

1 Not everybody has an inner voice: Behavioral consequences of anendophasia

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Abstract

It is commonly assumed that inner speech – the experience of thought as occurring in a natural language – is both frequent and universal. Recent evidence, however, suggests that the experience of inner speech varies between people, ranging from constant to non-existent. We propose a name for a lack of the experience of inner speech – anendophasia – and report four studies examining some of its behavioral consequences. We found that people who report low levels of inner speech ($N = 46$) have lower performance on a verbal working memory task and have more difficulty performing rhyme judgments compared with people who report high levels of inner speech ($N = 47$). Task switching performance, previously linked to endogenous verbal cueing, and categorical effects on perceptual judgments were unaffected by differences in inner speech.

Statement of Relevance

Most people say that they experience an inner voice, and that this inner voice plays an important role in their daily lives. However, a minority of people report that they do not experience such an inner voice. Until now, it has not been systematically investigated whether these self-reported differences have consequences for how people solve problems and act in the world. In this article, we found that people with less inner speech differed from people with more inner speech on some tasks that we thought would involve inner speech, but not others. It is important to understand such individual differences in inner speech use because it has consequences for how we discuss the role of inner speech generally in areas like mental health, social cognition, and self-regulation.

Keywords: inner speech, rhyme judgments, categorization, task switching, verbal working memory, individual differences

Not everybody has an inner voice: Behavioral consequences of anendophasia

1 Introduction

Everyone, it is often said, has an inner voice, and most of our waking hours are claimed to be filled with inner speech: ‘Daily, human beings are engaged in a form of inner dialogue, which enables them to [engage in] high-level cognition, including self-control, self-attention and self-regulation.’: (Chella & Pipitone, 2020, p. 287); ‘We all hear a voice inside our brain, commonly called “inner voice”, “inner speech” or referred to as “verbal thoughts”’ (Perrone-Bertolotti, Rapin, Lachaux, Baciú, and Loevenbruck (2014), p. 22). Most people do report experiencing inner speech (Alderson-Day & Fernyhough, 2015; Heavey & Hurlburt, 2008; Morin, Duhnych, & Racy, 2018) and because we often assume that our experiences mirror those of others, the majority experience comes to be viewed as universal (Lupyan, Uchiyama, Thompson, & Casasanto, 2023). The assumption that everyone has an inner voice has served as a stepping stone for research into the functions of inner speech – if everyone has it, it must be important. Speculations have ranged from the idea that natural language constitutes (at least some types of) thought (Bermúdez, 2007; Carruthers, 2002; Clark, 1998; Frankish, 2018; Gauker, 2011; Morin, 2018) to investigations of connections between inner speech and specific processes such as cognitive control (Alderson-Day & Fernyhough, 2015; Cragg & Nation, 2010; Emerson & Miyake, 2003; Morin et al., 2018). But not everyone experiences inner speech. This is attested by personal narratives such as ‘What it’s like living without an inner voice’ (Soloducha, 2020); ‘People With No Internal Monologue Explain What It’s Like In Their Head’ (Felton, 2020), as well as more systematic investigations both targeting variation in inner speech (Alderson-Day, Mitrenga, Wilkinson, McCarthy-Jones, & Fernyhough, 2018; Brinthaup, 2019; Hurlburt, Heavey, & Kelsey, 2013) and auditory imagery, which has sometimes been used as a proxy for inner speech (Dawes, Keogh, Andrillon, & Pearson, 2020; Hinwar & Lambert, 2021).

1.1 The Present Study

We recruited participants differing in subjectively reported inner speech and tested them on four behavioral tasks. These tasks were chosen based on prior theoretical claims that suggested performance on them may differ as a function of inner speech. The first is a rhyme judgment task: participants saw pairs of images and needed to indicate whether their names rhyme or not. We reasoned that although participants with low inner speech would have no trouble naming the objects, a lesser reliance on inner speech would make it harder to compare the names in memory – necessary for making a rhyme judgment (Geva, Bennett, Warburton, & Patterson, 2011; Langland-Hassan, Faries, Richardson, & Dietz, 2015). Just as visual imagery has been predicted (and sometimes found) to be linked to visual memory, we tested whether inner speech predicted memory for verbal material. We focused on memory for sets of words that were either phonologically similar and orthographically different or orthographically similar and phonologically different. Less inner speech was predicted to be associated with poorer overall memory for verbal material, but to the extent that phonological similarity creates memory confusion (Baddeley, 1966; Murray, 1968), less inner speech may be associated with a reduced phonological similarity effect. There is substantial evidence that inner speech is often recruited for behavioral control when participants have to switch between different tasks (Baddeley, Chincotta, & Adlam, 2001; Emerson & Miyake, 2003; Miyake, Emerson, Padilla, & Ahn, 2004). For example, when asked to switch between adding and subtracting numbers, participants show a selective impairment if they undergo articulatory suppression, but no such impairment is found if the cues are exogenously provided (e.g., a symbol or color cue is used to inform participants whether they should add or subtract) (see Nedergaard, Wallentin, & Lupyan, 2022 for a systematic review of verbal interference effects). We reasoned that people who do not habitually use inner speech might be selectively impaired when they have to rely on self-generated cues. On the other hand, it is possible that they have learned to rely on other strategies in which case no difference would be found. Our fourth task involved examining category effects in perception. There is considerable evidence that language induces more categorical

representations from basic perception onward (Forder & Lupyan, 2019; Perry & Lupyan, 2014; e.g., Winawer et al., 2007). In a study examining the effects of conceptual categories, Lupyan, Thompson-Schill, and Swingley (2010) showed that controlling for visual differences, people’s ability to tell whether two stimuli were physically the same was affected by the categorical status of those stimuli. For example, it took longer to distinguish two cats than an equally visually similar cat and dog. We wondered whether such category effects, insofar as they may be in part induced by feedback from verbal labels, may be reduced in people with less inner speech.

2 Open Practices Statement

The experiment code and materials, data, and analysis scripts for the present study are publicly accessible at <https://anonymous.4open.science/r/anendophasia-6F15>. The present study was not preregistered.

3 Methods

3.1 Participants

We recruited participants online who had previously completed the Internal Representations Questionnaire (Roebuck & Lupyan, 2020) as part of unrelated studies, contacting participants with verbal factor scores < 3.5 (bottom 16%-ile) or > 4.25 (top 40%-ile) on the Verbal factor of the questionnaire which is largely centered on propensity to experience and rely on inner speech. For example, one item with a high loading on the Verbal factor was ‘I think about problems in my mind in the form of a conversation with myself’. One item with a high loading on the Visual factor was ‘I often enjoy the use of mental pictures to reminisce’. The percentile cut-offs were asymmetric because it was more difficult to recruit participants reporting low levels of inner speech, and because the distribution in verbal scores on the IRQ is negatively skewed. Recruiting for example the top and bottom quartiles would have resulted in a “low inner speech” group who had moderate amounts of self-stated inner speech. We received ethical approval from [redacted]. Ten participants were excluded for responding randomly, missing at least one

experiment, or clearly not complying with task instructions. Our final sample included 47 participants with relatively high verbal factor scores on the IRQ and 46 participants with low verbal factor scores. The two groups were balanced in terms of age, gender, education level, dyslexia, and first language. See Table 1. Due to a technical error, demographic data for one participant with less inner speech was missing. We were interested in detecting medium-to-large effects. Our sample size allows us to detect effect sizes of approximately .6 at 80% power or .7 at 91% power.

Table 1

Comparisons of demographic characteristics of the group with more inner speech and the group with less inner speech.

Measure	More inner speech	Less inner speech	Test for difference
Age	Median = 37; range = 18-67	Median = 39; range = 18-70	$t(88.43) = -0.19; p = .85$
Gender	22 female, 25 male	19 female, 26 male	$\chi^2(1) = 0.05; p = .82$
Native English-speaker	47 native speakers, 0 non-native speakers	41 native speakers, 4 non-native speakers	$\chi^2(1) = 2.49; p = .11$
Dyslexia	46 non-dyslexic, 1 self-diagnosed	44 non-dyslexic, 1 self-diagnosed	$\chi^2(1) < 0.01; p = 1$
Education level	12 high school diploma, 14 some college - no degree, 6 associate's degree, 14 bachelor's degree, 1 master's degree	1 less than high school, 8 high school diploma, 7 some college - no degree, 11 associate's degree, 2 bachelor's degree, 2 master's degree, 2 PhD, law, or medical degree	$t(84.46) = -0.23; p = .82$

3.2 Method: Verbal working memory

3.2.1 Materials and procedure. We used word sets from Baddeley (1966) which were designed to vary in phonological and orthographic similarity, while holding constant other psycholinguistic factors. The phonologically-similar set contained the words “bought”, “sort”, “taut”, “caught”, and “wart”. The orthographically similar set contained the words “rough”, “cough”, “through”, “dough”, and “bough”. The control set contained the words “plea”, “friend”, “sleigh”, “row”, and “board”. On a given trial, participants saw five written words in random order from one of the sets. The words were

presented sequentially, see Figure 1. After the last word, participants were asked to type the five words they just saw in the order they saw them. Participants began the task by completing two practice trials with full feedback (correct/incorrect and the stimulus words – drawn from a different set than the ones used in the real experiment – shown in order). Participants then performed 24 trials in total with eight trials from each of the three word sets. The order of both set type and words within a trial were randomized. There was no limit to how long participants could spend on reproducing the words on a given trial.

