SIMPLE, EFFECTIVE THERAPY

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WORDS-IN-NOISE: THE RIGHT EAR FIX

Like most people I hate to steer people wrong. So, when I noticed that the usual approach to improving poor WINT performance in the right ear was not working well I tried to find a fix and mentioned the problem in the April issue of SET. I reported that my initial approach to fixing the problem was not working too well, but a modification seemed to have promise. It continues to do well so I think we may have a fix for the right-ear noise problem.

There were more SET issues on WINT than I had planned because this seemed like an important problem. In addition, this curiosity presented a most interesting theoretical/physiological question that goes well beyond WINT and auditory processing.

BACKGROUND

Speech-in-noise training is an important component of auditory processing training. I have used the WINT procedure for the past 40 years. The series generally starts with speech-in-quiet and then background noise is introduced at a rather faint level. From this point the intensity is increased 2dB for each 10 words. WINT is halted when the noise is at 0dB SNR (Vickie Hamilton recently asked why we don't go into the negative SNRs. One could certainly do that.) This procedure is repeated on subsequent visits (using different words) and almost invariably errors are reduced over time. We have seen quite good results on the therapy materials as well as on the speech-in-noise retest and in the assessments of parents and teachers regarding the initial noise problems (see SET v 2, #3).

We usually present WINT binaurally through a loudspeaker or headphones. But it seemed to be a good idea to also check individual ears to uncover if there were unilateral problems. a) We

use a single ear for the telephone and perhaps for other electronic devices, and also b) the binaural advantage (in noise) is likely most effective when the two ears are about equally effective.

To compare the performance of the two ears we use the Alternate (ALT) procedure. We test each ear with similar noise conditions at about the same time to avoid bias and maximize face validity (see SET v 2, #3). Often we repeat ALT the following session to be sure that we are dealing with real rather than momentary problems. For the second ALT we reverse the first ear tested to insure that it is not an order effect.

The Problem

When we did the ALT procedure we often found that the right ear was poorer than the left and this was generally confirmed when we repeated ALT, so we began working on the poorer ear. When it was the left ear we saw rather quick or expected progress with training. But this was not the case with the right ear. Right ear training results were divided into 3 groups. One group improved as we would expect, a second group remained at about same level as when they began (± 3dB) and the last group got poorer with training to that ear. These last two groups were of interest and concern. This was very strange, but the job was to figure out how to improve that ear and if not whether we should be doing right ear therapy alone. (This right ear phenomenon could lead to some interesting research.)

Initial Right Ear Deficit Hypothesis

I remember reading two articles, one with dyslexics and the other with kids who had APD that reported a phenomenon that could explain these results. For the dyslexics, when reading, they found that the areas of the brain that should have been physiologically active for reading were at rest. In the other study, I believe there was a similar finding that would explain an ear difference (my recollection is left ear better when given before the right ear but poorer when the right ear was tested first). I thought if the easier right- ear condition was given first that the left-ear system may have gotten too lazy instead of providing for even greater attention that it would require (or something like that).

When I mentioned my idea to my Psychologist colleague at work, who does NeuroFeedback therapy, he had a different take. Dr. Avery Bratt indicated that in his literature they have described a similar phenomenon, which I found both fascinating and a better fit to my right-ear WINT problem. He explained that in some cases in which there is a high EEG ratio of theta waves to beta waves (a high theta-beta ratio), they saw similar problems. A high ratio of theta waves suggests poor attention, concentration difficulties, distractibility and poor

