Helping the World Think Better

SPORTS REPORT

Before creating the report, the raw waves and P300 waveforms should be reviewed for potential confounding problems and/or excessive artifacts (see physician IFU). All eyes closed results are from data collected during the P300 protocol.

Audio P300

The WAVi P300 is an event-related EEG signal time-locked to the onset of the higher (rare) tone and is displayed as a negative voltage occurring roughly 300 milliseconds after the tone is delivered. The amplitude is considered proportional to the amount of attentional resources devoted to recognizing the tone and the latency a measure of classification speed. An increase in latency and/or a decrease in amplitude has been observed in various conditions associated with reduced cognitive function, including aging, dementia, depressive disorders, trauma, and vascular issues. Some clinicians use this non-specific P300 measurement to investigate interventions that increase amplitude and/or decrease latency, others use P300 as a basis for patient tracking.

WAVi administers 200 common and 40 rare tones. The reports show the largest amplitude (in uV) and shortest latency (in ms) from the 6 central parietal channels alongside age-matched values into which 66% of the patients are expected to fall. Typically, P300 latencies fall between 250-400 ms. In the absence of a strong P300, longer latencies may be reported and it is suggested that in these cases the P300 waveforms be reviewed, as well as literature associating long latencies with various conditions. For comparison reports the percent change from baseline is shown alongside the expected change from a personal average. This means that on any given test, 66% of the patients should fall within twice this range if from a single baseline.

Audio Reaction Time

Physical reaction time to an audio stimulus is recorded when the patient clicks the mouse as they hear the high tone of the P300. This measure is considered distinct from the latency measure of brain speed. A P300 latency measurement can therefore be taken even if the patient does not click the mouse. Reaction time is known to slow with trauma, aging, and other conditions.

Trail Making

The Trail Making Test is a commonly-used neuropsychological test that is sensitive to a variety of neurological impairments and processes, providing information on visual search, scanning, speed of processing, mental flexibility, and executive functions. The scores represent the amount of time required to complete the task. The cognitive alternation required by Part B reflects executive functioning, although other cognitive abilities, such as psychomotor speed and visual scanning, are also required for the successful completion of the test. Studies show declining performance with increasing age, which form the basis of the age references presented on the reports.

Theta/Beta at Cz

The WAVi report compares the patient theta/beta ratio to a reference. Theta/beta ratios associate with cortical arousal and high theta/beta ratios have been shown to consistently differentiate between ADHD and normal samples, with meta analyses showing up to 94% sensitivity and specificity. Eyes-open focused providing the strongest result. The theta/beta ratio trait may arise with other conditions, and with some medication as well and so this non-specific measure is included in the sports report because some researchers want to screen for changes in state, medications, or for pre-existing conditions while investigating trauma management.

F3/F4 Alpha Power

EEG studies have found a link between hemispheric asymmetry in frontal regions of the cortex and depressive symptoms, with meta analyses showing moderately large effect sizes suggesting that both depression and anxiety are meaningfully related to relative right-sided resting frontal EEG asymmetry at rest (F3/F4 <1). It has been proposed that an atypical pattern of resting frontal cortical asymmetry can serve as a stable, trait-like risk factor for the subsequent development of depression or other emotion related disturbances, where hemispheric specialization for cortical systems mediates motivational and emotional processes.

This measure is included in the sports report because some researchers want to screen for changes in state, medications, or for pre-existing conditions while investigating trauma management.

Tension

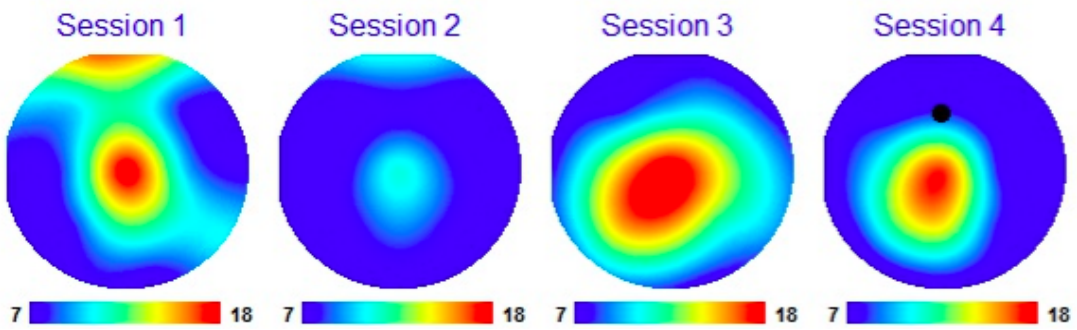
WAVi software IFU includes asking the subject to clinch so that both the administrator and subject get a feel for the effects of muscles tension on the EEG signals, typically in the beta frequency range. Because muscle tension, both in the neck and jaw, can be associated with a potential concussive impact and often presents with similar symptoms as concussion, clinicians may want to manage this tension. Excess muscle tension may be seen in 2 ways from the scan: both from heightened activity on the raw signal or from the ratios presented here.

