



## Testing cranial nerve VII: It is all in the wording



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### ARTICLE INFO

#### Article history:

Received 22 December 2015

Received in revised form 4 February 2016

Accepted 8 February 2016

Available online 11 February 2016

#### Keywords:

Cranial nerve VII

Neurological examination

Clinical neurology

### ABSTRACT

During our practice of clinical neurological examination we frequently observed that patients, upon testing of cranial nerve VII, when instructed to “wrinkle their forehead” (to evaluate the innervation of the *M. frontalis*), seem to falsely “frown” (i.e. innervate the corrugator supercilii). Here, we set out to prospectively evaluate prevalence and characteristics of this phenomenon.

Using a semi-structured questionnaire, we show that the majority of colleagues at our center shared our observation. Further, we demonstrate that of 113 unselected prospectively examined patients in fact 54.9% showed false frowning. This effect was irrespective of gender and only marginally influenced by age, chief complaint and clinical setting. Of note, all patients with initial frowning (or other “incorrect” reaction), when instructed to “raise their eye-brows”, showed correct wrinkling.

In summary, we were able to prospectively assess a highly prevalent artifact of the clinical exam, highlighting the critical significance of the correct wording during the neurological exam.

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### 1. Introduction

Next to history-taking, the detailed clinical exam [1–3] is the major cornerstone of the diagnostic process in clinical neurology, which continues to hold true in the age of broad availability of ‘technical’ exams including laboratory and CSF analysis, electrophysiology and multimodal imaging studies [4]. Although fundamentally important, aspects related to the clinical exam receive relatively little scientific attention in the modern era.

Despite some commonly accepted standards, the neurological exam is necessarily to some extent “subjective”, i.e. dependent on the techniques used by the individual examiner, which may introduce significant artifacts and bias.

Here we would like to draw attention to an observation, which we were often struck by during our own “individualized” practice of clinical neurology. Specifically, we noticed that during testing of cranial nerve VII, many patients, when instructed to “wrinkle their forehead” (to evaluate the innervation of the *M. frontalis*) will falsely “frown” (i.e. innervate the corrugator supercilii muscle). From a neuroanatomical standpoint, this phenomenon does not have a substantial diagnostic impact, since both the *M. frontalis* and the *M. corrugator supercilii*, as muscles of the upper half of the face, have the same type of differential innervation pattern in central vs. peripheral facial palsy. However, we feel that specifically testing the *M. frontalis* (as opposed to the *M.*

corrugator supercilii) makes it easier to detect one-sided weakness of the upper half of the face.

To gain more insight on the prevalence and clinical characteristics of this observation, we set out to prospectively evaluate this phenomenon in our department.

### 2. Methods

First, we asked neurological colleagues (both residents, fellows and staff physicians) from our department about their own experiences using a semi-structured questionnaire. All questioned colleagues were asked not to discuss the study and the questions asked with other colleagues, and colleagues who had already heard about the study and its scope were not included. Next, we set out to prospectively instruct all eligible patients during physical exam with the following standardized instruction in German language: “Please do wrinkle your forehead” (original instruction: “Bitte runzeln Sie Ihre Stirn”) and systematically assess patients’ reactions, with the following options: a) correct wrinkling of the forehead, b) frowning, c) other reaction (e.g. closing of eyes etc.). In case of reactions b) or c), patients were further instructed in German language “Please raise your eye-brows” (original instruction: “Bitte ziehen Sie Ihre Augenbrauen nach oben”), and the reactions were likewise documented. Clinical setting (outpatient clinics, emergency unit, specialty clinics, neurological consult), age, gender and chief complaint were recorded. Level of education was not systematically assessed, but patients’ profession was recorded, as far as available as part of the routine clinical interview. To be eligible, patients had to be fluent in German language; aphasic patients and patients with cognitive disturbances or disturbed level of consciousness were not included. The

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study was performed in a department for adult neurology, so patients <18 years of age were not included. In a first pilot phase (February 2015), all patients were examined and tested by a single neurologist (CF), while further neurologists with different levels of expertise (CF, EA, CL, TF) participated in a second study phase (March to April 2015). All examiners were instructed to use exactly the same wording in all cases and not to give any non-verbal clues (e.g. by pantomime).

### 3. Results

We interviewed a total of 20 neurological colleagues (12 male) from our department, all of whom did not participate in the clinical examinations of this study. The majority of colleagues ( $n = 14$ ; 70%) reported using about the same wording, and 57% of these spontaneously reported having made similar observations. 80% answered the question “Have you ever observed that patients do frown as opposed to wrinkling their forehead when instructed to wrinkle their forehead?” with “yes”, with 88% reporting this phenomenon to occur “in roughly 50% of cases” ( $n = 4$ ) or “very frequently” ( $n = 10$ ).