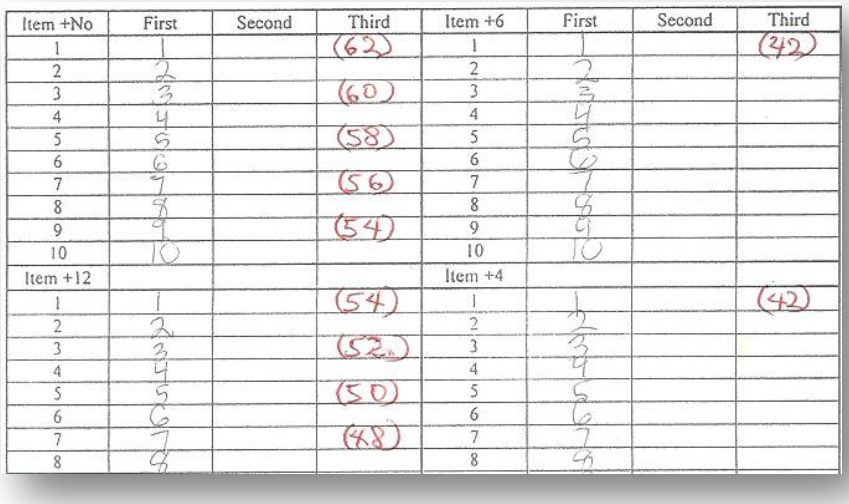
comprehension. When they found that theta was much higher than beta waves during a learning situation and if further pressure was applied to perform better; performance actually got worse. In such cases there is an increase in high beta and an increase in the theta beta ratio that causes poorer performance (Swingle, 2008). Wow, what an important phenomenon and how many situations would that apply to in addition to WINT. If some of our kids are consciously or unconsciously up tight (lets hypothesize high beta) then it would be a good idea to calm them down in some way.

Initial and Subsequent Attempts to Improve Right Ear Performance

Before I had heard of the theta-beta ratio I had devised a procedure based on the Stenger Effect. You may remember the Stenger describes a situation in which the same word is presented to both ears at the same time but when one is significantly louder than the other, we're only aware of the louder one. It appears that we are just attending to the louder ear. So I used a fade procedure with equal intensity to each ear and gradually reduced the level to the left ear. Initially, with equal intensity to each ear the image is heard in the midline. When the left ear signal is reduced by 2 or 4dB there appears to be little change in the location of the word, but with further reduction of the left ear the image appears to gradually move toward the louder ear. When it is 10 or 15dB more intense in normal hearers the image appears to be completely in the more intense ear (the right ear in this case). But this approach did not seem to improve the performance of the children.

In my initial attempts I let the youngster know what I was doing (i.e., there is a problem with the right ear and I will gradually reduce the left ear from binaural condition to the right ear). But, once I realized that it could be some aspect of anxiety-attention I modified the approach and instituted a diversion. With a potentially high theta-beta ratio it might be better not to mention the right ear and to surreptitiously reduce the level in the left ear. Therefore to keep the child's mind off the change and which ear was being stimulated I had the children enter a "1" after they said the first word and a "2" after the second word etc. (see Figure 1). For each sublist they begin the numbering again from 1 to 10.

I did not know if I should expect an immediate improvement or a gradual one for the right ear. That is, would it improve "attention" immediately or gradually in the right ear? Another consideration was that if there was a processing problem in the right ear for whatever reason then just correcting the attention aspect would not alter the performance dramatically right away. I was eager to see if it would work out and if so would it be fast improvement or slow.



Item +No	First	Second	Third	Item +6	First	Second	Third
1	1		(62)	1	1		(42)
2	2			2	2		
3	3		(60)	3	3		
4	4			4	4		
5	5		(58)	5	5		
6	6			6	6		
7	7		(56)	7	7		
8	8			8	8		
9	9		(54)	9	9		
10	10			10	10		
Item +12				Item +4			
1	1		(54)	1	1		(42)
2	2			2	2		
3	3		(52)	3	3		
4	4			4	4		
5	5		(50)	5	5		
6	6			6	6		
7	7		(48)	7	7		
8	8			8	8		

Figure 1. The first time this child took the WINT-1 fade procedure. She wrote in the numbers in the "first" column after saying the word etc. In red I show you the levels that I was gradually reducing in her left ear (until 62dB right & 42dB left).

THE UNOBTRUSIVE FADE PROCEDURES (UFP)

I am sorry to say that I could not figure out how to do the fade procedure with the WINT-3 CD (that is speech in one channel and noise in the other - used with an audiometer) because I could not reduce both the speech and noise in the left ear alone and maintain the level in the right ear. I was only able to do it with the WINT-1 CD (that has the same built-in increments of noise in both channels). WINT-1 has 8 subsists per series beginning with no noise, then +12dB SNR, +10 etc. I set both channels to 62dB and then gradually reduced the left-ear-channel as shown in Figure 1. As you can see I generally keep the same level when I go from one sublist to the next (note 54dB for both). I don't know if that is helpful or not, so that is not an important part of the procedure.

