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# SOURCES OF BETWEEN-SUBJECTS VARIABILITY IN PERCEPTUAL ASYMMETRIES: A META-ANALYTIC REVIEW

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**Abstract**—A number of studies have reported correlations between subjects' asymmetry scores on left and right hemisphere specialized tasks. In this paper we report the results of meta-analyses performed on these correlations. Results showed positive correlations between subjects' asymmetry scores on left and right hemisphere specialized tasks in both modalities (asymmetry scores were computed as R–L for both left and right hemisphere specialized tasks). Thus, in both modalities, some of the between-subjects variability in asymmetry scores appears to reflect non-stimulus specific individual differences in perceptual asymmetry. For the visual asymmetry tasks, results also showed that the subjects' asymmetry scores on left and right hemisphere specialized tasks were more highly correlated under conditions of bilateral than unilateral input. This finding suggests that bilateral tasks may be more sensitive to "characteristic perceptual asymmetry" than unilateral tasks.

## INTRODUCTION

PERCEPTUAL asymmetries of normal right-handed subjects on commonly used laterality tasks (e.g. divided visual half-field tasks, dichotic listening tasks) are extremely variable in both direction and magnitude. Typically only about 70% of right-handed subjects show the "expected" left hemisphere superiority for processing verbal materials and right hemisphere superiority for processing visuo-spatial and musical materials (for a review, see [45]). Among subjects who have the same direction of perceptual asymmetries, there are wide variations in the magnitude of these asymmetries. A number of hypotheses have been proposed to explain these variations in perceptual asymmetries among right-handed subjects. Among them are individual differences in hemispheric specialization (e.g. [6, 26, 34, 48, 57]), random error in measurements (e.g. [9, 10, 43, 44, 53]) and individual differences in "characteristic perceptual asymmetry" (e.g. [25, 28, 30, 46, 49]).

Although a number of studies have suggested that between-subjects variation in perceptual asymmetries reflect individual differences in hemispheric specialization (e.g. [6, 48]), clinical evidence indicates that patterns of hemispheric specialization are extremely consistent among right-handed subjects. For example, sodium amytal testing carried out with patients who have intractable focal epilepsy indicates that about 95% of right-handed subjects have productive language functions lateralized to the left hemisphere [39]. In contrast, the proportion of normal right-handed subjects with "expected" right visual-

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field left hemisphere superiorities for processing verbal material is only about 70%. The apparent discrepancy between the data from studies of clinical and normal subjects may stem from the use of different tasks in these studies (e.g. language production vs language comprehension tasks). It is also possible that patterns of hemispheric specialization in clinical patients have changed in response to long-standing brain damage. However, it is generally acknowledged that whatever the factors contributing to this discrepancy, right-handed normal subjects are not as variable in their patterns of hemispheric specialization as laterality test data might indicate.

Some studies have proposed that between-subjects variability in asymmetry scores on laterality tasks reflect "random error in measurements" (e.g. [9, 10, 43, 44, 53]). This proposal has been made, in part, in an attempt to explain the wide discrepancy between normal and clinical laterality data described above. Prior studies have also shown that the majority of laterality tasks have only low-to-moderate reliabilities (for a review, see [45]), suggesting that a large proportion of between-subjects variability may, in fact, reflect random error. However, some laterality tasks have been shown to be highly reliable (e.g. [29, 54]), and even for these tasks, the magnitude and direction of subjects' asymmetry score does not correspond well with the clinical data. For example, WEXLER *et al.* [54] report a test–retest reliability of 0.91 for their dichotic listening test, yet 23% of right-handed subjects in this study (computed from Fig. 1 in [54]) showed a reversed direction of asymmetry. Thus, the primary source of between-subjects variability of this task may be neither random error in measurements nor individual differences in hemispheric specialization, but some other stable individual trait(s).*