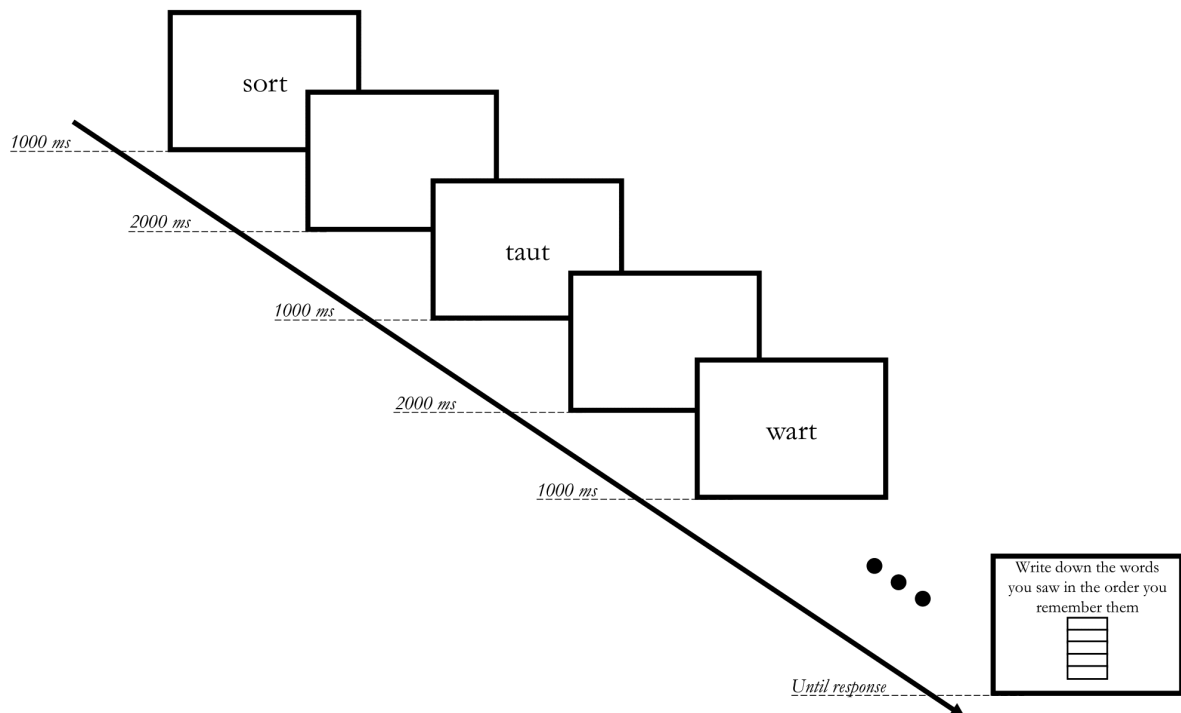


Figure 1. A schematic of the procedure in the verbal working memory experiment. In this example, the words are drawn from the phonological similarity set. Participants saw five words on each trial - three words are presented on the figure for ease of interpretation.

3.3 Method: Rhyme judgments

3.3.1 Materials and procedure. We constructed a set of rhyme pairs with 20 orthographic pairs (e.g., “sock” and “clock”) and 20 non-orthographic pairs (e.g., “drawer” and “door”). See Appendix A for the full set of images, associated words, and name agreement scores. The images were selected from the MultiPic database (Duñabeitia et al., 2018) and from Rossion and Pourtois (2004) because those image sets contained simple images (objects with no background) that had relatively high name agreement and represented the words we selected for the rhyme pairs. On each trial, participants saw two images of items presented simultaneously and were asked to judge whether the names of the items rhymed or not. Participants completed 60 rhyme judgments in randomized order (20 orthographic rhymes, 20 non-orthographic rhymes, and 20 no-rhyme control trials). There was a 5000 ms response deadline. See Figure 2.

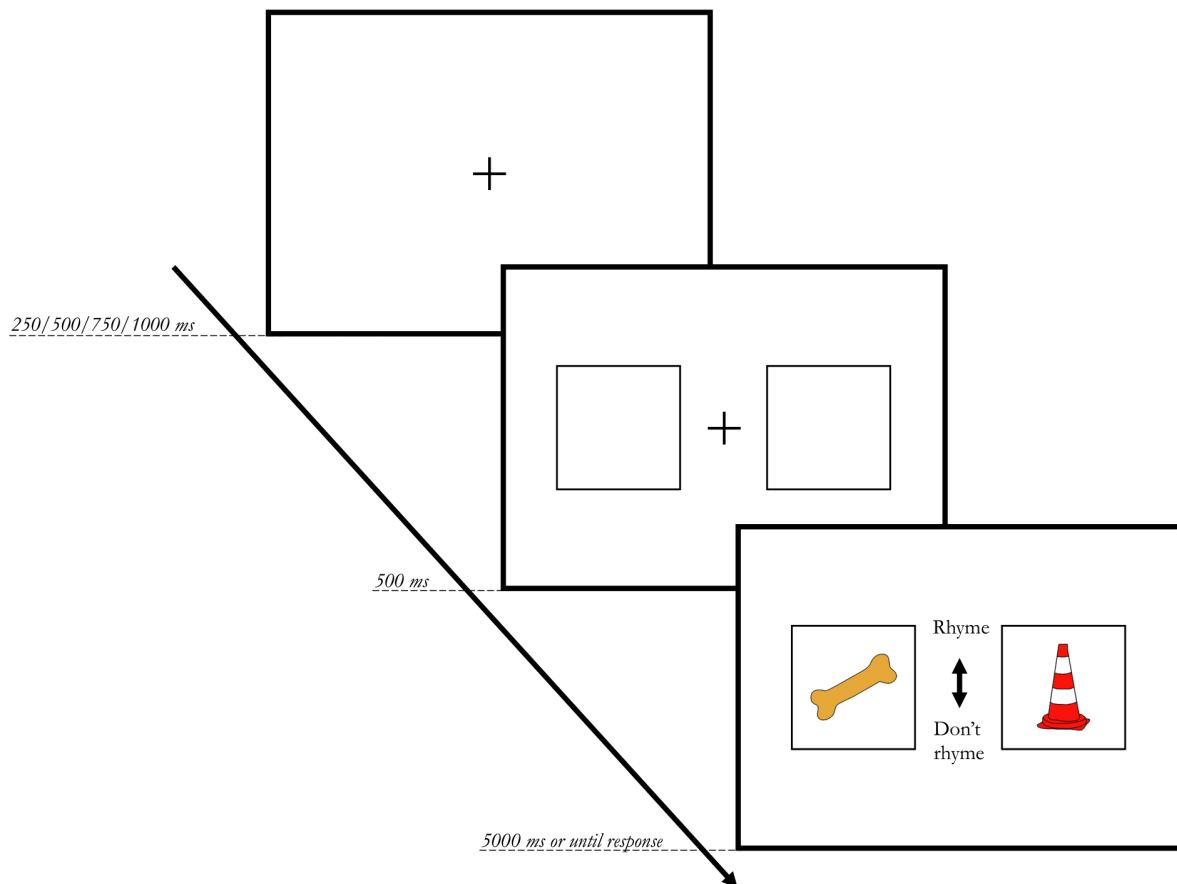


Figure 2. A sketch of a rhyme judgment trial. The stimuli here exemplify an orthographic rhyme – "bone" and "cone" – and the correct answer would therefore be "Rhyme".

3.4 Method: Task switching

3.4.1 Materials and procedure. On each block, participants were shown 30 randomly selected integers between 13 and 96 and asked to add or subtract 3 from each. All participants completed five blocks beginning with blocked addition or blocked subtraction, followed by (in a counterbalanced order) a block where problems alternated between addition and subtraction with the operation marked by color (red/blue), marked with a symbol (+/-), or not marked. The unmarked block required participants to remember which operation they had just done. In the switching conditions, a response counted as correct if it was the correct arithmetic and if the operation was switched from the previous trial (from addition to subtraction or vice versa). See Figure 3.

