

# Differential effects of temporal-cortical and hippocampal lesions on a fused-words dichotic listening test

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## The Principle of Fused Rhymed Words Test

**FRWT:** The "Fused Words" (FW) Test, a dichotic listening (DL) test can be applied in questions of speech lateralization and callosal functions (Wexler BE & Halwes T 1983). Simultaneously two different but rhyming words are presented to the subjects, while they believe to hear only one. For the purpose of synchronisation, the respective word-pairs were digitally edited from recordings of natural speech.

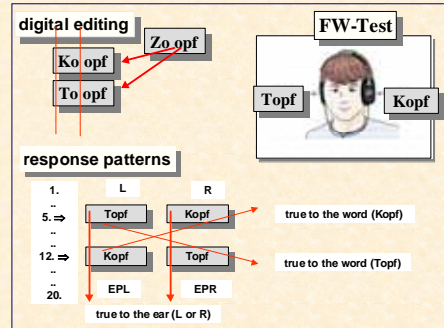
The present German adaptation of this test (FW10b, Hättig & Beier 2000) consists of 10 fused word pairs (Items). In a complete run every item is presented in both orientations (A-B and B-A) in a pseudo random order (= 20 dichotic presentations). The complete test consists of 8 different pseudo random runs (= 160 dichotic presentations).

After each presentation the subjects respond with the word which they believe was presented (actually two were presented).

If the subject responds within a run in both orientations with the word from the same ear ("true to the ear") then one ear-point (EP) is counted for the respective ear (L or R). All other possible response combinations ("true to word") do not contribute to the lateralization score.

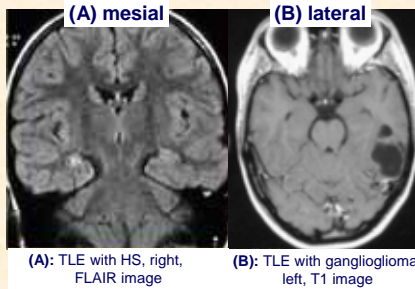
From the resulting EPs (max. 80) the lateralization index lambda ( $\lambda$ ) is computed ( $\lambda = \ln(EPR/EPL)$ ). If EP-L or EP-R equals zero (0) then 0 is substituted by 1.

Before the presentation of the dichotic stimuli, monaural word recognition is tested. Each of the 20 words is presented to each ear monaurally (= 40 monaural presentations). All presentations, responses and computations are realized and coordinated by PC programs. The administration of the complete test (200 presentations) mostly takes between 17 and 20 minutes (200 x 6 sec = 1200 sec = 20 min), depending upon the response speed of the subject.



**Introduction:** Validation studies of FW-tests indicated a high correlation with the language lateralization classification by the Wada-Test in the categories left, bilateral and right (Zatorre 1989, Fernandes & Smith 2000).

In an preliminary validation study of the present German adaptation of this test (FW10b) in a group of 23 Wada-examined epilepsy patients a concordance of 86% with the results from the Wada lateralization was found (Hättig & Beier 2000). As in the american original, to disentangle bilaterality and to differentiate the group of left lateralized and bilateral organized individuals created the most difficulties. In healthy subjects this test showed valid results in an fMRI study (Hund-Georgiadis et al. 2002).



Some studies indicate, that FW - tests are less susceptible to attentional effects than CV syllables - tests (Asbjornsen AE & Bryden MP 1996). But there is still a controversy whether FW-tests are free from significant contralateral ear suppression (lesion effect) in candidates for epilepsy surgery. For the interpretation of FW-tests in such a clinical context this seems to be a crucial question.

We studied whether a lesion, which involves extra hippocampal temporal structures (temporal stem, temporal neocortex) affects the FW-DL outcome more than a pure hippocampal lesion (hippocampus sclerosis, HS). The factor temporal pathology (tP) consists of two classes (mesial vs lateral). In the temporal-mesial group only HS were included. The temporal-lateral group consists of pathologies with heterogeneous aetiologies in the temporal lobe.

### (1) All Wada Categories

	lateral		mesial		all temporal	
N	30		52		82	
N	15	15	33	19	48	34
Index	left	right	left	right	left	right
Lambda	0,45 <	1,53	1,02 <	1,56	0,88 <	1,53
EP-L	7,73 >	5,20	5,21 >	3,00	6,21 >	3,97
EP-R	9,93 <	18,93	13,09 <	17,47	5,92 <	18,12

**Methods:** From the Berlin Epilepsy Center the data of N=82 patients with refractory temporal lobe epilepsies were categorized according to whether their lesion involved extra hippocampal temporal structures (temporal stem, temporal neocortex, temporo-mesial, N=52). Before surgery all patients passed an extended neuropsychological evaluation, a FW-DL test and a standardized MRI (coronar, saggital and temporal planes with T1, T2, IR and FLAIR images). The Wada Test was administered according to the Bethel-Cleveland protocol as a bilateral same day injection. Roughly half of the patients had their first injection into the lesion side (intended operation side, Bengner et al. 2003).

**Results (1): All Wada Categories**  
In the temporal-lateral group we observed a significant effect of contralateral ear suppression on answers from the right ear (REP) in left-sided lesions ( $p=0.05$ ), irrespective of Wada lateralization.