LEVY *et al.* [30] have proposed that such between-subjects variations among right-handed subjects in asymmetry scores reflect individual differences in perceptual asymmetry that are not stimulus-specific, referred to in this paper as "characteristic perceptual asymmetry". According to this hypothesis, the direction and degree of "characteristic perceptual asymmetry" varies widely among normal right-handed subjects, ranging from strong asymmetries in favor of the left-side of space, to nearly equal asymmetries, to strong asymmetries in favor of the right-side of space. In contrast, patterns of hemispheric specialization are posited to be extremely consistent among right-handed subjects. Thus, according to this hypothesis, both hemispheric specialization and "characteristic perceptual asymmetry" affect asymmetry scores, but between-subjects variability in asymmetry scores is largely attributable to variations in "characteristic perceptual asymmetry". Levy *et al.*'s hypothesis predicts that individual subjects will tend to maintain the same position relative to other subjects in the distribution of asymmetry scores on any laterality task performed. A number of recent studies provide evidence consistent with this prediction (e.g. [25, 28, 30, 46, 49]).

The underlying cause of variations in "characteristic perceptual asymmetry" remains at issue. LEVY *et al.* [30] have proposed that variations in "characteristic perceptual asymmetry" reflect individual differences in the relative arousal levels of the left and right hemispheres. They argue that the existence of individual differences in hemispheric arousal

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*A recent study by ZATORRE [58] has shown that direction of asymmetry on Wexler *et al.*'s test is related to speech lateralization determined by the sodium amytal test. However, there were wide individual variations in the degree of perceptual asymmetry among subjects with speech lateralized to the same side. These individual variations and, to some extent, variations between subjects with speech lateralized to different hemispheres may reflect individual differences in perceptual asymmetry that is not stimulus specific, referred to as "characteristic perceptual asymmetry" in this paper (see TEXT).

asymmetries is supported by data from a variety of sources, including baseline EEG asymmetries (e.g. [2, 13, 36]), baseline cerebral blood flow (e.g. [11]) and lateral eye movements in the experimentor-facing-subject condition (e.g. [16]). Evidence that this arousal asymmetry is a stable characteristic of an individual emerges from the relatively high reliabilities of these measures (e.g. [11, 13]). For example, EHRLICHMAN and WEINER [13] report a test–retest reliability of 0.88 for EEG asymmetry measures obtained on 11 normal right-handed subjects. Thus, a subject's asymmetry scores on laterality tasks may be shifted to the left or right, in favor of the side of space contralateral to the more aroused hemisphere.

Alternatively, some researchers have proposed that "characteristic perceptual asymmetry" may be mediated by peripheral factors such as asymmetric pathway dominance rather than central factors such as hemispheric arousal asymmetries. For example, in the visual modality, Hellige *et al.* [17] have suggested that individuals may differ in the efficiency with which information is transmitted to the cortex from the left or right visual fields. In the auditory modality, LAUTER ([27], see also [49]) has proposed that there may be stable individual differences in the efficiency with which information is transmitted to the cortex from the left and right ear. EFRON [12] has proposed that individual differences in perceptual asymmetry in the auditory modality may be mediated by asymmetries in the peripheral auditory system at or below the level of the brain-stem.

In the current paper, meta-analyses are preformed on correlations reported in the literature between subjects' asymmetry scores on left and right hemisphere specialized tasks. The aim of these meta-analyses is to differentiate among the hypotheses that between-subjects variability in asymmetry scores primarily reflect: (a) individual differences in characteristic perceptual asymmetry; (b) individual differences in hemispheric specialization; or (c) random error in measurement. If between-subjects variability in asymmetry scores reflects individual differences in "characteristic perceptual asymmetry", the correlation between subjects' asymmetry scores on left and right hemisphere specialized tasks should be positive (asymmetry scores are computed as R–L for both tasks). The prediction for the hemispheric specialization hypothesis is not immediately obvious, because it depends on the particular relation one posits between left and right hemisphere specialization. One view, which we will examine, is that individuals vary in "hemispheric specialization strength" [26, 34, 57]. According to this view, some subjects are "strongly" lateralized, showing large left hemisphere advantages on verbal tasks and large right hemisphere advantages on non-verbal spatial tasks, whereas other subjects are "weakly" lateralized, showing small advantages on both types of tasks. Such a relation would be supported by a negative correlation between subjects' asymmetry scores on left and right hemisphere specialized tasks. Finally, if between-subjects variability in asymmetry scores is primarily attributable to random error in measurements, a non-significant correlation between subjects' asymmetry scores on left and right hemisphere specialized tasks would be expected.

