

Effects of Selective Serotonin Reuptake Inhibitors on Auditory Processing: Case Study

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Abstract

Auditory sensitivity and processing ability were evaluated in a patient who suffered from hyperacusis, difficulty understanding speech, withdrawn depression, lethargy, and hypersensitivity to touch, pressure, and light. Treatment with fluvoxamine and fluoxetine (selective serotonin reuptake inhibitors) reversibly alleviated complaints. Testing while medicated and unmedicated (after voluntary withdrawal from medication for several weeks) revealed no difference in pure-tone thresholds, speech thresholds, word recognition scores, tympanograms, or acoustic reflex thresholds. Medicated SCAN•A (a screening test for central auditory processing disorders) results were normal, and unmedicated results were abnormal. Unmedicated transient otoacoustic emissions and auditory brainstem response waves I, III, and V were significantly larger bilaterally. Uncomfortable loudness levels indicated greater tolerance during the medicated condition. Central processing and vigilance were evaluated with analog-synthesized three-formant consonant-vowel syllables. While medicated, responses to stimuli at each ear revealed well-defined, labeling crossovers of about 90 msec. Vowel identification matched normal subject responses; labeling of /gE/jE/ and /bE/wE/ continua was well defined but all crossover points differed from normals ($p < .0001$). During unmedicated testing, responses to /gE/jE/ began at medicated levels but approached chance levels for the entire continuum within 10 min; labeling of /bE/wE/ was consistent with medicated responses throughout with earlier than normal crossover points.

Key Words: Auditory brainstem responses, central auditory processing, depression, hyperacusis, phoneme identification, selective serotonin reuptake inhibitors, serotonin

Abbreviations: ABRs = auditory brainstem responses, ALRs = auditory late potentials, CNS = central nervous system, GABA = gamma-aminobutyric acid, 5-HT = 5-hydroxytryptamine, OCB = olivocochlear bundle, SAS = sparse acoustic stimuli, SSRIs = selective serotonin reuptake inhibitors, TEOAEs = transient evoked otoacoustic emissions, UCL = uncomfortable loudness level

Serotonin (5-hydroxytryptamine, 5-HT) is a classic neurotransmitter involved in stimulus reactivity and sensory reception. It is described as having multiple functions in the vertebrate nervous system and modulates sensory, motor, autonomic, and enteric neuronal activity, in addition to influencing vascular and other smooth muscle responses. In the central nervous system (CNS), serotonin is

thought to play a role in many normal and abnormal physiologic and behavioral phenomena, including body temperature regulation, pain modulation, aggression, learning, sleep, anxiety, depression, information processing, and extraction of signals from background activity. Generally, serotonin has inhibitory actions on CNS neurons involved in the transmission of sensory information while facilitating the excitation of motor neurons in the brain stem and spinal cord. By increasing and decreasing the serotonergic activity, the central serotonergic systems help to gate the influx of sensory information while modulating the tone of motor output systems (Vandermaelen, 1985). It has also been suggested that the serotonergic system may be acting in concert with cholinergic receptors to

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improve auditory filtering (Johnson et al, 1998). It has been hypothesized that cerebral serotonin plays an important role in inhibitory modulation, giving rise to activities of an inhibitory type, although participation of other neurotransmitters such as gamma-aminobutyric acid (GABA) and glycine are also required for a complex function such as audition (Calogero et al, 1977).

In the cochlea, 5-HT varicose fibers were found within the intraganglionic spiral bundle, the spiral inner, and the tunnel bundles that are thought to be part of the olivocochlear lateral efferent system (Gil-Loyzaga et al, 1997). In the auditory brainstem structures, serotonin receptors of the subtype 5-HT_{1A} were localized in the anteroventral cochlear nucleus and the pericentral and dorsomedial subdivisions of the inferior colliculus (Thompson et al, 1994). In the auditory cortex, the primary auditory cortex was much more densely innervated by serotonergic fibers than secondary areas (Lewis et al, 1986). Harper and Wallace (1995), using histochemical methods, found that in the young and old ferret (21 postnatal days to adulthood), serotonin fibers were located in the primary auditory cortex mainly in layers I to III. Sheldon and Aghajanian (1990, 1991) demonstrated that serotonin exhibits excitatory influence on GABAergic interneurons via 5-HT₂ receptors, which, in turn, influence pyramidal cells in an inhibitory manner. Hence, it has been postulated that intensity coding in the auditory cortex is probably controlled by inhibition; the intensity dependence of the auditory evoked potentials may be modulated by serotonin at GABAergic interneurons, which eventually affect the excitability of pyramidal cells (Juckel et al, 1997).

