."

Note 3: Occasionally combined with MC 6 and MC 7 as in "When the boy came back home, mom was mad because he was all wet." A person who says this should receive full credit for MCs 6, 7, and 8.

†† 9. ***[1]The boy [2]gets [3]an umbrella***

9.1. see 3.1

9.2. takes, receives, has, asks for, carries, retrieves, picks up, holds

9.3. it (if appropriate referent)

Note: Sometimes produced as "The mother [2]***gives*** [1]***the boy*** [3]***an umbrella***." Or "she ***[2]gave [3]it to [1]him.***" (if appropriate referents).

†† 10. ***[1]The boy [2]goes [3]back to school***.

10.1. see 3.1

10.2. walks, leaves, heads, starts, takes, is, sets forth, proceeds

10.3. out, again, along, back, in the rain, off, on his way, with the umbrella, (leaves) the house, the school bus

Note 1: Sometimes produced as "[3]***Off*** [1]***he*** [2]***goes*** again."

Note 2: Occasionally combined with MC 9, as in "He goes out with the umbrella." A person who says this should receive full credit for MCs 9 and 10.

† Indicates concepts produced by 50% of the normative sample
†† Indicates concepts produced by 66% of the normative sample

Appendix 3. Examples of statements that received each MC code for the discourse tasks

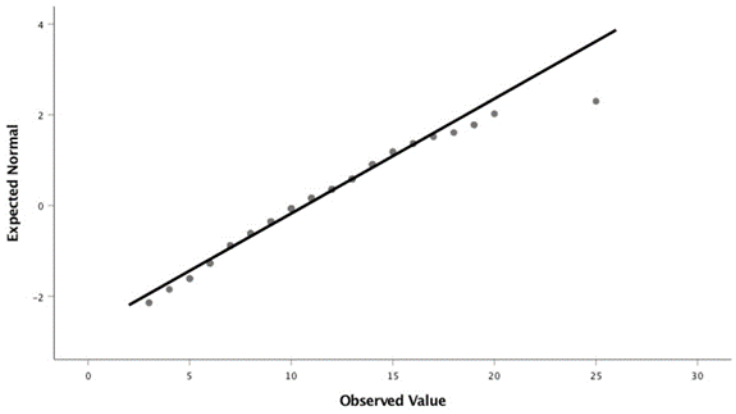
Table

| Cat in the Tree | |
|---|---|
| **[1]*The little girl* [2]*was riding* [3]*her bicycle***. | |
| AC | **"Sally was pedaling her bike around."** |
| AI | **"little girl… bike."**<br>● *No verb is produced.* |
| IC | **"He was riding a tricycle."**<br>● *Incorrect pronoun "he."* |
| II | **"little boy… dirt bike."**<br>● *Incorrect noun use.*<br>● *No verb is produced.* |
| Refused Umbrella | |
| **[1]*The boy* [2]*walks* [3]*to school*.** | |
| AC | **"Timmy headed out to school."** |
| AI | **"and he goes"**<br>● *Clear pronoun referent from previous statement.*<br>● *Omitted essential element "to school."* |
| IC | **"so she goes outside."**<br>● *Incorrect pronoun "she."* |

| | |
|---|---|
| II | **“she runs.”**<br>● *Incorrect pronoun “she.”*<br>● *Omitted essential element “to school”* |

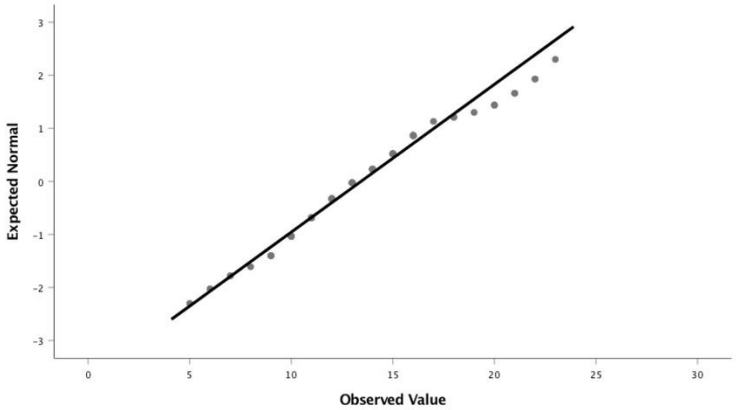
**Supplemental material**

Supplementary Figure 1 – Relevant Concepts




Quantile*Quantile (Q*Q) plots where quantiles (subdivisions of the distribution) of observed values (circles) are plotted against expected values (straight line) for number of relevant concepts produced by all speakers for the Cat in the Tree narrative. Points farther from the line indicate greater deviations from the expected values, and thus, from normal.