The present review makes use of quantitative meta-analytic procedures. A quantitative meta-analysis applies statistical procedures to a collection of empirical findings from individual studies for the purpose of integrating them (for a review, see [41, 42, 55]). GLASS *et al.* [15] note that the findings of multiple studies should be regarded as a complex data set, no more comprehensible without statistical analysis than would be hundreds of data points in one study. Correlational studies are especially amenable to meta-analytic procedures, as they provide a readily available common metric across studies [42]. A consideration of the correlations between subjects' asymmetry scores in a meta-analytic context is enhanced by the fact that reliabilities of asymmetry scores in most individual studies are only low to moderate (for a review, see [45]). The reliability coefficient of a measure establishes the upper bound for the correlation between observed variables. For example, if the reliabilities of two variables are the same, the correlation between the two variables cannot be greater than the reliability coefficient [35]. Insofar as non-significant correlations in individual studies may be attributable to Type II errors (i.e. errors of incorrectly retaining a false null hypothesis), because of low to moderate reliabilities of the individual laterality tests, a meta-analysis may provide an opportunity to examine correlations among subject's asymmetry scores on tasks that differentially involve the left and right hemisphere with sufficient statistical power.

## METHOD

Correlations from individual studies included in the meta-analyses described in this paper were obtained primarily from reviewing articles from the following journals: *Brain and Cognition*, *Brain and Language*, *Canadian Journal of Psychology*, *Cortex*, *Journal of Experimental Psychology: Human Perception and Performance* and *Neuropsychologia*. The period of journal articles surveyed was from the mid-1960s to 1989. Twenty-seven correlations reported in 18 research articles were collected. A total of 848 subjects (715 right-handed and 133 left-handed) were involved in computing the 27 correlations. If a study reported results from right-handed and left-handed subjects separately, they were coded separately. The correlations and their associated study conditions are summarized in Appendices 1 3. For each study included in the meta-analyses the number of subjects tested, handedness of subjects, simuli and dependent variables are described. In addition, the correlations between subjects' asymmetry scores on left and right hemisphere specialized tasks and their associated $P$-values are listed (see Appendices 1 3).

Some studies report more than one correlation relevant to the present meta-analysis by administering multiple laterality tasks to the same subjects. Including multiple results from the same subjects could inflate the sample size of statistical tests and effects beyond the number of independent studies [42, 55]. Thus, in a given meta-analysis, only one correlation was included from a single group of subjects, regardless of the number of correlations reported in the original study. The correlation chosen to be included was the one computed between the left and right hemisphere specialized tasks with the most significant asymmetries. For inclusion in the meta-analysis, laterality tasks were required to show the "expected" direction of mean perceptual asymmetry (i.e. perceptual asymmetry in favor of the right sensory field on verbal tasks and perceptual asymmetry in favor of the left sensory field on visuo-spatial or musical tasks). However, we did not require that these asymmetries attain statistical significance at the conventional level. Of the 27 correlations reviewed, seven involved one task with a mean asymmetry score that was not statistically significant but that was in the expected direction.

"Stouffer's $Z$" was the meta-analytic method used. This method involves adding the standard normal deviates associated with the one-tailed $P$-value for each correlation included in the meta-analysis. This sum is then divided by the square root of the number of correlations being combined:

$$Z = \frac{\sum z}{\sqrt{N}} \qquad (1)$$

where $N$ = the number of correlations combined. The resulting $Z$ is referred to the standard normal table for significance testing (for a more complete description of this method, see [41, 42]).

## RESULTS

### *Divided visual field studies*

Twelve correlations between subjects' asymmetry scores on left and right hemisphere specialized divided visual-field tasks were entered into the meta-analysis (asymmetry scores were computed as R–L for both tasks). Appendix 1 summarizes the study conditions associated with each correlation. The obtained $Z$ was significantly positive ($Z = 4.54$, $P < 0.0001$), consistent with the view that between-subjects variability in asymmetry scores reflects individual differences in "characteristic perceptual asymmetry".