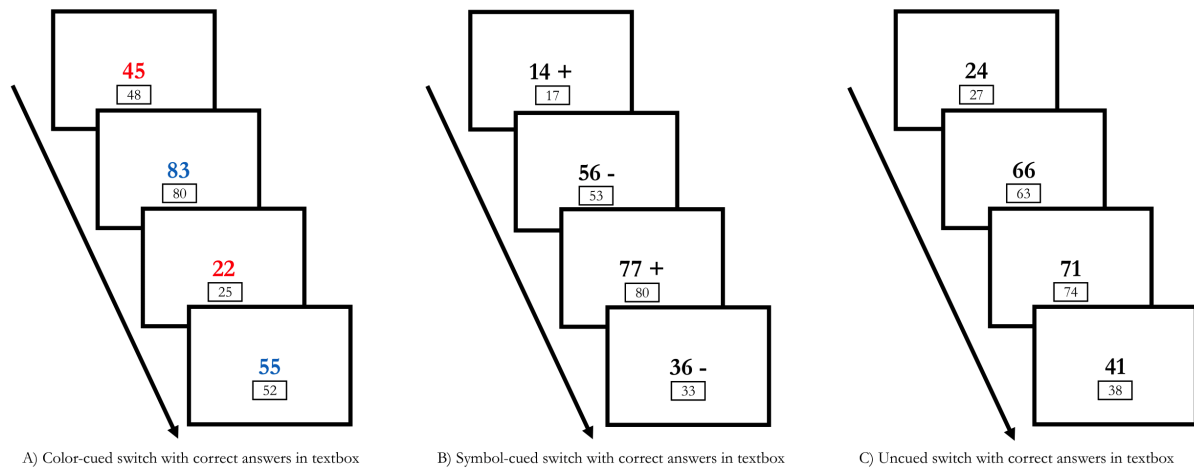


Figure 3. A sketch of the three switched conditions in the task switching experiment. Figure A shows four color-cued switch trials with correct answers, Figure B shows four symbol-cued switch trials with correct answers, and Figure C shows four uncued switch trials with correct answers.

3.5 Method: Same/different judgments

3.5.1 Materials and procedure. This experiment used three different black silhouettes of cats and three different black silhouettes of dogs. Participants completed two blocked conditions: making physical identity judgments (same means physically identical) and making category judgments (same means same category). We are only interested in the physical identity judgments here. Participants completed 200 total trials and received feedback after incorrect responses ('incorrect' in red font). See Figure 4.

3.6 Method: Questionnaire

After completing the four experiments, participants answered a series of questions about their experience with inner speech (e.g. 'How often do you have songs stuck in your head?' and 'Do you ever rehearse a conversation before you have it in real life where you simulate what you will say and how the other person will respond?') and completed the Varieties of Inner Speech Questionnaire-Revised (VISQ-R) (Alderson-Day et al., 2018). See Supplemental Materials for the full set of custom questions.

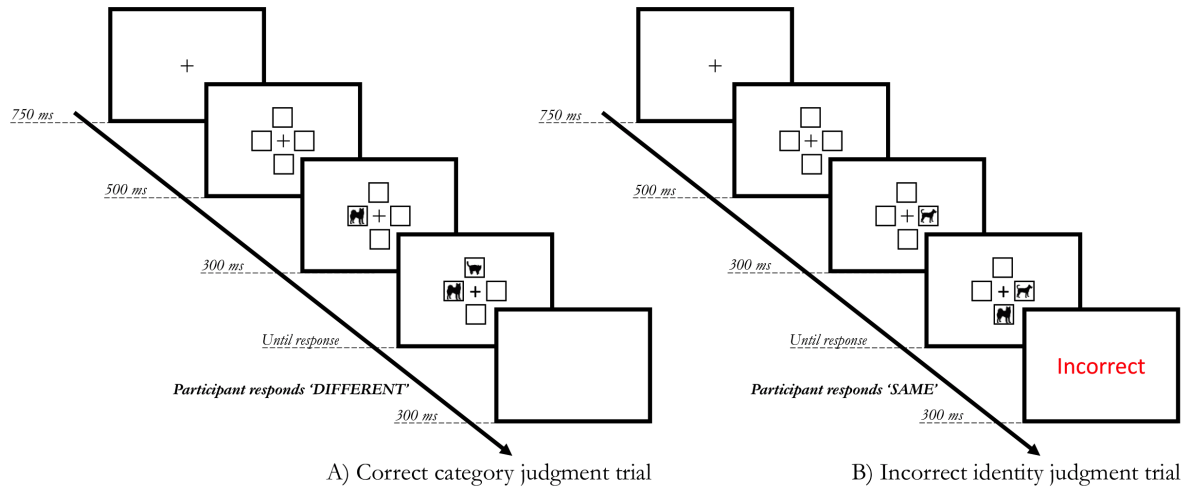


Figure 4. A sketch of the two conditions of the category judgment experiment. On Figure A, we see a correct category judgment trial where the participant responds that the cat and dog silhouettes represent different animals. On Figure B, we see an incorrect identity judgment trial where the participant responds that the two dogs are identical.

3.7 Data analysis

All analyses were conducted in R version 4.1.3 (R Core Team, 2022). Participants and items (where appropriate) were modeled as random intercepts; random slopes were included for within-subject factors unless it prevented convergence. All predictors were centered. Reaction times were log-transformed to yield a more normal distribution. Accuracies were modeled using logistic regression. For ease of interpretation, the figures show the two inner speech groups as distinct but all the statistical models use verbal score (average score on the verbal representation items on the Internal Representations Questionnaire) as a continuous predictor. Error bars on all figures represent within-participant 95% confidence intervals around the mean (adjusted for repeated measures). All four experiments were conducted using custom-written software with the JavaScript package jsPsych version 6 (De Leeuw, 2015), and data and code can be found at <https://anonymous.4open.science/r/anendophasia-6F15>.

4 Results

4.1 Verbal working memory

4.1.1 Descriptive statistics by group: Verbal working memory.

Participants with more inner speech recalled more words correctly. This advantage was evident both when we scored only correctly ordered responses as correct as well as when we scored correctly recalled items regardless of their position (see Table 2 and Figure 5).

Table 2

Descriptive statistics by group in the verbal working memory experiment.

Group	Word set	Score (item and position)	95% CI (item and position)	Score (item only)	95% CI (item only)
More inner speech	Control set	4.19	0.13	4.51	0.08
More inner speech	Orthographic similarity set	3.72	0.14	4.18	0.10
More inner speech	Phonological similarity set	3.43	0.16	4.11	0.10
Less inner speech	Control set	3.69	0.15	4.17	0.11
Less inner speech	Orthographic similarity set	3.52	0.15	4.10	0.11
Less inner speech	Phonological similarity set	3.02	0.15	3.81	0.11

4.1.2 Statistical models: Verbal working memory. Participants remembered phonologically similar words significantly worse ($M = 3.22$) than orthographically-similar words ($M = 3.62$) ($\beta = -0.72$; $SE = 0.08$; $t = -8.84$; $p < .001$) which were in turn remembered worse than the dissimilar words ($M = 3.94$) ($\beta = -0.33$; $SE = 0.08$; $t = -3.98$; $p < .001$). Collapsing across the three types of word lists, greater inner speech was associated with better performance ($\beta = 0.27$; $SE = 0.10$; $t = 2.60$; $p = .011$). This effect remained significant when we disregard the recalled order of the words, counting only whether they recalled the correct words ($\beta = 0.19$; $SE = 0.08$; $t = 2.57$; $p = .012$). There were no interaction effects (all $p > .10$), although numerically, the effect of inner speech was smallest for orthographically similar words (see Figure 5).

