Musical processing in Aphasia
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Introduction
Persons with aphasia (PWA) demonstrate difficulties with auditory processing across language domains, including phonetic, semantic and syntactic contrasts. Less is known about their ability to process non-linguistic stimuli such as music. Existing research on processing musical structure in PWA has been equivocal. Some studies have found difficulties in processing harmonic structure and chord sequences of Western music (Patel et al., 2008; Sammler et al., 2011), while two case studies found preserved musical processing (Peretz, 1993, Slevc et al., 2016).

A better understanding of musical processing in aphasia is relevant for several reasons. First, there are claims about the neuro-rehabilitative effects of listening to music and musical instrumental training for neurologically based disorders (Francois et al., 2015). Investigating processing of musical structure in PWA will enable better prediction of the therapeutic benefit associated with musical engagement. Secondly, it informs the theoretical debate about the extent to which musical and linguistic processing rely on the same neural and cognitive resources, given that language and Western music both have hierarchical “syntactic” structure (Patel, 2003). While psycholinguistic and neuroimaging studies support sharing of neural and cognitive substrates (e.g., LaCroix et al., 2015), findings in persons with brain damage have been equivocal (Peretz, 2006).

This study investigated three questions, 1) whether musical structure processing is compromised in persons with aphasia, 2) whether there is a relationship between processing of musical and linguistic structure, and 3) if prior musical experience is associated with structural processing of music and language.

Methods
14 individuals with aphasia (14 female, Mean (SD) age=60 (10.1) years) and 20 age and education matched right-handed neurotypical adults (13 female, Mean (SD) age=60 (8.2) years) participated in this study. All were primary speakers of English with at least a high school education. All participants with aphasia had suffered a single left hemisphere cerebrovascular accident. Participants provided self-report on extent of musical experience (Ollen, 2006). The aphasia severity range of PWA was 30.8 to 100 (Aphasia Quotient from the Western Aphasia Battery-Revised, Kertesz, 2006), and included persons with anomic (N=13), Broca’s (N=8), conduction (N=2) and Wernicke’s (N=1) aphasia. Musical expertise was measured by the Ollen Musical Sophistication index (OMSI, Ollen 2006), which is a self-report questionnaire on engagement in various music-related activities (playing instruments, attending concerts, composing music, etc.)

Four computer-based tasks of sensitivity to structure in music and language were administered in a counterbalanced order. All participants responded with their left hand to accommodate for left hemiparesis in PWA. Two comparable acceptability judgment tasks were developed as explicit measures of sensitivity: goodness judgments of sentences that sometimes contained morphosyntactic violations (Sentence Judgment) and judging chord sequences that sometimes included out-of-key chords (Chord Judgment). These tasks were considered explicit because participants typically made judgments after listening to the entire sentence/chord sequence. Accuracy of acceptability judgments was the key measure, and hence A-prime, a measure of signal detection, was computed (Zhang & Meuller, 2005).

Two implicit measures of syntactic and musical structure were used, Word Monitoring, where target words to be monitored sometimes followed morphosyntactic violations, and Harmonic Priming,
where participants made timbre judgments (trumpet or voice) on the final chords of sequences that ended on harmonically expected (tonic) or less expected (subdominant) chords. The task demands of word monitoring were comparable to that of harmonic priming. The premise of these implicit tasks is that participants speed to detect the target word or timbre is affected if it immediately follows an unexpected element such as a morphosyntactic violation or subdominant chord. Hence the priming effect, calculated as the response time difference between unexpected and expected conditions, is the key dependent measure of automatic processing of syntax. This difference was transformed to a standardized (z) score to enable comparisons between control and PWA while disregarding the overall slower responses of PWA.

Results and Discussion
Both PWA and control groups performed above chance on the explicit judgment tasks (A’ > .5). However, PWA were significantly worse than healthy controls in sensitivity to the Sentence Judgement (PWA A’ Mean(SD) = .77(.15) vs. control A’ Mean(SD) = .96(.03); F(1,41) = 27, p < .001). In contrast, groups did not differ on the Chord judgment task (PWA A’ Mean(SD) = .7(.19) vs. control A’ Mean(SD) = .77(13); F(1,41) = 1.9, p > .05). Both groups showed implicit automatic processing of linguistic and musical syntax in Word monitoring and Harmonic Priming respectively, with showing different response speed to unexpected versus expected stimuli. There were no significant group differences for either language (Word monitoring effect for PWA Mean(SD) = 114(206.3) vs. control Mean(SD) = 101.5(35.4); F(1,41) = .08, p > .05) or music (Harmonic Priming effect PWA Mean(SD) = 9.7(340) vs. control Mean(SD) = -35.8(86.3); F(1,41) = .34, p > .05). For PWA, prior musical expertise (as measured by OMSI and years of musical practice) correlated significantly with a variety of language measures including Sentence Judgment, Word Monitoring effect, WAB-AQ (all Spearman rs > .7, all p-values < .01).

To summarize, PWA performed worse than the control group only in explicit Sentence Judgment, and were comparable to the control group in automatic syntactic processing (Word monitoring) and musical processing (Chord Judgment and Harmonic Priming). And there was an association between language abilities in PWA (both syntactic processing and overall aphasia severity) and prior musical expertise. These results are partially consistent with the only other group comparison of PWA and healthy adults on explicit and implicit linguistic and musical syntactic tasks (Patel et al., 2008). While both studies found explicit linguistic syntactic judgment to be impaired, Patel et al. also found impaired PWA performance on the remaining three tasks. Overall, our findings show preserved musical processing in PWA, and lend support to the idea that prior musical experience affords a cognitive reserve for language deficits in post-stroke aphasia.

References