Concu et al (1978) showed that the changes in brain serotonin levels were correlated with the latency of the Pa component in auditory evoked potentials in rats. 5-Hydroxytryptophan brought about a significant increase in the latency of the Pa component. They attributed the increase in the latency to the inhibitory effect upon the central acoustic pathways to increased synthesis of brain 5-HT. Bhargava and McKean (1977) found serotonergic mediation of auditory brainstem responses (ABRs) in rats and suggested that 5-HT decreased the number of neural elements firing or the response amplitudes of fibers making up the relays in the auditory pathway. Wu and Siegel (1990) demonstrated the facilitation of the acoustic startle reflex in response to serotonin depletion. Davis et al (1980) reported

inhibition of the startle reflex in response to serotonin infusion in the lateral ventricle. Ebert and Ostwald (1992) demonstrated increased inhibition of spontaneous neural activity on local iontophoresis of serotonin into the cochlear nucleus. These studies support the notion that a potential action of serotonin modulation is tonic inhibition of acoustic pathways.

Inverse relationships between the intensity dependence of auditory late potentials (ALRs) and peripheral measures of serotonin have been found in several studies (Hegerl et al, 1991a, b, 1994; Hegerl and Juckel, 1993; Proietti-Cecchini et al, 1997). A strong amplitude increase of ALRs with increasing stimulus intensity is attributed to low serotonergic neurotransmission (Hegerl et al, 1995). Such intensity dependence has not been documented in ABRs. ABRs have dominated clinically among auditory evoked potential tests. Hence, in this investigation, the intensity dependence test using ABRs and otoacoustic emission testing along with the standard audiologic tests were included.

This study explored the audiologic performance, speech perception, and auditory comprehension performance in a subject prescribed with fluvoxamine and fluoxetine, two widely prescribed selective serotonin reuptake inhibitors (SSRIs). SSRIs facilitate serotonergic transmission by potent and selective inhibition of serotonin reuptake into presynaptic neurons (Pinder, 1997; Hiemke and Hartter, 2000). Fluoxetine was the first specific SSRI described in the literature and was found not to share noradrenergic activity but almost exclusively to affect pure 5-HT reuptake properties (Lucas, 1992). Fluoxetine was found to have at least 1000-fold higher affinity for the 5-HT uptake site than radioligand binding to α 1-, α 2-, β -adrenergic, dopaminergic, muscarinic, histaminergic, opiate, GABAergic, and benzodiazepine receptors (Wong et al, 1995). Recently, there has been a report regarding the use of fluoxetine as a treatment for tinnitus (Shemen, 1998). Fluvoxamine's selectivity for blocking the uptake of serotonin was found to be markedly higher than for norepinephrine or dopamine (Hiemke and Hartter, 2000). Fluvoxamine has an elimination half-life of 16 hours; fluoxetine and its active metabolites have a half-life of 1.9 to 7 days (Leonard, 1992). Also, unlike other antidepressants (tricyclic compounds, monoamine oxidase inhibitors, and neuroleptics), SSRIs do not produce adverse anticholinergic effects like cardiotoxicity, sedation, or weight gain; they do reduce platelet 5-HT levels significantly (Hughes et al, 1996;

Narayan et al, 1998). Peripheral measures such as blood 5-HT levels have been widely used in the search for biochemical abnormalities in psychiatric illness and in the evaluation of the effects of psychotropic drugs on the 5-HT system (Perez et al, 1998).

METHOD

The subject of this case study, a 27-year-old female with no reported hearing loss or tinnitus, exhibited withdrawn depression and various hyperesthesias: hyperacusis and hypersensitivity to touch, pressure, and light. Her taste and smell were spared. She had difficulty comprehending speech and often required multiple repetitions of an utterance. The subject was diagnosed 6 years earlier with low serotonergic activity. Treatment with sertraline hydrochloride, also an SSRI, did not seem to help after 4 weeks. This was followed by the prescription of imipramine, a tricyclic antidepressant, which also did not help relieve her symptoms. The subject was then prescribed fluvoxamine (50 mg/day) and fluoxetine (20 mg/day), which reversibly alleviated her symptoms. Family history indicated that her younger sister exhibits similar symptoms and is on the same medications. Furthermore, the subject has six cousins and an uncle exhibiting depression; all are on medication.