4.1.3 Strategies: Verbal working memory. There low and high inner speech groups were similar in their reported use of talking out loud as a strategy for remembering the words: 10 out of 47 in the high inner speech group; 13 out of 46 in the

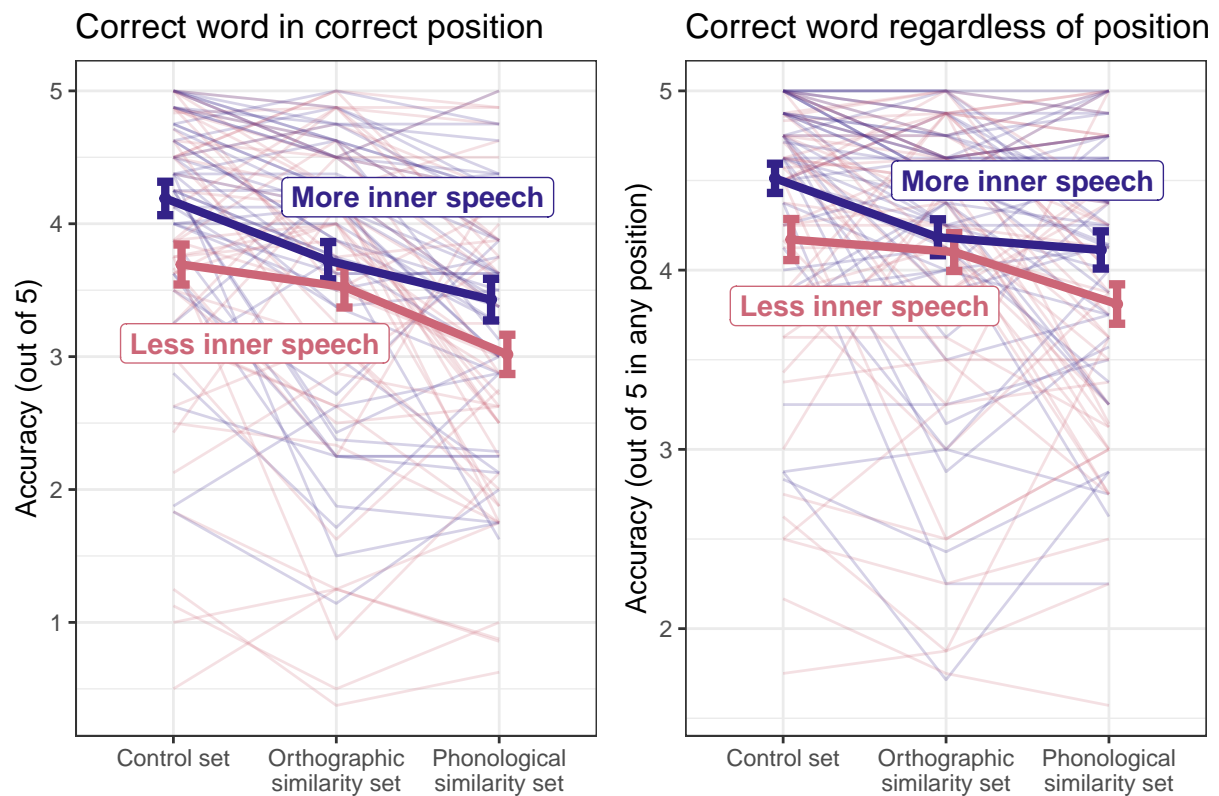


Figure 5. Score on the verbal working memory task by word set.

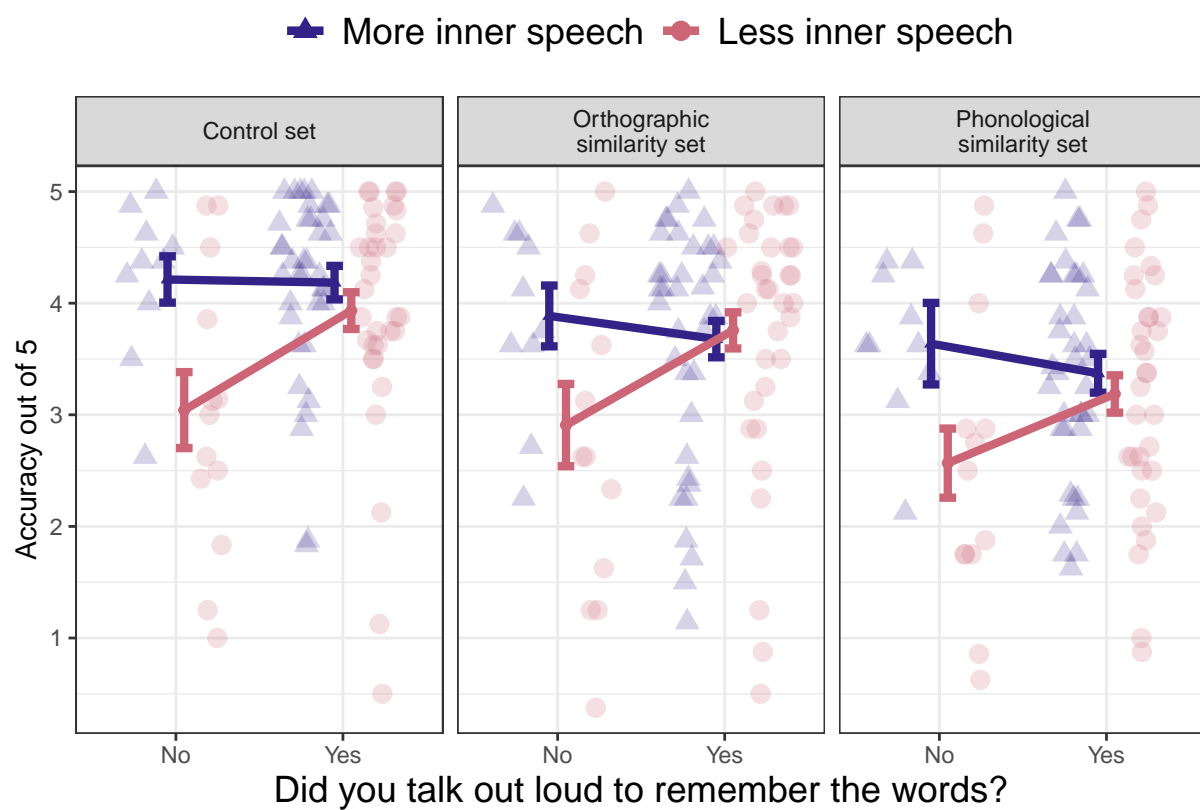


Figure 6. Verbal working memory performance by whether participants reported talking out loud to help them remember or not.

low-inner speech group ($\chi^2(1) = 0.29$, $p = .59$). Nevertheless, talking out loud was associated with performance in different ways between the two groups (see Figure 6). As the figure makes clear, the main effect of inner speech on recall comes almost entirely from participants who do not report talking out loud to help them remember the words (interaction effect: $\beta = -0.50$; $SE = 0.23$; $t = -2.19$; $p = .031$). Using overt language appears to largely offset differences in inner speech, but establishing the causal role of overt speech would require experimentally manipulating it.

4.2 Rhyme judgments

Five image pairs of rhyming objects – bin/chin, cab/crab, rake/cake, wave/cave, and park/shark – were incorrectly judged not to rhyme on at least half the trials where they appeared. This was most likely because participants did not name one or both of the images with the intended names (mean agreement rating for these 10 images = 0.58; range = 0.05 to 1). We therefore excluded these trials from further analysis.

4.2.1 Descriptive statistics by group: Rhyme judgments. Participants who reported having more inner speech were both faster and more accurate than participants who reported having less inner speech on all three types of trials, see Table 3, and Figure 7.

Table 3

Descriptive statistics on rhyming accuracy and reaction time by group and by rhyme type.

Group	Type of rhyme trial	Reaction time (ms)	95% CI (reaction time)	Accuracy	95% CI (accu- racy)
More inner speech	Non-orthographic rhyme	1853	51	82.77	2.86
More inner speech	No rhyme	1931	53	97.52	1.36
More inner speech	Orthographic rhyme	1719	55	91.21	2.48
Less inner speech	Non-orthographic rhyme	1970	54	76.20	3.21
Less inner speech	No rhyme	2024	60	93.84	1.87
Less inner speech	Orthographic rhyme	1859	60	83.62	3.22

4.2.2 Statistical models: Rhyme judgments. Participants took longer to make rhyme judgments on no-rhyme trials ($M = 1981$ ms) compared with orthographic