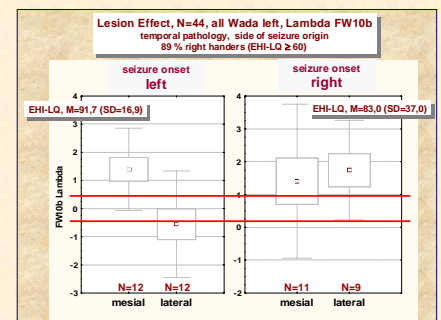
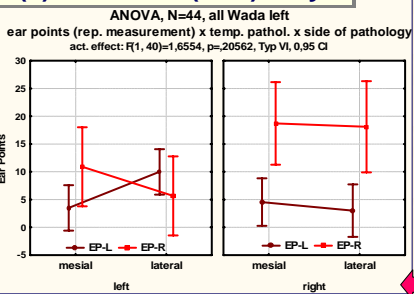
**Results (2): ANOVA with Ear - Points, EP-L, EP-R**  
For further analysis we selected only those patients N=44 showing left hemispheric language lateralization in the Wada test (W-L). Among the 25 male (age M=38,8 SD=12,1) and 19 female (M=34,6 SD=8,7) patients were 5 non-dextrals (EHLQ  $\leq +60$ ). The epilepsy started in women 1,8 years earlier and the duration of the epilepsies until the present assessment were 1,9 years shorter. Patients with temporal-lateral pathology tended to be younger (33,7 vs. 40,0 years,  $t=1,99$ ,  $p=0,053$ ) and their epilepsies were of a shorter duration (16,9 vs. 22,0 years,  $t=-1,89$ ,  $p=0,100$ ).

Patients with right temporal lobe pathology had fairly normal right ear responses. Left TLE patients showed a general suppression of EP-R (red bars, left half). Furthermore, in patients with left hemispheric pathology the lateral group had a stronger EP-R reduction and at the same time an increase in EP-L. The general ANOVA model was significant for EP-R and showed the expected significant interaction between EP (R1) and the side of seizure onset (SSO), ( $F=7,07$ ,  $p=0,011$ ).

**Results (3): ANOVA with Lambda Values (SSO x tP)**  
The lambda values had homogeneous variances (Levene  $F=1,314$ ,  $p=0,283$ ) and the global model was significant ( $F=3,78$ ,  $p=0,017$ ). The ANOVA showed significant effects for SSO (main effect  $F=4,35$ ,  $p=0,043$ ) and the interaction between SSO and tP ( $F=4,29$ ,  $p=0,044$ ). For left SSO the contrast between the mesial and lateral group was significant ( $F(1,40)=6,941$ ,  $p=0,011$ ) while for the right SSO it was not ( $F(1,40)=0,166$ ,  $p=0,685$ ).

The ANOVA at the level of the lambda values showed that only the left - lateral group had reduced lambda indices (see graph below). Values above the upper and below the lower horizontal red lines indicate significant left-hemispheric (+) or right-hemispheric (-) language lateralization with the FW10b test (reference data from a sample of N=68 healthy male right handers).

### (2) Wada-left (W-L) only



### General Model

	R	EP	tP	Model	Max	Min	F	Res	Res	F	p
EP-L	0,39	0,154	0,090	357,008	3	119,023	1967,727	40	48,193	2,419	0,080
EP-R	0,42	0,178	0,117	1292,982	3	430,99	5956,654	40	148,91	2,894	0,047

### ANOVA

N=44, ANOVA, 3 Factors, R1=rep. measurement (Ear-Points, EP)						
	SQ	FG	MG	F	p	
Constant	7520,419	1	7520,41	113,245	0,000000	
(SSO) side of seizure onset, (left:right)	277,342	1	277,342	4,1763	0,047617	
(tP) side of pathology, (mes-lat)	1,427	1	1,427	0,0170	0,897003	
SSO x tP	15,795	1	15,795	0,2377	0,628541	
Error	2658,327	40	66,460			
R1 (EP, rep Measur.), EP-R, EP-L	1421,562	1	1421,56	10,7938	0,002124	
R1 (EP, rep Measur.) x SSO	931,608	1	931,608	7,0738	0,011988	
R1 (EP, rep Measur.) x tP	158,790	1	158,790	1,2057	0,278755	
R1 (EP, rep Measur.) x SSO x tP	218,023	1	218,023	1,6554	0,205618	
Fehler	5268,054	40	131,701			

### Conclusions

- Evidence of significant lesion effects in a dichotic fused words test in patients with TLE.
- General suppression of responses from the right ear, in patients with mesial or lateral temporal lobe pathology and Wada left hemispheric language (W-L).
- Stronger EP-R suppression and increase of EP-L in patients with left lateral pathology in W-L patients.

**Discussion:** The involvement of neocortex and other extra-hippocampal structures in temporal lesions seem to play a crucial role for contralateral ear suppression in FW-DL tests. In patients with pure hippocampal lesions a contralateral ear suppression effect was seen too, but no elevation of EP-L. The elevation of EP-L in the left-lateral group needs further analysis and may indicate a partial compensational shift of language functions to the right hemisphere, which is not met by the Wada procedure.

Contradicting results in the literature concerning the lesion effects of FW-tests are possibly due to the inclusion or exclusion of patients with lesions in the extra-hippocampal temporal lobe.

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