Procedure

Standard clinical procedures were used for (1) pure-tone threshold testing (250–8000 Hz), (2) impedance testing (tympanograms and acoustic reflex thresholds), (3) speech audiometry (speech threshold, word recognition score), (4) click evoked ABR testing, (5) transient evoked otoacoustic emission (TEOAE) testing, (6) uncomfortable loudness level (UCL) testing, and (7) SCAN•A testing (a screening test for cen-

tral auditory processing disorders; Keith, 1986). In addition, phoneme identification (labeling) of consonant-vowel syllables lying along a 12-step phoneme continua was also performed. The consonant-vowel stimuli consisted of synthesized, three-formant, nonredundant, "sparse" acoustic stimuli (SAS) (used successfully in seizure research; Daly et al, 1980) for the single distinctive feature homorganic stop-glide (bE/wE) and the two-feature nonhomorganic stop-glide (gE/jE) contrasts. Blood serum serotonin levels were measured during a medicated and an unmedicated period after ensuring that the subject was in the respective period for at least 6 weeks.

Following approval by the Institutional Review Board at the University of North Texas, the subject willingly underwent a battery of tests while medicated and 2 to 6 weeks following supervised withdrawals of medication (untreated/unmedicated). Pure-tone threshold test, speech audiometric test, and the UCL test (based on Hawkins' [1980] loudness discomfort level testing procedure) were administered using a GSI-10 clinical audiometer. The SCAN•A test, also administered using a GSI-10 clinical audiometer, consists of four subtests: Auditory Figure Ground, Filtered Words, Competing Words, and Competing Sentences. Impedance testing was carried out using a GSI-33 clinical impedance bridge. TEOAE testing was achieved with the Otodynamics Analyzer (ILO92 Otodynamics Ltd.; Version 5 software). TEOAEs evoked in response to 80 dB peSPL nonlinear clicks were measured at the default frequencies (0.8, 1.6, 2.4, 3.2, and 4 kHz) automatically calculated by the ILO92 system. ABRs were obtained on a Bio-Logic Navigator system (Bio-Logic Systems Corp.) using alternating clicks presented monaurally at 11.1/sec repetition rate, averaged over 1024 runs. The electrode impedances during all sessions were maintained at 1000 ohms. Table 1 summarizes the tests

Table 1 Tests Performed on the Subject During Three Unmedicated and Two Medicated Sessions

<i>Session</i>	<i>Condition During Test</i>	<i>Duration in the Condition</i>	<i>Tests Conducted</i>
1	Unmedicated	4 weeks	ABR, UCL, IMP
2	Unmedicated	6 weeks	PT, ST, WRS, SCAN•A, TEOAE, ABR
3	Medicated	6 months	PT, ST, WRS, SCAN•A, TEOAE, ABR, UCL, IMP
4	Medicated	9 months	ABR, speech perception tests
5	Unmedicated	3 weeks	Speech perception tests

ABR = auditory brainstem response, UCL = uncomfortable loudness level, IMP = impedance audiometry, PT = pure-tone test, ST = speech threshold, WRS = word recognition score, SCAN•A = screening test for auditory processing disorders, TEOAE = transient evoked otoacoustic emissions.

performed on the subject during three unmedicated and two medicated sessions within a span of 1 year and 7 months.

Due to the small sample size, the binomial test for small samples was used to identify significant differences between medicated and unmedicated conditions. The criterion adopted for statistical significance was $p < .05$.

RESULTS

Information on the blood serotonin levels was reported to us by the subject based on the records obtained from her physician's office. Serum 5-HT level measured using the high-performance liquid chromatography technique after 6 weeks of no medication was reported to be 146 ng/mL. During that period, the subject reported lethargy, hyperacusis, and irritation with clothing and jewelry. She reported that she was impatient with people at work and at home and could not meet the needs of her active 5-year-old child. Serum 5-HT level during a medicated condition was reported to be 43 ng/mL. The subject reported no hyperacusis, no hyperesthesia, and no withdrawal and, in fact, held a full-time job with no complaints. Dealing with her 5-year-old child did not seem burdensome.

Analysis of data indicated no clinically remarkable differences between the unmedicated and medicated conditions for (1) pure-tone thresholds, (2) speech thresholds, (3) word recognition scores, or (4) tympanograms and acoustic reflex thresholds. Under both conditions, pure-tone thresholds were less than 15 dB HL at frequencies 250 through 8000 Hz. Speech thresholds were within normal limits and matched with pure-tone averages. Word recognition scores were 100 percent bilaterally, and type A tympanograms were obtained in both ears. Ipsilateral and contralateral acoustic reflex thresholds were absent with right ear as probe ear and

Table 2 Transient Evoked Otoacoustic Emission Amplitudes (dB SPL) Obtained From a Medicated and an Unmedicated Condition

	Frequency (Hz)				
	800	1600	2400	3200	4000
Unmedicated right	10	24	15	22	18
Medicated right	5	19	16	19	17
Unmedicated left	5	21	20	26	28
Medicated left	1	14	12	24	25

within normal limits with left ear as probe ear for both conditions. UCLs were, however, different for the two conditions. In the unmedicated condition, the subject's UCLs were 80 and 85 dB HL in the right and left ears, respectively. In the medicated condition, it was 110 dB HL and 95 dB HL, respectively.