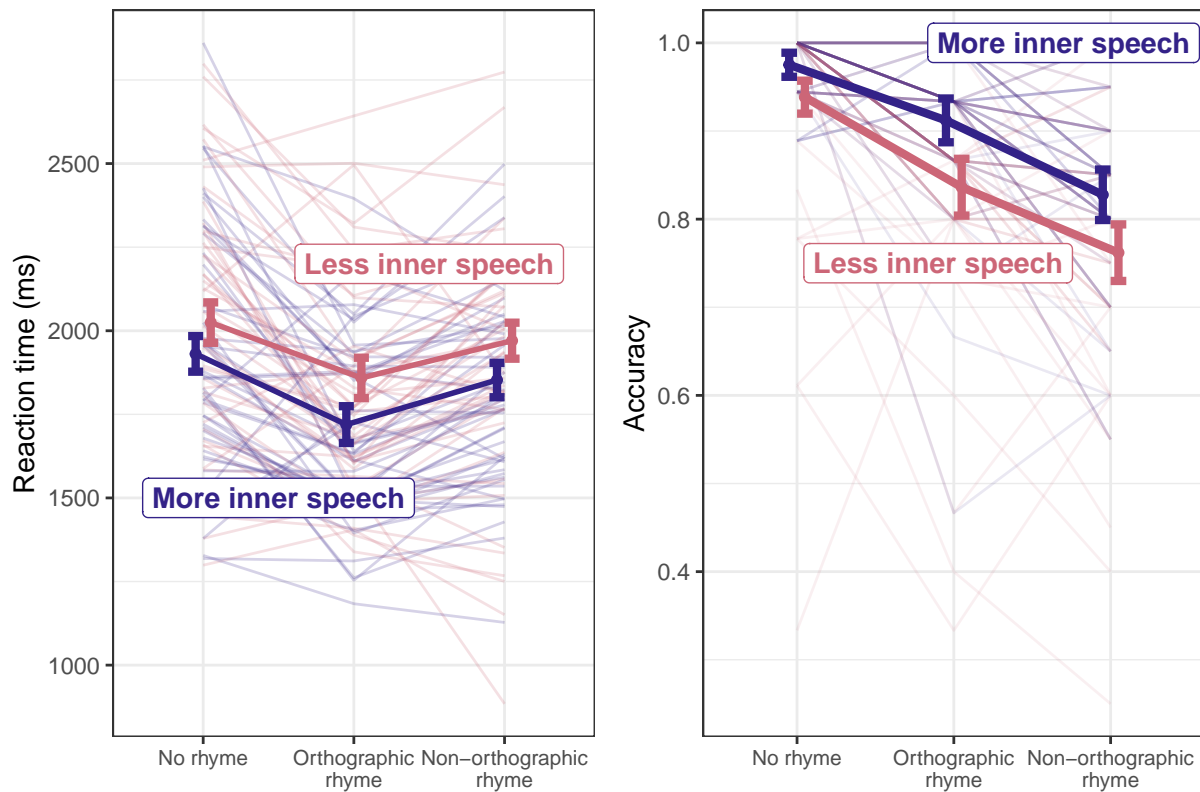


Figure 7. Reaction time and accuracy across groups by rhyme type.

219 trials ($M = 1730$ ms) ($\beta = 0.12$; $SE = 0.04$; $t = 2.97$; $p = .005$). Non-orthographic trials
 220 ($M = 1821$ ms) did not differ significantly from orthographic trials ($\beta = 0.04$; $SE = 0.04$;
 221 $t = 1.11$; $p = .27$). Higher name agreement was associated with faster RTs, ($\beta = -0.04$;
 222 $SE = 0.02$; $t = -2.25$; $p = .029$). Reported inner speech had no effect on speed of rhyme
 223 judgments ($\beta = -0.02$; $SE = 0.02$; $t = -0.81$; $p = .42$). There were no interactions
 224 between rhyme type and inner speech (both p 's $> .29$) or between inner speech and the
 225 effect of name agreement on accuracy ($p > .97$).

226 Participants were more accurate when judging no-rhyme trials as not rhyming (M
 227 $= 95.7\%$) than on orthographic rhyme judgments ($M = 87.5\%$) ($\beta = 1.30$; $SE = 0.29$; $z =$
 228 4.49 ; $p < .001$) and were less accurate on non-orthographic rhyme judgments ($M =$
 229 79.5%) than on orthographic rhyme judgments ($\beta = -0.58$; $SE = 0.26$; $z = -2.18$; $p =$
 230 $.029$). A higher verbal score was associated with a higher likelihood of responding
 231 accurately ($\beta = 0.31$; $SE = 0.12$; $z = 2.57$; $p = .010$). Name agreement was not
 232 correlated with accuracy easier ($p > .13$). There was no significant interaction between

rhyme type and inner speech (both $p > .31$) or between inner speech and effect of name agreement on accuracy ($p = .32$).

4.2.3 Strategies: Rhyme judgments. Asked about their strategies, similar proportions of participants in both groups reported naming the pictures out loud: 23 out of 47 in the higher inner speech group and 21 out of 46 in the lower inner speech group ($\chi^2(1) = 0.01$, $p = .91$). We observed a similar interaction here as with the memory task (Figure 8). Saying the words out loud reduced the accuracy advantage associated with having more inner speech for both non-orthographic rhymes ($\beta = -0.72$; $SE = 0.28$; $z = -2.53$; $p = .012$) and orthographic rhymes ($\beta = -0.69$; $SE = 0.31$; $z = -2.25$; $p = .024$). This result is consistent with participants relying on inner speech. Those who experience it less may need to use overt language to reap the same benefit.

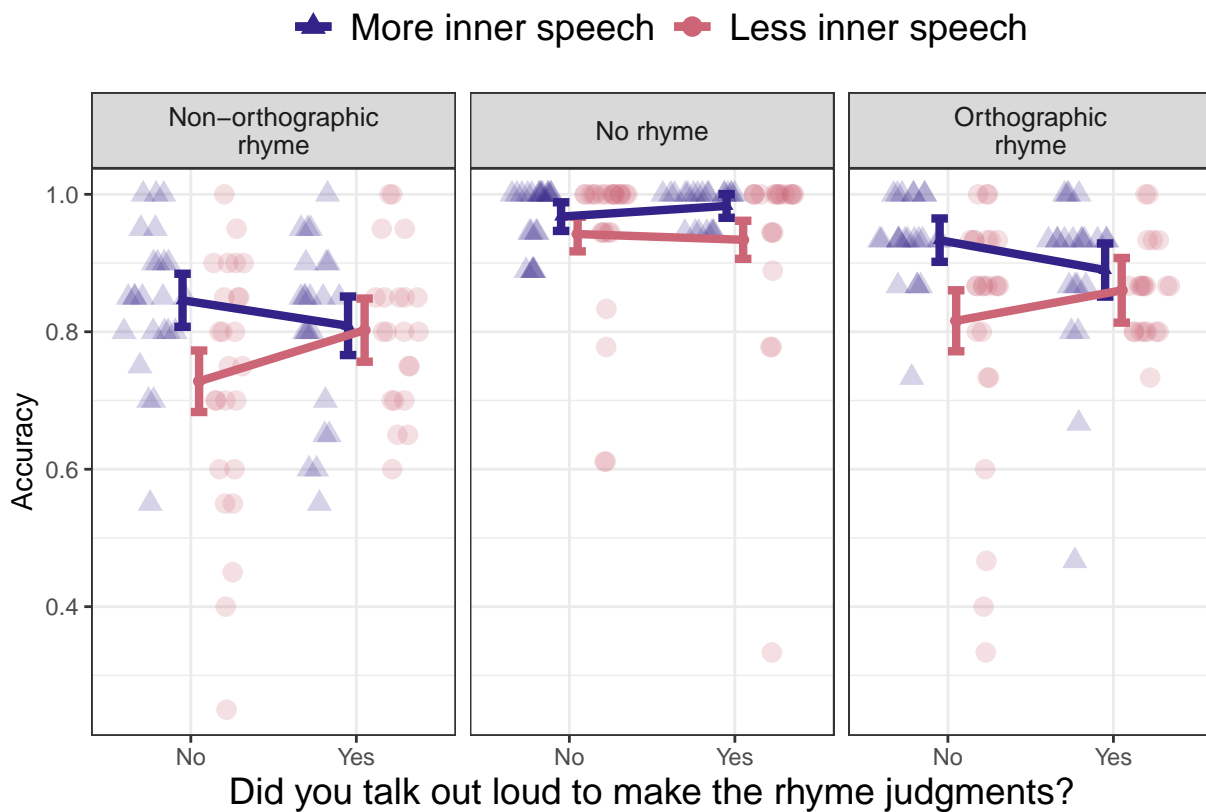


Figure 8. Reaction time and accuracy by whether participants indicated that they had talked out loud to make the rhyme judgments.

4.3 Task switching

We excluded trials over 10 seconds (0.5 % of trials). We also recalculated the accuracy measure so that any trial in the three switch conditions where participants in fact switched between adding and subtracting counted as correct (as long as the arithmetic itself was also correct). We did this to prevent a failure to switch once resulting in the remaining trials counting as incorrect.

4.3.1 Descriptive statistics: Task switching. As can be seen from Table 4 and Figure 9, accuracy was generally quite high in all conditions, and reaction times were comparable across the two groups of participants.

Table 4

Descriptive statistics of reaction time and accuracy on the task switching experiment.