Helping the World Think Better

Audio P300 Memory/Attention (Best Central Parietal)	Session 1 (7/31/2014)	Session 2 (11/1/2015)	Session 3 (11/14/2015)	Session 4 (1/21/2016)	Ref. Range (20 yrs)
P300 Delay	248 ms	280 ms	344 ms	272 ms	257–305 ms
Test/Retest Change	-	12%	38%	9%	6%
P300 Voltage	18 µV	11 µV	18 µV	17 µV	12–22 µV
Test/Retest Change	-	-34%	2%	-4%	12%
Physical Reaction Time Increases with age.	0 (±53) ms	252 (±34) ms	229 (±39) ms	209 (±28) ms	246–316 ms
Assessments					
Trail Making Test A	N/A	N/A	N/A	N/A	12–28 sec
Trail Making Test B	N/A	N/A	N/A	N/A	33–77 sec
State (Power)					
CZ Eyes Closed Theta/Beta	1.7	2.2	1.8	1.8	0.8–2.8
F3/F4 Eyes Closed Alpha Asymmetric in some depression and anxiety	1.7	1.2	0.9	1.3	0.8–1.2
Muscle Tension (β Power)					
T3/CZ (Left Jaw)	0.7	0.8	0.6	0.8	-
T4/CZ (Right Jaw)	0.8	0.7	0.6	0.6	-
O1/PZ (Left Neck)	1.1	1.1	1.0	1.3	-
O2/PZ (Right Neck)	1.3	1.3	1.1	1.3	-

P300 Depth (µV)

BLACK DOTS INDICATE LOCATIONS WITH LESS THAN 25 CLEAN P300 RESPONSES



References

Audio P300

1. Polich, J. (2004). Phys Med Rehabil Clin N Am, 15, 133-161.
2. Gordeev, S. (2007). Human Physiology, 33(2), 236-246.
3. Dupuis, F. et al. (2000). Clinical Neuroscience and Neuropathology, 11, 4087-4092.
4. De Beaumont, L. et al. (2009). Brain, 1, 695-708.
5. Müller, A. et al. (2015). NeuroReport, 26, 952-957.
6. Rapp, P. et al. (2015). Front Hum Neurosci, 9, 11-57.
7. Broglio, S., Pontifex M., O'Connor P., and Hillman C. (2009). J Neurotrauma, 26(9),1463-1470.
8. Boone J. et al. (2016). Event-related potentials and heart-health. In progress.
9. Age-matched values extrapolated from V. Iragui et al. (1993). Psychophysiology, 30,10-22; Podar et al. (2016). ERP for Sports Concussion. In progress.

Audio Reaction Time

1. Eckner, J., Kutcher, J., Broglio, S., & Richardson, J. (2014). British J Sports Med, 48(2), 112-118.
2. Tun, P and Lachman, M. (2008). Dev Psychol, 44(5), 1421-1429.

Trail Making

1. Ashendorf et al. (2008). Archives of Clinical Neuropsychology, 23(2),129-137.
2. Tombaugh, T. (2004). Archives of Clinical Neuropsychology, 19, 203-214.

Theta/Beta at Cz

1. Reference values extrapolated from Snyder, S. and Hall, J. (2006). Journal of Clinical Neurophysiology 23(5), 440-455; Podar et al. (2016). ERP for Sports Concussion. In progress.
2. Snyder, S. and Hall, J. (2006). Journal of Clinical Neurophysiology, 23(5), 440-455.
3. Loo, S. and Russell, B. (2005). Applied Neuropsychology 12(2), 64-76.
4. Arns, M., Conners, C., Kraemer, H. (2013). J Atten Disord, 17(5), 374-383.

F3/F4 Alpha Power

1. Thibodeau, R., Jorgensen, S., and Kim, S. (2006). Journal of Abnormal Psychology, 115(4), 715-729.

Muscle Beta Tension

1. Reference values for beta power from Podar et al. (2016). ERP for Sports Concussion. In progress.