Of the 12 correlations included in the meta-analysis, eight were obtained from right-handed subjects and the other four correlations were obtained from left-handed subjects or both left- and right-handed subjects. In order to investigate possible effects of subjects' handedness on the correlation, a separate meta-analysis was run for the two sets of correlations. For both sets of correlations, the obtained $Z$ was significantly positive (right-handers: $Z=3.44$, $P<0.001$; left-handers or both left- and right-handers: $Z=3.00$, $P<0.01$) and did not significantly differ from each other ($P>0.10$). Thus, it does not appear to be the case that effects of "characteristic perceptual asymmetry" differ for right- and left-handed individuals [21, 25].

Six of the 12 correlations included in the meta-analysis were obtained from tasks using bilateral input and the other six were obtained from tasks using unilateral input. On bilateral tasks two stimuli are presented simultaneously to the subject, one lateralized to the left visual field and the other lateralized to the right visual field, whereas on unilateral tasks one stimulus is presented on each trial, lateralized either to the left or right visual field. In order to compare the correlations obtained under these two presentation conditions, a separate meta-analysis was carried out on the two data sets. For the bilateral tasks, the obtained $Z$ was significantly positive ($Z=5.03$, $P<0.0001$). However, for the unilateral tasks, the obtained $Z$ was only marginally significant ($Z=1.39$, $P<0.10$). A contrast revealed that bilateral tasks yielded a more significant $Z$ than unilateral tasks ($P<0.05$). Thus, bilateral tasks appear to be more sensitive to individual differences in "characteristic perceptual asymmetry" than unilateral tasks [20, 22].

*Free-vision and divided field studies*

Seven correlations between subjects' asymmetry scores on verbal divided visual-field tasks and the free-vision face task developed by LEVY *et al.* [31] were entered into another meta-analysis. The free-vision face task involves judging which of the two mirror-imaged chimeric faces, the one with the smile to the subject's left or the one with the smile to the subject's right, looks happier. Subjects as a group showed a strong bias to choose the face with the smile to their left as looking happier (e.g. [29, 31]).

Appendix 2 summarizes the study conditions associated with each correlation. As for the divided visual-field studies, the obtained $Z$ over the seven correlations was significantly positive ($Z=3.05$, $P<0.01$). The positive direction of the obtained $Z$ is again consistent with the view that between-subjects variability on the free-vision task as well as on divided visual-field tasks reflects individual differences in "characteristic perceptual asymmetry". Of the seven correlations included in the meta-analysis, six were obtained from right-handed subjects and only one was obtained from left-handed subjects. Considering the correlations obtained from right-handed subjects only, the obtained $Z$ was significantly positive ($Z=1.95$, $P<0.05$). The one correlation involving left-handed subjects [25] was obtained from 32 subjects and was significant ($r=0.55$, $P<0.001$).

Four of the seven correlations included in the meta-analysis involved asymmetry scores on the free-vision face task and a bilateral divided visual-field task, and the other three involved asymmetry scores on the free-vision face task and a unilateral divided visual-field task. In order to compare the correlations obtained under conditions of bilateral vs unilateral presentation of stimuli, a separate meta-analysis was run for the two data sets. For studies relating bilateral tachistoscopic tasks and the free-vision task, the obtained $Z$ was significantly positive ($Z=3.01$, $P<0.01$). In contrast, for studies relating unilateral tachistoscopic tasks and the free-vision task, the obtained $Z$ was not significant ($Z=1.19$, $P>0.10$). However, a contrast between these two $Z$s failed to reach statistical significance ($P>0.10$).

*Dichotic listening studies*

In order to investigate the hypothesis that between-subjects variability in auditory asymmetry scores reflect characteristic perceptual asymmetry, eight correlations between subjects' asymmetry scores on left and right hemisphere specialized dichotic listening tasks were entered into another meta-analysis. Appendix 3 summarizes the study conditions associated with each correlation. Consistent with the results of the meta-analyses involving the bilaterally presented visual tasks, the obtained $Z$ was significantly positive ($Z=1.89$, $P<0.05$). Of the eight correlations included in this meta-analysis, six were obtained from right-handed subjects, one from left-handed subjects [56] and one from trained musicians and non-musicians who were right-handed [57]. A separate meta-analysis carried out on the correlations obtained from the six studies including right-handed subjects yielded a significantly positive $Z$ ($Z=3.40$, $P<0.001$). The correlation involving left-handed subjects was based on only six subjects and was not significant ($r=-0.25$, $P>0.50$). Finally, testing 24 musicians and 24 non-musicians, ZATORRE [57] reported a significantly negative correlation ($r=-0.36$, $P<0.05$). This negative correlation may be attributable to a between-group difference between musicians and non-musicians, rather than to a negative correlation within either of these groups.