Supplementary Figure 1 – Refused Umbrella

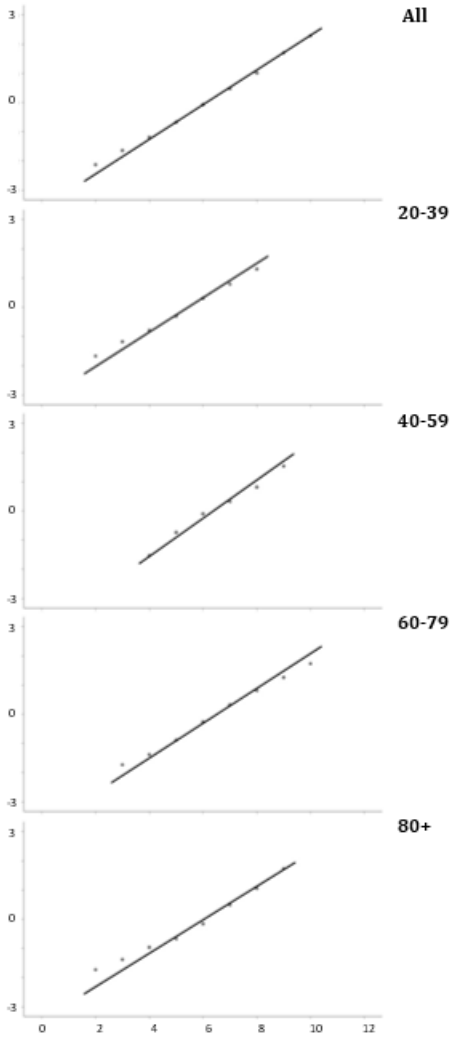



Supplementary Figure 1 – Refused Umbrella

Supplementary Figure 2 – Cat in the Tree

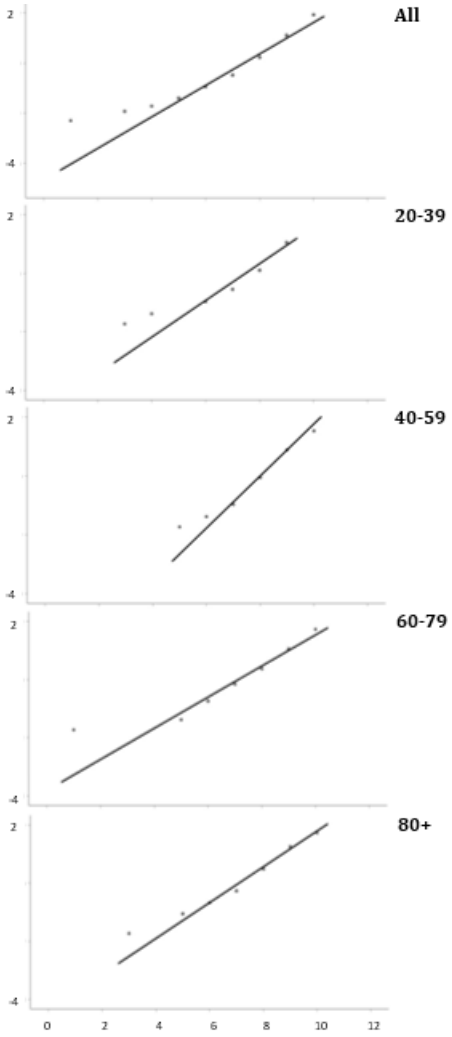
Quantile-Quantile (Q-Q) plots where quantiles (subdivisions of the distribution) of observed values (circles) are plotted against expected values (straight line) for number of Accurate and Complete (AC) main concepts produced by speakers for the Cat in the Tree narrative. From top to bottom, plots are for the entire normative sample, the 20-39 age group, the 40-59 age group, the 60-79 age group, and

the 80+ age group. Points farther from the line indicate greater deviations from the expected values, and thus, from normal.




Supplementary Figure 3 – Refused Umbrella

Quantile-Quantile (Q-Q) plots where quantiles (subdivisions of the distribution) of observed values (circles) are plotted against expected values (straight line) for number of Accurate and Complete (AC) main concepts produced by speakers for the Refused Umbrella narrative. From top to bottom, plots are for the entire normative sample, the 20-39 age group, the 40-59 age group, the 60-79 age group, and the 80+ age group. Points farther from the line indicate greater deviations from the expected values, and thus, from normal.

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# Additional information

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