Discrete amplitudes of TEOAE response spectrum at 800, 1600, 2400, 3200, and 4000 Hz were analyzed and the values are presented in Table 2. TEOAEs averaged across mid frequencies (1600, 2400, and 3200 Hz) indicated an average of 5 dB SPL stronger emissions for the unmedicated condition in both ears. TEOAE test-retest within-ear variability is usually less than 4 dB (Franklin et al, 1992; Marshall and Heller, 1998). Furthermore, when emissions from all five frequencies were taken into account, the binomial test for small samples indicated significantly greater TEOAEs for the unmedicated condition ($p < .05$).

The SCAN•A results (Table 3) indicated that the composite and all subtest scores were in the disordered range for the unmedicated condition; medicated scores were all within normal limits.

Figure 1 shows a set of unmedicated and medicated ABR waveforms for right and left ears. The electrode impedances were maintained at 1000 ohms during all test conditions. By

Table 3 SCAN•A Results

Subtests	Subject's Standard Score—Unmedicated	Subject's Standard Score—Medicated	Normal Score	Questionable Score	Disordered Score
Filtered Word	3	11	7–16	4–7	1–4
Auditory Figure Ground	1	13	7–16	4–7	1–4
Competing Words	5	14	7–16	4–7	1–4
Competing Sentences	6	9	7–16	4–7	1–4
Composite score	52	113	85–130	70–85	55–70

Subject's unmedicated and medicated test results for the Filtered Word, Auditory Figure Ground, Competing Words, and Competing Sentence tests, along with the Composite scores, are depicted. Also shown are the ranges of scores for normal, questionable, and disordered categories on the SCAN•A test.

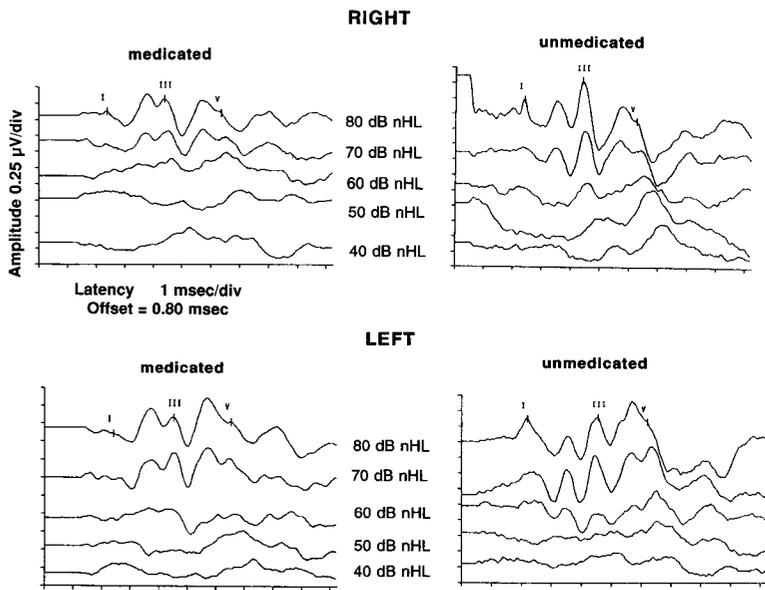


Figure 1 Typical auditory brainstem responses obtained during medicated (left panels) and unmedicated (right panels) conditions, with alternating clicks presented at a repetition rate of 11.1/sec. Upper panels are responses from the right ear and lower panels are from the left ear.

inspection, unmedicated ABR amplitudes were larger than medicated ABR amplitudes, especially at higher intensity levels.