One additional study [47], not included in the analyses reported above, bears a similarity to the free-vision task result in the visual modality. In this study, left and right stimuli were presented through audiospeakers rather than headphones and thus, were available to both ears. Calculations based on individual subjects' data reported in this study [47] revealed a significant positive correlation between asymmetry scores on left and right hemisphere specialized tasks ($r=0.49$, $P<0.05$).

## DISCUSSION

Subjects' asymmetry scores on left and right hemisphere specialized tasks are positively correlated. The present review indicates that this was true for a variety of laterality tasks (divided visual-field tasks, free-vision tasks, dichotic listening tasks, free-field listening tasks). These results suggest that between-subjects variability in asymmetry scores reflects individual differences in perceptual asymmetry that are not stimulus-specific [21, 25, 28, 30]. The finding of positive correlations between subjects' asymmetry scores on left and right hemisphere specialized tasks is not consistent with the view that between-subjects variability in asymmetry scores is attributable to individual differences in "hemispheric specialization strength", as this hypothesis would predict a negative correlation. Random error of measurement on these tasks also does not provide an adequate explanation for the positive correlations.

A number of prior studies have assumed that between-subjects variability in asymmetry scores reflect individual differences in hemispheric specialization. For example, a number of studies have examined the correlation between subjects' asymmetry scores and their cognitive task scores (for a review, see [32]), with the objective of examining the relation between individual differences in hemispheric specialization and cognitive performance. The present study suggests that these correlations may reflect the relation betwen individual differences in "characteristic perceptual asymmetry" and cognitive performance, rather than the relation between individual differences in hemispheric specialization and cognitive performance. This may be particularly the case when asymmetry scores are obtained from tasks using bilateral stimulus presentation [22]. Other studies that have related variations in subjects' asymmetry scores to individual traits such as field dependence/independence, hypnotizability, etc. (for a review, see [3]) may similarly mis-specify the sources of between-subjects variability in asymmetry scores.

Group differences in asymmetry scores (e.g. males vs females, normals vs dyslexics) also have been attributed to differences in hemispheric specialization (e.g. [34]). Alternatively, the group differences could be due to group differences in "characteristic perceptual asymmetry". For example, the distribution of "characteristic perceptual asymmetry" for some special groups such as dyslexics may be biased toward the left sensory field–right hemisphere relative to normals. Empirically, these two hypotheses, i.e. group differences attributable to differences in hemispheric specialization vs "characteristic perceptual asymmetry", can be discriminated by administering a set of laterality tasks to subject groups of interest. A finding that the group difference in asymmetry scores is not stimulus-specific would favor the view that the group difference is related to "characteristic perceptual asymmetry" rather than hemispheric specialization.

The underlying cause of "characteristic perceptual asymmetry" may be asymmetry in central [30] and/or peripheral factors (e.g. [17, 49]). Two findings in the present study support on central mediation. First, results of the present study indicate that between-subjects variability on free-vision or free-field listening tasks reflect variations in "characteristic perceptual asymmetry". The free-vision or free-field listening tasks do not involve lateralizing input to one sensory field and therefore, peripheral factors such as pathway dominance, even if they exist, would have to play a minor role on these tasks. Thus, sensitivity of free-vision or free-field listening tasks to "characteristic perceptual asymmetry" suggests that at least some of the between-subjects variability is attributable to central factors such as hemispheric arousal asymmetry.