Group	Condition	Mean reaction time (ms)	95% CI (reaction time)	Accuracy	95% CI (accu- racy)
More inner speech	Blocked addition	2287	47	97.94	0.83
More inner speech	Color-cued switch	2775	62	95.64	1.16
More inner speech	Blocked subtraction	2528	54	97.65	0.89
More inner speech	Symbol-cued switch	2564	54	97.72	0.86
More inner speech	Un-cued switch	2679	59	94.59	1.29
Less inner speech	Blocked addition	2312	46	98.32	0.76
Less inner speech	Color-cued switch	2781	63	95.08	1.26
Less inner speech	Blocked subtraction	2573	55	97.80	0.88
Less inner speech	Symbol-cued switch	2640	56	96.72	1.03
Less inner speech	Un-cued switch	2710	64	93.19	1.47

4.3.2 Statistical models: Task switching. Participants responded less accurately in the symbol-cued switch condition ($M = 97.2\%$), in the color-cued switch condition ($M = 95.4\%$), and in the un-cued switch condition ($M = 93.9\%$) compared with the blocked addition condition ($M = 98.1\%$) (addition versus symbol-cue: $\beta = -0.42$; $SE = 0.18$; $z = -2.32$; $p = .020$; addition versus color-cue: $\beta = -0.97$; $SE = 0.17$; $z = -5.84$; $p < .001$; addition versus un-cued: $\beta = -1.27$; $SE = 0.16$; $z = -7.92$; $p < .001$). Accuracy did not differ between blocked subtraction ($M = 97.7\%$) and blocked addition ($p = .24$). More inner speech was not associated with different accuracy ($p = .55$) and there were no

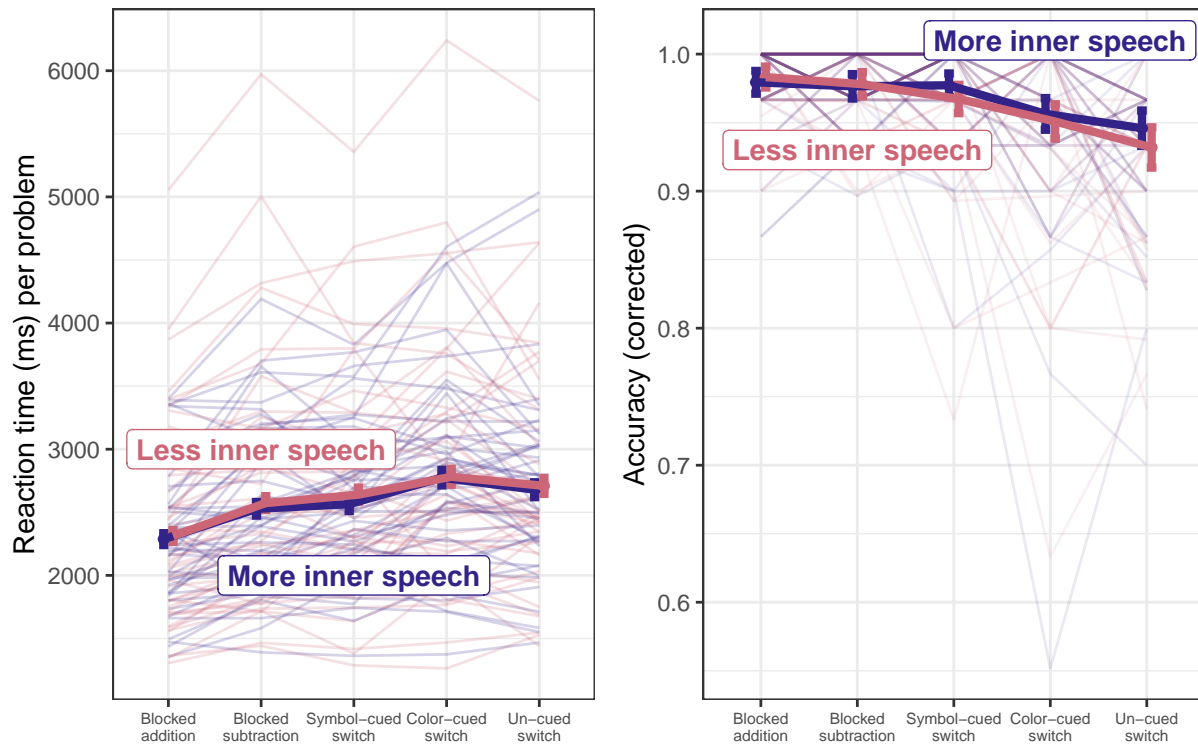


Figure 9. Reaction time and accuracy across conditions in the task switching experiment.

interaction effects between inner speech and block-type (all p 's $> .07$). Numerically, verbal score interacted with the un-cued condition and cancelled out the very slight (non-significant) reaction time advantage of a higher verbal score.

Participants responded faster in the blocked addition condition ($M = 2300$ ms) compared with the subtraction condition ($M = 2550$ ms) ($\beta = 0.09$; $SE = 0.01$; $t = 8.41$; $p < .001$), the symbol-cued switch condition ($M = 2601$ ms) ($\beta = 0.12$; $SE = 0.01$; $t = 9.69$; $p < .001$), the color-cued switch condition ($M = 2778$ ms) ($\beta = 0.19$; $SE = 0.02$; $t = 12.23$; $p < .001$), and the un-cued switch condition ($M = 2694$ ms) ($\beta = 0.15$; $SE = 0.02$; $t = 9.39$; $p < .001$). More reported inner speech did not predict reaction times ($p = .81$), and there were no interaction effects (all p 's $> .51$).

4.3.3 Strategies: Task switching. There was no significant difference between how many participants with more inner speech (20 out of 47) and how many participants with less inner speech (13 out of 46) reported that they had talked to themselves out loud during the task switching experiment ($\chi^2(1) = 1$, $p = .32$). There were no obvious differences between the effects that talking out loud had on these two

276 groups (see accuracy and reaction time Figure 10).

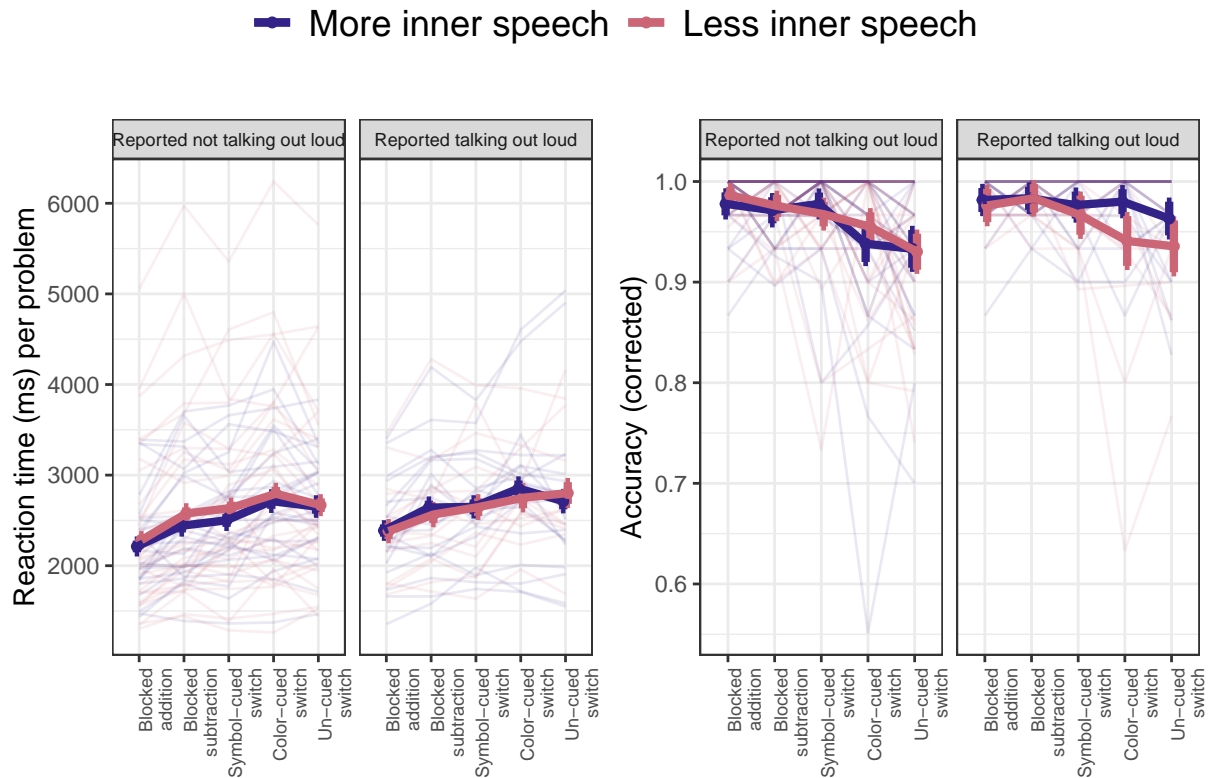


Figure 10. Reaction time (ms) and accuracy in the task switching experiment by whether participants reported talking out loud to remember the correct rule or not.