Figure 2 displays intensity/amplitude functions for ABR waves I, III, and V measured during two medicated and two unmedicated conditions for right and left ears. At higher

intensities of 70 and 80 dB nHL, ABR waves III and V in both ears consistently showed greater amplitudes for unmedicated conditions. This was also true for the 60 dB nHL condition in the left ear. This pattern was not exhibited for wave I in a consistent manner. It is also important to note that in the unmedicated condition, consis-

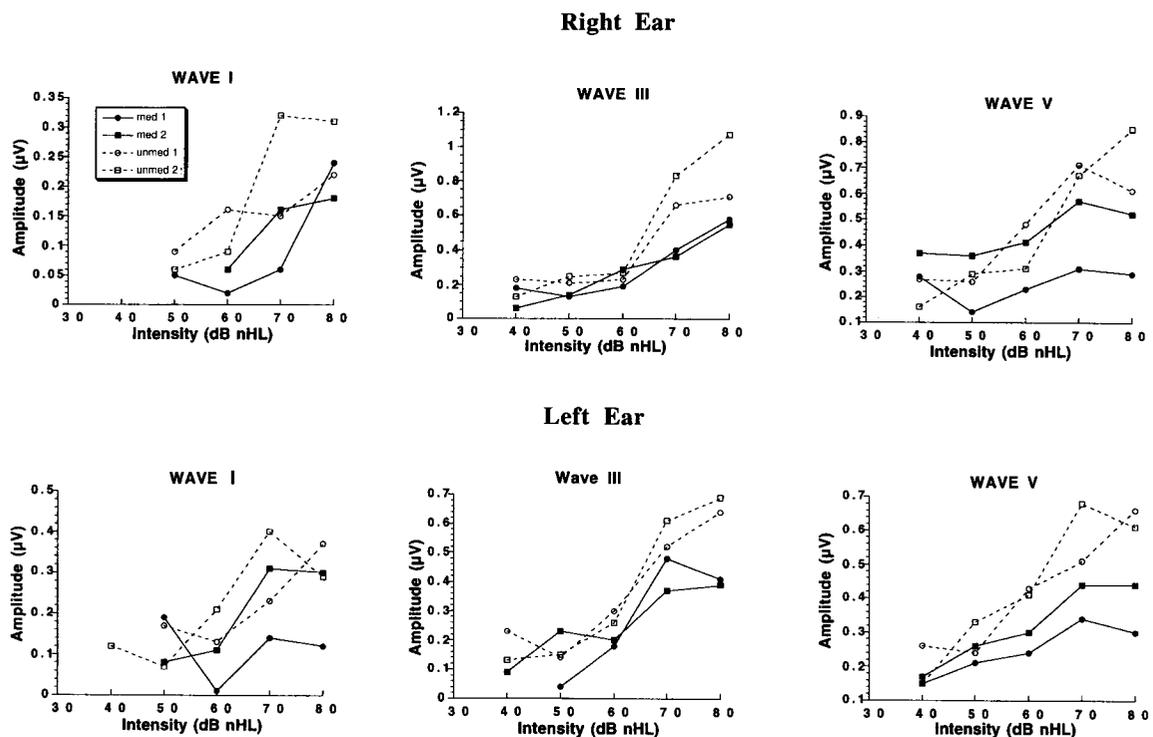


Figure 2 Stimulus intensity level versus amplitude functions of auditory brainstem response waves I, III, and V for right and left ears for two medicated and two unmedicated conditions.