The child is told that she will be hearing some words as she usually does (though the earphones) and what I would like her to do is to say the word that she hears first and then to mark down "1" in the first box. Then after saying word 2 to write down "2" in the next box and so on. After the first 10 words I point to the next group of boxes and ask the child to do the same. To add authenticity to the writing task I occasionally glanced at the sheet and compliment the child. Fortunately, no one yet has asked me why they are doing this. Yesterday I had a child with some motor difficulty and I had to stop the CD fairly often at first, but less so as we went along. I tend not to make repairs/corrections when there are errors

using this procedure. It gets unnecessarily complicated with the written the numbers and corrections might call attention to right-ear errors.

The Results So Far

I have data for 8 children. While this is not a great number, the data look fairly consistent for the UFP so we can look tentatively at the results to date. The children range in age from 7 to 13 years (mean = 10.0) and there are 5 boys and 3 girls. Each of them had poorer ALT performance in the right ear compared to the left and compared to their loudspeaker (FF) performance.

Figure 2 is interesting and encouraging but some of the data are based on few or interpolated scores. Because of spaces in the data it was necessary to interpolate so I moved up scores by one or 2 series to avoid having or omitting single scores etc. We will start at the bottom of the figure on the left side. The loudspeaker (FF) condition shows the curve across the series. What struck me first was that this curve for the 8 children is very similar to the curves in the previous issues that represent larger populations. So an important observation is that no harm was done to the regular FF condition despite the number of series that were devoted to working with the individual ears in this group.

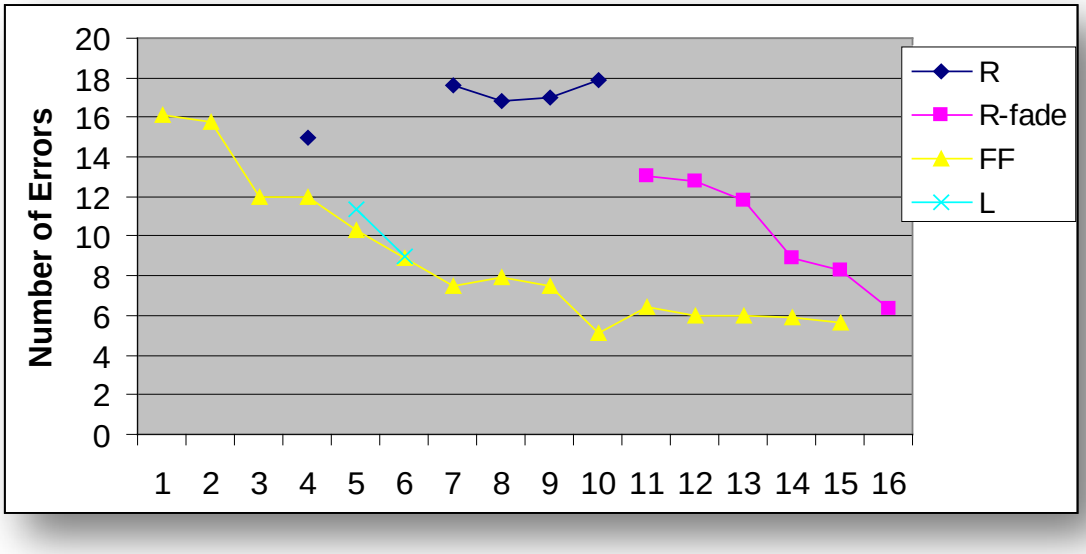


Figure 2. This shows initial errors in the right ear, the subsequent UFP as well as the FF curve and two ALT scores for the left ear. The X-axis shows performance across the 16 series.

Look at the bottom of Figure 2 on the left side. The loudspeaker (FF) condition shows the error-curve across the series. What struck me first was that this curve for the 8 children is very similar to the curves in the previous issues that represent larger populations. So an important

implication is that no harm was done to the regular FF improvement despite the number of series that were devoted to working with the individual ears.

The second curve is just two data points for the left (L) ear (series 5 and 6). It is interesting to see that these means hug the FF data and show importantly that the left ear is consistent with the FF data in these subjects (who have right ear deficits). When we look at the first two points for the right (R) ear data we can see that although the initial R-ALT score was poorer than the L-ALT and FF scores; the second R-ALT was even poorer than the first one! This is the pattern that caused my initial R-ear concern in the previous samples that may be explained by the theta-beta ratio.

I am not confident in the last 3 R-data points (series 8-10) because before I interpolated the data the curve looked better. With time and more data we shall have a more solid understanding– but, so far so good.