277 4.4 Same/different judgments

278 We excluded trials with RTs above 5 seconds (0.7 %) and below 200 ms (0.07 %).
 279 Overall accuracy was high, 95.53, and did not differ between the two inner speech groups
 280 (95.58 %) and the group with less inner speech (95.48 %). In subsequent RT analyses, we
 281 only include correct trials.

282 **4.4.1 Statistical models: Same/different judgments.** The key test for
 283 this experiment was whether the two groups behaved differently when giving correct
 284 ‘DIFFERENT’ responses on identity trials when the two images belonged to the same
 285 category. That is, we expected participants with more inner speech to be slower to make
 286 correct ‘DIFFERENT’ responses when both stimuli were from the same category but
 287 physically different (i.e., dog_1 versus dog_2). See Figure 11. However, participants with
 288 more inner speech were not specifically adversely affected by the within-category
 289 interference (interaction effect: $\beta = 0.00$; $SE = 0.01$; $t = -0.06$; $p = .95$). Within-category

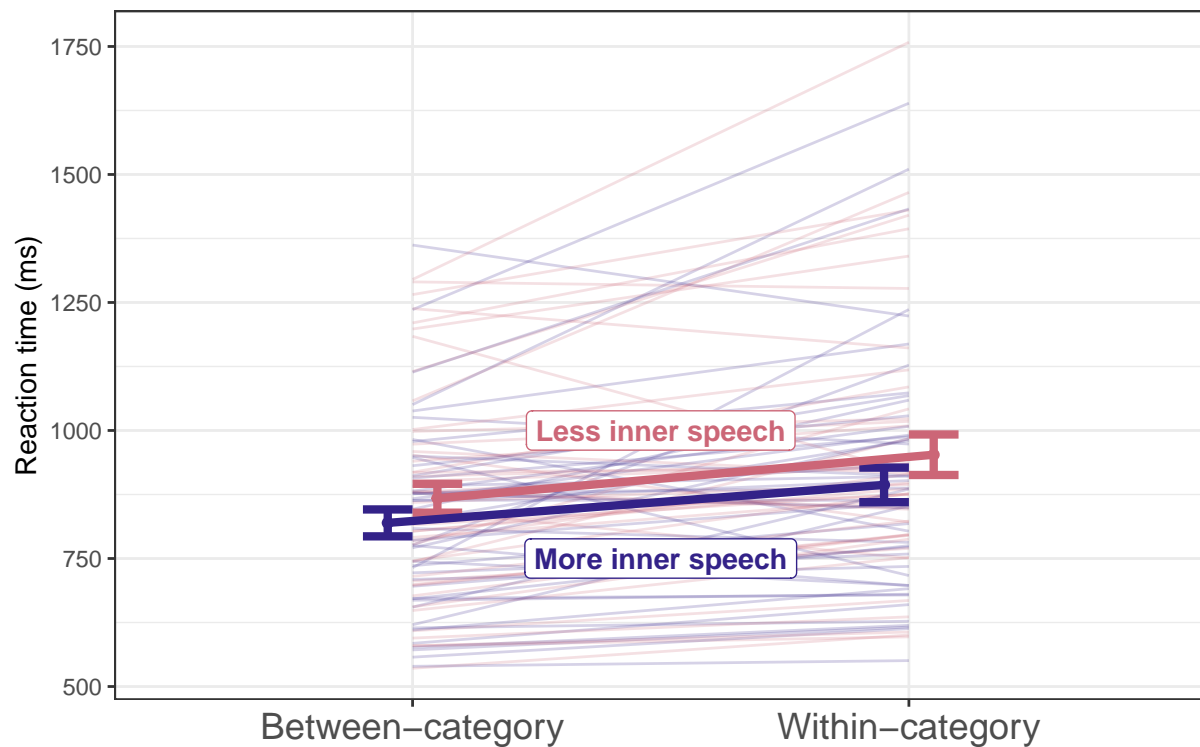


Figure 11. Reaction time on identity trials where the correct response was ‘DIFFERENT’ either because the two silhouettes were from different categories or different images from the same category.

trials were generally associated with significantly slower reaction times ($M = 923$ ms) than between-category trials ($M = 843$ ms) ($\beta = -0.08$; $SE = 0.01$; $t = -7.71$; $p < .001$).

4.4.2 Strategies: Same/different judgments. There was no significant difference between how many participants with more inner speech (9 out of 47) and how many participants with less inner speech (4 out of 46) reported that they had talked to themselves out loud during the task switching experiment ($\chi^2(1) = 1.33$, $p = .25$). There were no differences between the effects that talking out loud had on these two groups.

4.5 Intertask correlations

In addition to finding (or not finding) differences in task performance as a function of inner speech, it is often informative to see whether correlations between tasks and conditions show a different pattern in people with more vs. less inner speech (Keogh, Wicken, & Pearson, 2021). See Figure 12 for a visualization of how performance on the tasks correlated within the participant groups with more or less inner speech.

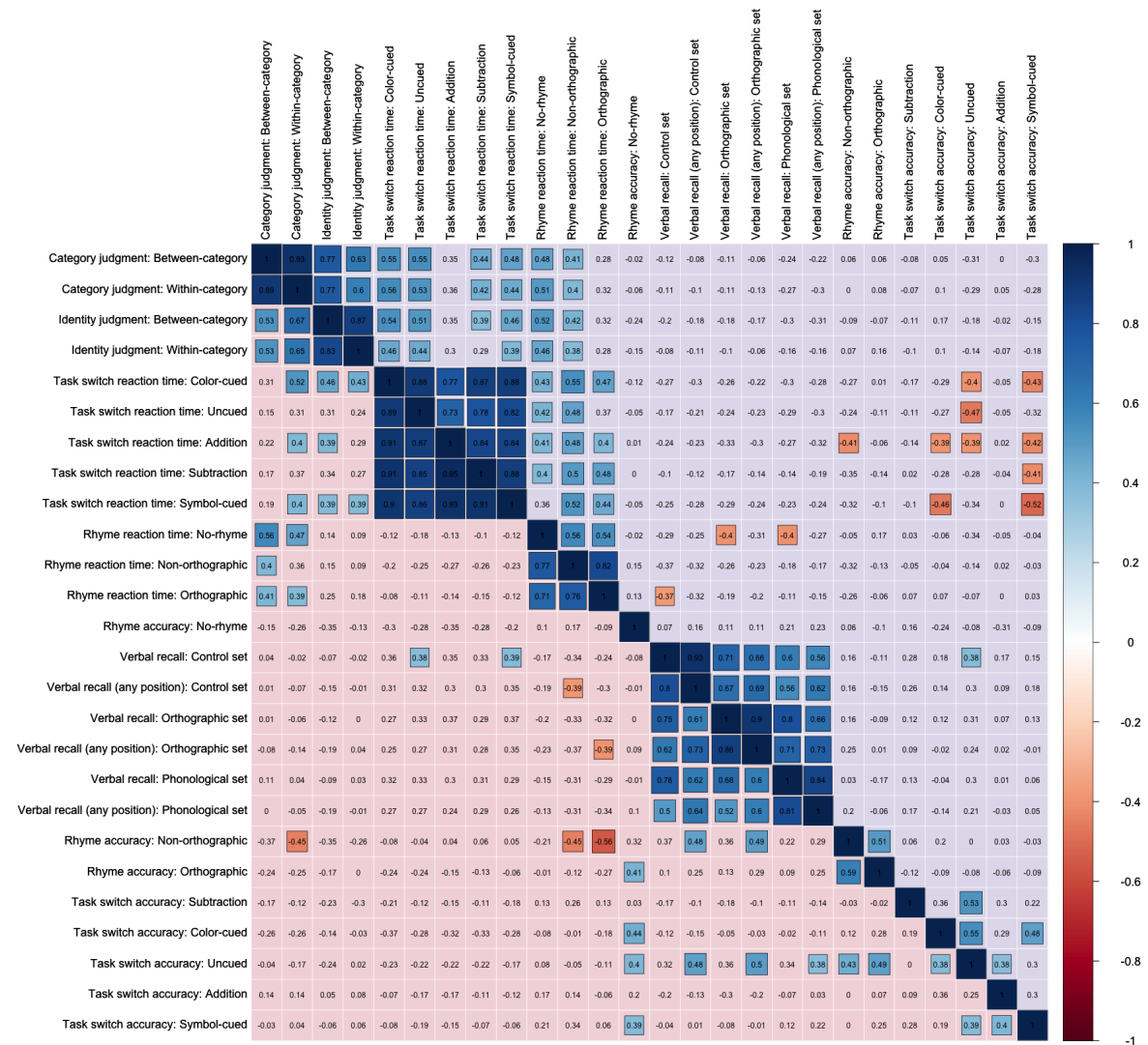


Figure 12. Intertask correlations in the total sample of participants with more and less inner speech. Colored squares represent significant correlations at $p < .01$ which with the given sample size (N less inner speech = 45; N more inner speech = 47) is equivalent to a correlation coefficient of at least $r = \pm .38$. The upper triangle represents intertask correlations for the participant group with more inner speech while the lower triangle represents intertask correlations for the participant group with less inner speech.