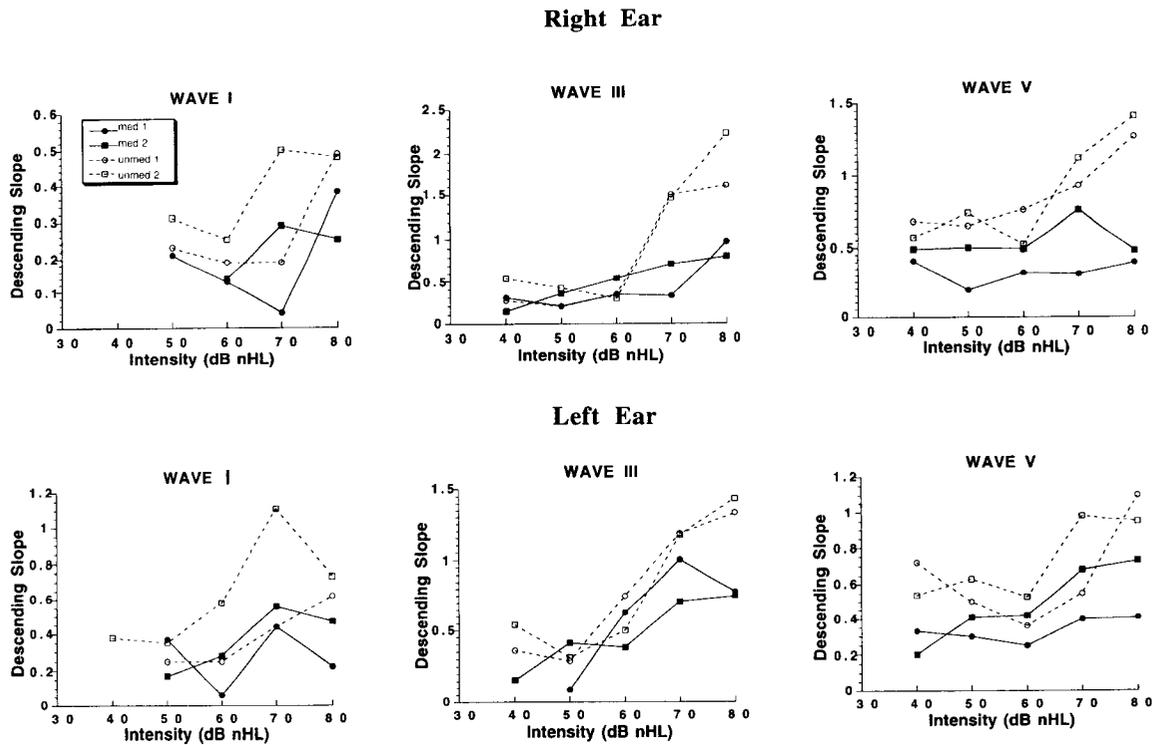


Figure 3 Stimulus intensity level versus descending slopes of auditory brainstem response waves I, III, and V obtained for right and left ears during two medicated and two unmedicated conditions.

tently greater amplitude values for waves III and V were noted only for higher intensity levels and not for lower intensity levels. When amplitude data were collapsed for all intensity levels tested, the binomial test for small samples indicated a significantly greater amplitude for the unmedicated condition compared to the medicated condition ($p < .005$).

Figure 3 presents descending slope/intensity functions for ABR waves I, III, and V; slopes were calculated using the slope vector method (Gopal and Kowalski, 1999). With this method, a descending slope was obtained by measuring the amplitude of a peak from its highest point to the following trough and dividing it by the time

interval between the respective peak and trough. Slope analysis results also indicated that, for the most part, ABR peaks III and V showed steeper/higher slopes during unmedicated recordings for intensities of 70 and 80 dB nHL compared to their medicated counterparts. Descending slopes were significantly greater in the unmedicated condition ($p < .005$, the binomial test for small samples) than for the medicated condition.

Figure 4 exhibits percent correct labeling responses for /gE/jE/ and /bE/wE/. For both continua, the medicated condition yielded well-behaved labeling crossovers at significantly earlier points ($p < .0001$) on the stimulus con-

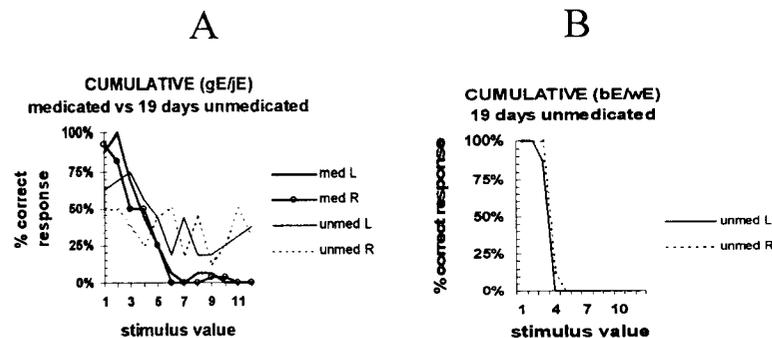


Figure 4 A, Mean percent correct /gE/jE/ labeling function during medicated and unmedicated conditions for right and left ears. B, Mean percent correct /bE/wE/ labeling function for unmedicated condition in the right and left ears. Since unmedicated responses did not differ from the medicated responses, only unmedicated function is depicted.

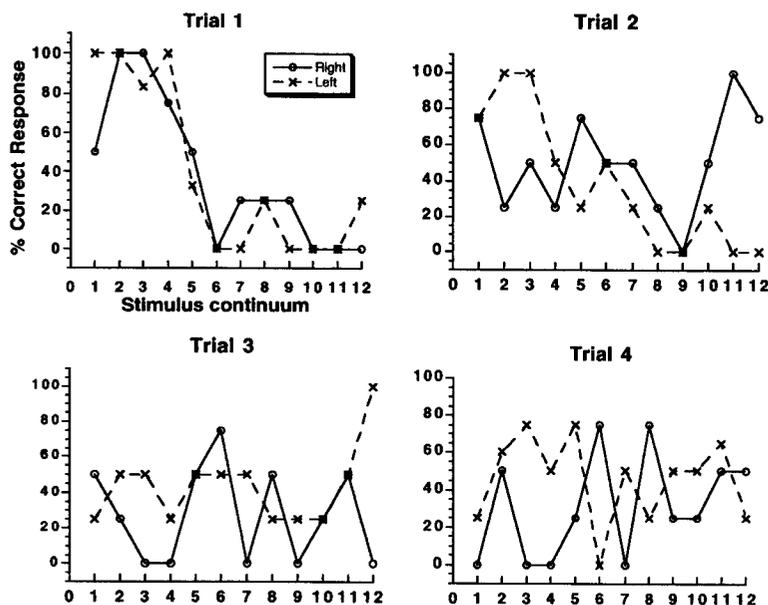


Figure 5 Percent correct response identification of /gE/jE/ labeling function in the first four trials during the unmedicated condition, indicating random assignment of phoneme labels.