Second, the differential sensitivity of unilateral and bilateral tasks to "characteristic perceptual asymmetry" also is consistent with the view that "characteristic perceptual asymmetry" is at least partially mediated by central factors [20, 22]. No such difference in sensitivity would be expected if "characteristic perceptual asymmetry" is mediated by peripheral factors only. The higher sensitivity of bilateral than unilateral stimulation to "characteristic perceptual asymmetry" may be related to the varying demands these two types of tasks make on subjects' processing resources [20, 22]. In particular, under bilateral presentation conditions, in which processing resources are relatively limited, there may be a tendency for subjects to allocate more resources to the hemisphere that is "characteristically" more aroused (cf. [38, 40]). Thus, some subjects may allocate more resources to the left hemisphere and others may allocate more resources to the right hemisphere. This would exaggerate arousal differences between the hemispheres, with the result that bilateral presentation is more sensitive to variations in hemispheric arousal asymmetry (or "characteristic perceptual asymmetry") than the unilateral presentation.

Consistent with the present finding that "characteristic perceptual asymmetry" is more readily revealed by bilateral than unilateral stimulation, hemineglect following unilateral brain damage is also much more apparent under conditions of bilateral than unilateral stimulation, and sometimes, is only apparent under conditions of bilateral stimulation (for a review, see [4]). Similar to the tendency of normal subjects to allocate more processing resources to the hemisphere that is characteristically more aroused under conditions of bilateral input, brain -damaged patients may allocate most processing resources to the intact hemisphere under conditions of bilateral input (cf. [38, 40]).

The parallels between "characteristic perceptual asymmetry" in normal adults and hemineglect in brain-damaged patients may be attributable to the fact that perceptual asymmetries in both populations reflect an imbalance in hemispheric arousal. In normals, the degree and direction of this arousal asymmetry may be a trait of each individual, whereas in brain-damaged patients, the imbalance may be determined primarily by characteristics of the lesion such as side, location and size. Nonetheless, at least to some extent, a patient's premorbid arousal asymmetry may be significantly related to the magnitude/direction of hemineglect shown following brain damage [20, 22]. For example, hemineglect following right hemisphere damage may be stronger among subjects with "characteristic perceptual asymmetry" in favor of the RVF (assumed to reflect greater left hemisphere arousal) than among subjects with "characteristic perceptual asymmetry" in favor of the LVF (assumed to reflect greater right hemisphere arousal). The reverse would be expected following damage to the left hemisphere. That is, when the patient's characteristic arousal asymmetry biases attention to the side of space ipsilateral to the lesion, the tendency to neglect the contralateral field may be exaggerated. In contrast, when the patient's characteristic arousal asymmetry biases attention to the side of space contralateral to the lesion, the tendency to neglect the contralateral field may be attenuated. Studying "extinction to simultaneous stimulation" in monkeys with lesion techniques, a similar prediction was made by EIDELBERG and SCHWARTZ [14]. That is, they suggested that any postoperative changes in extinction should be evaluated relative to preoperative lateralized biases.

Finally, an important question raised by the present review is whether characteristic perceptual asymmetries in the visual vs auditory modalities are related or independent. This issue is difficult to address from a review of literature, as existing studies have either been within a single modality, or if cross-modal, have only examined the relation between asymmetry scores on *verbal* visual and auditory tasks (for a review, see [24, 45]) rather than the relation between asymmetry scores in the visual and auditory modalities more generally. We [23] have recently addressed this issue by entering subjects' asymmetry scores on multiple bilateral visual-field tasks and multiple dichotic listening tasks into a principal component analysis (PCA). The results of this study indicate that characteristic perceptual asymmetries are mediated by both modality-specific and modality-general components, though they are affected more by the modality-specific component. Nonetheless, the finding of a modality general component lends support to the hypothesis that central factors play a role in mediating "characteristic perceptual asymmetry". Whether the modality specific component is mediated by central or peripheral factors remains an open question.

In sum, results of the present meta-analyses are consistent with the view that between-subjects variability in asymmetry scores reflect individual differences in non-stimulus-specific perceptual asymmetries [30]. The influence of a stable, task-independent trait, such as "characteristic perceptual asymmetry" on subjects' asymmetry scores provides a potential explanation for the wide discrepancy in laterality findings between normal and clinical studies. The higher sensitivity of bilateral than unilateral stimulation to "characteristic perceptual asymmetry" in normals is consistent with the view that extinction to bilateral stimulation is not a new symptom that emerges following brain damage, but rather a normal phenomenon that is exaggerated as a result of brain damage [20, 22]. Finally, the present study underscores the importance of considering sources of between-subjects variability in asymmetry scores in interpreting results of laterality studies.