Measures within the tasks generally correlated, but we observed different correlations between the tasks for the two participant groups. For example, reaction times on rhyme judgments, task switching, and perceptual discrimination were more

intercorrelated for the group with more inner speech than for the group with less inner speech, suggesting that these relied on similar mechanisms for the former group. Participants with less inner speech showed a positive correlation between accuracy on uncued switch trials and (position-indifferent) verbal working memory and rhyming accuracy, suggesting that these tasks relied on similar mechanisms for this participant group.

4.6 Questionnaire measures

Responses to many of the included questions differed substantially as a function of inner speech¹. For reasons of space, however, we only report a few selected ones here (see Appendix for full results). The questions with the clearest differences concerned rehearsing and revising conversations where the participants with more inner speech reported doing so much more often than the participants with less inner speech did (revise past conversation: $t(87.95) = 5.93$; $p < .001$; practice future conversation: $t(89.33) = 5.33$; $p < .001$). Of the VISQ factors, the IRQ verbal representation score was mostly related to the dialogicality of inner speech ($r(90) = .70$; $p < .001$).

Participants who reported more inner speech estimated that more people generally experience their thoughts in the form of a conversation with themselves ($\beta = 5.08$; $SE = 2$; $t = 2.55$; $p = .013$) and that more people generally hear words in their “mind’s ear” when they read ($\beta = 5.09$; $SE = 2.07$; $t = 2.46$; $p = .016$). They did not, however, estimate that more people were able to see vivid images in their “mind’s eye” ($\beta = 1.17$; $SE = 2.25$; $t = 0.52$; $p = .61$).

5 Discussion

Our study is, to our knowledge, the first to conduct a systematic investigation of whether differences in inner speech have behavioral consequences. Participants who report experiencing less inner speech (our sample targeted those at $< 16\%$ ile of the verbal

¹ Data from one participant was missing so we report questionnaire data from 47 participants with more inner speech and 45 participants with less inner speech.

score on the Internal Representations Questionnaire) performed worse when judging whether the names of two images rhymed, and they had poorer verbal working memory regardless of the material. Interestingly, in both the rhyming experiment and the verbal working memory experiment, performance differences between the two groups disappeared when participants reported talking out loud to solve the problems, suggesting a kind of compensatory mechanism. Inner speech differences did not predict performance in task switching which suggests that while the inner voice can be used as a behavioral self-cue, other and equally effective strategies may be available. Lastly, categorical effects on perceptual discrimination were similar for the two groups suggesting either that the categorical effects in such tasks are not language-based, or that the speeded nature of such tasks makes the use of inner speech unlikely.

5.1 Anendophasia: A Lack of Inner Speech

People’s self-reports cannot always be taken at face value (Heavey & Hurlburt, 2008; Hurlburt, 2011; Hurlburt et al., 2013). But when people report that their experience rarely takes a verbal format, they are not just confabulating. This is evident both in the consistency of their subjective responses (Roebuck & Lupyan, 2020), and, as we report here, differences in objective performance. When investigating unusual human experiences, it helps to have a label. For example, the coining of “aphantasia” to the lack of visual imagery (Zeman et al., 2010) is both helpful for research – providing a useful keyword – and for self-identification; its introduction led to the creation of an online community with over 50,000 members (r/aphantasia). We would therefore like to propose a name for the phenomenon of a lack of inner speech: **anendophasia**: *an* (lack) + *endo* (inner) + *phasia* (speech). This term was developed in consultation with individuals who identify as lacking inner speech and has the benefit of including the familiar Greek root *phasia* (aphasia, paraphasia, etc.). Furthermore, “endophasia” has precedent in being used to refer to inner speech (Bergounioux, 2001; Loevenbruck et al., 2018). The term also avoids subsuming inner speech under “aphantasia” (Monzel, Mitchell, Macpherson, Pearson, & Zeman, 2022) because inner speech is both auditory and articulatory in

nature (whether it is better termed “inner hearing” or “inner speaking” is debated) and because the linguistic properties of inner speech are not reducible to phonology. For these reasons, we also do not believe the previously proposed term “anauralia” is appropriate (Hinwar & Lambert, 2021).

5.2 Relations to Visual Imagery, Auditory Imagery and “Unsymbolized” Thought

Can anendophasia be thought of as a lack of auditory imagery? We think not. First, many who lack inner speech report experiencing being able to hear music in their mind’s ear (although they also report being less likely to experience “earworms”). Second, although inner speech is often experienced as having phonological features – one of the reasons people often perceive it as speech (Langland-Hassan, 2018) – it can also involve an articulatory-motor dimension (Geva, 2018; Perrone-Bertolotti et al., 2014). Paradoxically, some people also claim to experience “wordless” inner speech akin to a series of tip of the tongue states (Hurlburt et al., 2013). When asked to reflect on what form their thoughts take, people who score low on both inner speech and visual imagery claim that they “think in concepts”. What it means to “think in concepts” without relying on language is not clear. Beyond informal self-reports, the existence of such non-verbal and non-perceptual phenomenal experiences is supported by Descriptive Experience Sampling (DES) (Heavey & Hurlburt, 2008; Hurlburt & Akhter, 2006). When participants are probed at random times and asked to report on their mental states, ~22% of the time their reports are consistent with what Hurlburt has called “unsymbolized thinking”. In such episodes, people feel that they think ‘a particular, definite thought without awareness of that thought being conveyed as words, images, or any other symbols’ (Heavey & Hurlburt, 2008, p. 802). Unsymbolized thinking is a slippery construct that tends to be defined in terms of what it is not. For example, Hurlburt and Akhter (2008) say that it is experienced as being ‘a thinking, not a feeling, not an intention, not an intimation, not a kinesthetic event, not a bodily event’ (p. 1366). A telling example is a participant wondering if her friend will arrive in a car or pickup

truck, but not experiencing any words or images. The question is a single undifferentiated whole. It is possible that unsymbolized thinking is subserved by the same verbal and perceptual processes, but with weak or absent conscious imagery (Vicente & Martinez-Manrique, 2016). Alternatively, it may correspond to a genuinely different form of experience in which people entertain more abstract conceptual representations which are less accessible to people with higher levels of inner speech and imagery.

5.3 Limitations

One limitation of our work is its reliance on wholly subjective questions for measuring inner speech. Considering that our focus is on differences in phenomenology, this is appropriate. At the same time, there is reason to be skeptical of people’s assessments of their inner experiences. People can be wrong about what they think they experience (Hurlburt & Schwitzgebel, 2011). It would be therefore helpful to supplement subjective assessments with objective ones of the sort becoming possible for differences in visual imagery (Kay, Keogh, Andrillon, & Pearson, 2022). Another limitation is the remaining possibility that differences we ascribe to inner speech come from a third factor, e.g., conscientiousness. Although we cannot rule out all third factors, it is worth noting that there is no evidence that inner speech was associated with across-the-board differences in performance. The effects were specific to certain task and condition combinations. We believe our results generalize across age, gender, and educational status, but it is an open question whether any of the relationships we report are specific to English speakers or Westerners. Lastly, while the term “anendophasia” connotes *lack* of inner speech, many of the participants in our “low inner speech” group reported having *some* inner speech. Screening a larger group to identify people who do not endorse having *any* inner speech would help in knowing whether the cognitive consequences of having less inner speech are continuous with having none.

6 Conclusion

Not everyone experiences inner speech. We proposed a name for a lack of inner speech: anendophasia. People who experience less inner speech were worse at making

rhyme judgments in response to images and remembering a list of words. Task switching performance was not, however, either slower or less accurate. Taken together, our experiments suggest that there are real behavioral consequences of experiencing less or more inner speech, and that these differences may often be masked because people with anendophasia use alternate strategies to achieve similar overall performance.

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