I was most curious how the UFP data would look (starting with series 11). The first 2 data points are about equal showing no dramatic improvement, but by the 4th session the UFP curve was descending rapidly. Although UFP started so much poorer than the FF scores by the end it appears that the FF and UFP scores were about equal. I'm excited to see this improvement with the UFP method.

Some Preliminary Thoughts about the Physiology of this Right Ear Deficit

What can account for the right ear (RE) errors to exceed those for the left ear (and FF as well) and then not improve with therapy?! If by chance it is due to the adverse theta-beta ratio why would that affect the RE in particular? We usually think of the LE as the weaker one because it requires a longer route to the auditory cortex in the L-hemisphere. That is, the main pathway from the LE goes to the R-hemisphere and from there must cross the corpus callosum to the L auditory cortex. On the other hand the RE information goes directly to the L auditory cortex.

I think that two major factors could contribute to the RE deficit. The first factor is based on the work of Efron et al. (1983). They showed that the anterior temporal lobe is associated with the "cocktail party effect". When the anterior temporal lobe was amputated the patients immediately experienced a great decrease in their understanding in noise. Importantly they hypothesized that from the anterior temporal lobe there is an efferent pathway that goes back to the auditory cortex (apparently ipsilaterally) and from there it descends to the cochlea. This would connect the anterior temporal lobe to speech-in-noise functions in the cochlea and that this suppression, or lack of suppression, is ipsilateral.

If Efron et al. are correct, the second factor is why is the affected ear the RE and how could this relate to the anxiety influence suggested by the theta-beta ratio? The most recent *Audiology*

Today provides a connection of anxiety with the anterior temporal lobes. Genna et al. (2010) state,

> *"…these fibers continue to the limbic[1] system, which is involved in emotional responses. Some fibers continue onto the amygdala, a small structure located deep within the [anterior[2]] temporal lobes that is active in emotional memory, learning and conditioning. Direct stimulation of the amygdala can produce flashbacks of fearful situations… (p 57)"*

[1] You may recall that I have discussed for many years the "limbic effect" with regard to speech-in-noise performance that appears to be anxiety related, which may be improved by WINT.
[2] My clarification because, for this discussion, the precise location of the amygdala is important.

This provides an explanation why the anterior temporal lobes may be involved in aspects of speech-in-noise as reported by Efron et al. and why I have associated WINT with desensitization training (Katz, 2009) and stated, "The first is a sharp decline in speech-in-noise errors that I associate primarily with the Limbic Effect. As noise becomes less annoying or distracting the children seem to be able to concentrate and respond better to the words. (p 74)"

While the L-hemisphere is associated with language and logical thinking, the R-hemisphere is associated with emotions. For this reason I assume that the R amygdala is the one that is "dominant" for emotions (just as the L is dominant for language). So the major negative effect might emanate from the R amygdala to the R auditory cortex (if Efron et al. were correct) and then down to the right brainstem and cochlea.

In WINT (a procedure that is influenced by anxiety and inattention) as anxiety and emotions increase from a high beta to an even higher level, it would make sense that it would increase the theta waves (reducing attention) and thereby reducing WINT performance primarily in the RE.

Now comes the Unobtrusive Fade Procedure. Without making an issue of the problem or the RE we give the child a distracting task that enables us to surreptitiously and gradually reduce the dB-level to the left ear. The child is more likely to be calmer/more attentive especially when it appears that the presentation is midline. After saying the word, it takes some concentration to do the numbering, so this distraction might reduce anxiety and draw attention away from which ear is doing the work.

Summary and Conclusion

Curiously we see depressed scores in the right-ear-only WINT condition in many children. These preliminary data suggest that the new fade procedure works well to correct the problem so that the right-ear performance at the end is consistent with the FF condition and that the FF condition is consistent with the data from those who do not have the right-ear problem. I feel rather confident that we have a fix for this deficit. Of course, we do not know how the children would have fared if we had continued to do the regular right-ear therapy, but likely not any better than these children. Further data are needed to confirm these findings. In addition to the WINT implications of the theta-beta ratio, there are other times when we see poorer attention in the children (and adults) when better attention is required.

Post Script

When I realized that the fix for the RE problem would require the WINT-1 for people who were likely using WINT-3, I contacted Upstate Advanced Technologies <gsbusat@frontiernet.net> to see if they could give a break to those who had one CD and wanted the other as well. They gladly agreed. Please check with them if you would like to get WINT-1 (or -3) as well.

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