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## APPENDIX 1. DIVIDED VISUAL-FIELD STUDIES

| Study | Left hemisphere task | Right hemisphere task | Dependent variable | *N* | *r* | *P* (two-tailed) |
|---|---|---|---|---|---|---|
| Bilateral tasks: | | | | | | |
| BOLES [6] | Words | Bargraphs | RT | 22R* | 0.70 | 0.0002 |
| | | | | 15L | 0.34 | 0.2150 |
| KIM [20] | Words | Faces | Accuracy | 32R | 0.36 | 0.0417 |
| KIM *et al.* [25] | Words | Faces | Accuracy | 32R | 0.28 | 0.1234 |
| | | | | 32L | 0.21 | 0.2486 |
| LEVINE *et al.* [28] | Words | Line drawings | Accuracy | 32R | 0.45 | 0.0097 |
| Unilateral tasks: | | | | | | |
| BRADSHAW *et al.* [7] | Words | Faces | RT | 48R & 48L | 0.34 | 0.0007 |
| BRYDEN [8] | Letters | Dots | Accuracy | 32R & 32L | 0.03 | 0.8139 |
| HELLIGE and MICHIMATA [18] | Category judgment | Metric judgement | RT | 46R | 0.16 | 0.2912 |
| KIM [20] | Words | Faces | Accuracy | 32R | 0.14 | 0.4349 |
| MARCEL and RAJAN [33] | Words | Faces | Accuracy and threshold | 40R | −0.09 | 0.5437 |
| ZOCCOLOTTI and OLTMAN [59] | Letters | Faces | RT | 18R | −0.35 | 0.1544 |

*R = Right-handed subjects. L = Left-handed subjects.

## APPENDIX 2. DIVIDED VISUAL-FIELD vs FREE-VISION FACEBOOK STUDIES

| Study | Left hemisphere task | Right hemisphere task | Dependent variable* | *N* | *r* | *P* (two-tailed) |
|---|---|---|---|---|---|---|
| Bilateral tasks vs free-vision: | | | | | | |
| BOGNER [5] | Words | Free-vision faces | Accuracy | 24R | 0.13 | 0.5355 |
| KIM [20] | Words | Free-vision faces | Accuracy | 32R | −0.07 | 0.7034 |
| KIM *et al.* [25] | Words | Free-vision faces | Accuracy | 32R | 0.43 | 0.0137 |
| | | | | 32L | 0.55 | 0.0011 |
| Unilateral task vs free-vision: | | | | | | |
| HELLIGE *et al.* [17] | CV syllables | Free-vision faces | Accuracy | 119R | 0.11 | 0.2336 |
| KIM [20] | Words | Free-vision faces | Accuracy | 32R | −0.16 | 0.3817 |
| LEVY *et al.* [30] | CVC syllables | Free-vision faces | Accuracy | 24R | 0.36 | 0.0803 |

*Entries are for the left hemisphere tasks. For right hemisphere facebook task, the dependent variable was left right preferences (see TEXT).

APPENDIX 3. DICHOTIC LISTENING STUDIES

| Study | Left hemisphere task | Right hemisphere task | Dependent variable | $N$ | $r$ | $P$ (two-tailed) |
|---|---|---|---|---|---|---|
| KIM [20] | Words | Melodies | Accuracy | 32R | 0.10 | 0.5748 |
| MURRAY [37] | CV syllables | High/low tones | Accuracy | 24R | 0.21 | 0.3246 |
| SIDTIS [49] | CV syllables | Square wave tones | Accuracy | 28R | 0.35* | 0.0678 |
| SPELLACY [51] | Words | Violin melodies | Accuracy | 32R | 0.22† | 0.2263 |
| SPELLACY and BLUMSTEIN [52] | CVC syllables | Sung melodies | Accuracy | 58R | 0.30 | 0.0221 |
| YUND and EFFRON [56] | CV syllables | High/low tones | Accuracy | 24R | 0.31 | 0.1404 |
| | | | | 6L | −0.25 | 0.6328 |
| ZATORRE [57] | CV syllables | Six-note melodies | Accuracy | 48R | −0.36 | 0.0119 |

*Given in SIDTIS [50].
†Given in SPELLACY and BLUMSTEIN [52].