tinua than reported for normal subjects by Liberman (1996). Labeling of /bE/wE/ did not differ significantly between medicated and unmedicated conditions (Fig. 4B depicting only unmedicated conditions for both ears). Figure 5 depicts the labeling function for /gE/jE/ from the first four trials during the unmedicated condition (all trials done on the same day, i.e., on the 19th day without medication). In trial 1, the first 8-min labeling trial of /gE/jE/ did not differ significantly from medicated performance. However, the next three successive unmedicated labeling trials, which began without delay from trial 1, differed significantly from the first unmedicated trial ($p < .001$). None of the last three successive unmedicated trials differed significantly from chance performance. Each successive trial after the first differed significantly ($p < .001$) from the next trial, each trial eliciting an essentially random assignment of phoneme labels across stimuli on the continuum.

DISCUSSION

While our subject was on SSRIs, the blood 5-HT levels dropped from 146 ng/mL to 43 ng/mL. Although both of these levels are within the normal or reference range (normal range = 25–208 ng/mL), this decrease in blood serotonin level is consistent with earlier studies (Lucas, 1992; Wong et al, 1995; Hughes et al, 1996; Narayan et al, 1998), which have indicated reduced whole-blood 5-HT and platelet 5-HT levels following SSRI treatment. The reduction in blood 5-HT levels with SSRI treatment is

thought to be due to the greater availability of 5-HT upon uptake inhibition leading to decreases in synthesis and release (turnover) of 5-HT (Wong et al, 1995). Results of this study indicate that SSRIs significantly changed the intensity dependence of ABR components. Fluoxetine and fluvoxamine induced less intensity dependence, whereas the absence of these compounds enhanced intensity dependence. SSRIs also reduced transient otoacoustic emissions, improved auditory processing skills considerably (as reflected from SCAN•A results), and improved the dynamic range of hearing in both ears by elevating UCLs. During medicated conditions, the subject reported amelioration of hyperacusis symptoms and normal sensitivity to bright light and touch. Everyday environmental sounds were no longer perceived as being annoying. Also, the subject expressed no difficulty understanding speech in everyday situations and no lethargic symptoms or depression with SSRIs. Test results from pure-tone, impedance, and speech audiometry, however, did not show any changes in the presence of SSRIs.

There is evidence from earlier research for a pronounced intensity dependence of cortical auditory evoked potentials, called the “augmenting pattern,” probably modulated by cortical serotonergic innervation (Hegerl and Juckel, 1993). It has also been suggested that if there is a decrease in the adaptive CNS mechanisms defending against sensory overstimulation, then subjects may augment their evoked potentials when stimuli are increased in intensity (Wang et al, 1996). Earlier studies (Kropp and Gerber,

1993; Schoenen et al, 1995) have attributed the increased amplitude of averaged evoked potentials to deficient habituation or even potentiation of the evoked responses to stimulus repetition. Habituation is primarily considered to be a protective mechanism against CNS overstimulation. This, in turn, may reflect a less adapting cortical/subcortical auditory mechanism increasingly failing to protect against auditory overstimulation. Marriage and Barnes (1995) have proposed that serotonin dysfunction is a probable cause of central (meaning no peripheral causes) hyperacusis.

In our study, increased ABR amplitudes obtained for higher stimulus intensity levels during unmedicated conditions (despite controlling all stimulus and recording parameters) suggest that the modulation of the intensity dependence exists in the auditory centers of the brain stem. We believe that the amplitude changes observed were not due to any electrode/electrode placement characteristics because (1) the impedances were at 1000 ohms for all conditions and (2) in this study, the unmedicated ABR amplitudes were systematically larger than medicated ABR amplitudes only at higher intensity levels and only for waves III and V. Earlier studies have indicated that the three auditory structures important for auditory information processing are cochlear nuclei, inferior colliculi, and primary auditory cortices. The activities in these centers are modulated by inhibitory inputs, which receive noradrenergic and serotonergic fibers (Cransac et al, 1998). Larger ABR amplitudes in the unmedicated conditions may reflect brainstem hyperexcitability. The abnormal findings on the SCAN•A test indicate a dysfunction in the unmedicated condition, which may be attributed to inadequate control by the auditory system during complex pattern extraction.

Otoacoustic emissions are dependent on the micromechanical integrity of the outer hair cells (Anderson and Kemp, 1979; Brownell, 1990). The outer hair cells are directly modulated by the olivocochlear bundle (OCB). Electrical stimulation of the medial OCB leads to a suppression of the otoacoustic emissions (Mountain, 1980; Siegel and Kim, 1982). Acetylcholine is an important neurotransmitter in the OCB, and serotonin has been found to influence cholinergic systems linked to cognitive processes such as attention and learning (Steckler and Sahgal, 1995). Case studies have indicated large ABR amplitudes in patients with tumors in the brain stem, which are thought to be due to a compromised OCB since there is evidence of OCB mod-

ulating the auditory nerve response (Musiek et al, 1994). In this case, it is speculated that for the unmedicated condition, the TEOAEs were larger due to the decreased inhibitory effects of the OCB, probably induced by low serotonin levels.

The phoneme labeling test results shed additional light on altered central processing. The medicated subject labeled the simple, one-feature /bE/wE/ continuum and the more complex, two-feature /gE/jE/ continuum. However, the crossover in labeling between the stop and the glide phonemes occurred for shorter, more rapidly moving formant transitions for both continua. That is, the subject accepted as glides very rapidly moving stimuli ordinarily labeled by normals as stops (Daly et al, 1980; Liberman, 1996). That is, the subject was "hyposensitive" to formant velocity, accepting what was faster moving as a good representative of what was ordinarily slower moving to the normal listener, thus labeling fewer of the /bE/ and /gE/ stimuli as stops. Equally interesting is the fact that the featurally "simpler" /bE/wE/ continuum was labeled equivalently under medicated and unmedicated conditions on repeated trials. The more complex place and manner differences conveyed by the /gE/jE/ (Stevens, 1998) continuum resulted in rapid, significant deterioration between the first and second through fourth sequential labeling trials, the latter three exhibiting chance performance. The unmedicated trial-linked loss of /gE/jE/ contrastivity must derive in part from the complex and nonredundant encoding (loading) of two distinctive features into a single acoustic feature, F_2 - F_3 transition velocities (time), in the milieu of reduced central serotonin levels. Redundant, natural speech encodes /gE/jE/ with multiple cues for place and manner in both the temporal and frequency domain (Stevens, 1998), whereas Haskins Laboratory workers (i.e., Daly et al [1980] and Liberman [1996]) used only a single temporal cue to convey two distinctive features. The presence of earlier crossovers demonstrates altered temporal-spectral processing of speech by this subject, even with the use of medication. Neural sharpening based on inhibitory processes is postulated as an important mechanism for enhancing segmental contrastivity prior to the phonologic identification of distinctive features (Liberman, 1996). The labeling data suggest that altered phoneme perception, probably at the acoustic versus phonetic clue interface, can be probed usefully in such patients with sparsely cued speech stimuli as well as those spectrally

and temporally distorted stimuli used by the SCAN test.

CONCLUSIONS

1. SSRIs did not have a significant effect on auditory thresholds in this subject. However, higher level auditory processing such as the ability to respond to unfavorable or distorted auditory signals and tolerance to loud sounds were found to improve with SSRIs.
2. Intensity dependence of the ABR was found to be greater in the absence of SSRI intake.
3. The transmitter deficiency appeared to alter processing of acoustic-phonetic features, even when medication was being taken, a deficit that was aggravated by task demands and by ambiguities introduced into the speech stimuli.
4. Labeling of consonants was altered significantly when the subject was medicated, with greater disruption of more complex labeling tasks when unmedicated; the most challenging consonant labeling task rapidly descended to chance performance on successive unmedicated trials. Therefore, SSRIs do not ensure normal speech perception performance.
5. Locating the sites along the auditory pathway where speech perception deficits may occur depends on checking cochlear function for deficits in basic psychoacoustic performance before introducing speech perception tasks whose accomplishment depends on specific sensory processing localized to specific CNS waystations above the level of the cochlea. The degradation of neural sharpening, especially when unmedicated, may be a key phenomenon in the deterioration of speech perception. However, reduction in oversensitivity with SSRI in auditory, visual, and touch modalities points to a more central effect than pure cochlear effects.

Limitations

1. Only a single subject was examined for this case study; generalization of these results is limited.
2. The possibility of other transmitter systems (e.g., cholinergic system) interacting synergistically with the serotonergic system cannot be ruled out.

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