A total of  $n = 113$  patients (50.4% male; phase 1:  $n = 41$ , phase 2:  $n = 72$ ) were included in both study phases (mean age: 52.7 yrs [phase 1] vs. 51.7 yrs [phase 2]; age range: 24–86 yrs [phase 1] vs. 19–84 yrs [phase 2]). Recruitment was performed in different clinical settings: 30% of patients (phase 1: 17%; phase 2: 38%) presented to our general neurology outpatient clinic as emergencies, 37% (phase 1: 10%; phase 2: 53%) were evaluated as part of an elective appointment and 33% (phase 1: 73%; phase 2: 10%) were primarily seen by other specialties and evaluated in the context of a neurological consult. The spectrum of underlying disease categories is presented in Table 1.

In the overall sample, 54.9% ( $n = 62$ ) of patients did “frown” as opposed to 42.5% ( $n = 48$ ) of patients with “correct wrinkling”; finally, 2.6% ( $n = 3$ ) showed another reaction (c; closing of eyes). Detailed results split by study phase and gender are presented in Table 2. The effect observed in the overall sample was less pronounced in the first smaller exploratory study phase (43.9% frowning vs. 56.1% correct wrinkling) and more pronounced in the second larger study phase (61.1% frowning vs. 34.7% correct wrinkling). In both study phases, no differences were noted for female vs. male gender. The proportion of patients with

**Table 1**  
Disease categories, split by study phase.

	Phase 1	Phase 2	Overall
Chief complaint/symptom			
Neurovascular disorders	2 (4.9%)	12 (16.7%)	14 (12.4%)
Peripheral nervous system	5 (12.2%)	6 (8.3%)	11 (9.7%)
Headache	2 (4.9%)	20 (27.8%)	22 (19.5%)
Vertigo	3 (7.3%)	6 (8.3%)	9 (8.0%)
Somatoform symptoms	0 (0%)	5 (6.9%)	5 (4.4%)
Sensory disturbances	2 (4.9%)	7 (9.7%)	9 (8.0%)
Inflammatory/infectious disorder	1 (2.4%)	1 (1.4%)	5 (4.4%)
Paroxysmal disorders	3 (7.3%)	6 (8.3%)	9 (8.0%)
Other	23 (56.1%)	9 (12.5%)	29 (25.7%)
Total	41	72	113

Comments: Diagnostic groups are tentative and – except for cases previously evaluated at our center – mostly represent working diagnoses established after the initial neurological evaluation. No systematic follow-up, incorporating diagnostic tests during the further hospital stay, was performed.

Some diagnostic groups (e.g. headache, vertigo) focus on typical chief complaints with a broad spectrum of differential diagnoses. The other diagnostic categories are briefly explained below, with representative examples.

*Paroxysmal disorders*: include epileptic seizures, syncope or transient neurological disturbances similar to or mimicking seizures. *Neurovascular disorders*: current or prior ischemic or hemorrhagic stroke, symptomatic or asymptomatic stenosis of cranial vessels. *Peripheral nervous system*: includes e.g. (lumbar) disc herniation, polyneuropathy, GBS, CIDP, carpal tunnel syndrome etc. *Somatoform symptoms*: complaints for which a non-organic/psychosomatic etiology was considered highly likely upon initial evaluation. *Inflammatory/infectious disorder*: e.g. myasthenia gravis, neuromyelitis optica. *Sensory disturbances*: sensory symptoms (e.g. paraesthesia, dysaesthesia, tingling) which could not be immediately related to a specific etiology upon initial evaluation.

**Table 2**  
Patients' reactions, split by study phase and gender.

	“Correct wrinkling”	“Frowning”	Other	All
<i>Phase 1</i>				
Male	12	9	0	21
Female	11	9	0	20
Σ	23	18	0	41
	(56.1%)	(43.9%)	(0%)	
<i>Phase 2</i>				
Male	12	22	2	36
Female	13	22	1	36
Σ	25	44	3	72
	(34.7%)	(61.1%)	(4.2%)	
<i>Overall study</i>				
	48	62	3	113
	(42.5%)	(54.9%)	(2.6%)	

“false frowning” was larger in patients seen as an emergency (68%) or as elective patients in the neurological outpatient department (57%) as opposed to patients seen as part of a neurological consult (41%). The rate of false frowning was higher in the group of patients <50 years of age (65%) than in the group >50 years of age (47%). For study phase 1, the proportion of patients who had received university training was roughly comparable between the groups of “correct wrinklers” vs. “false frowners” (22 vs. 28%), while in phase 2 more “false frowners” (20%) than “correct wrinklers” (8%) had university training.

All patients ( $n = 62$ , 100%) with initial frowning or other reaction (c), when instructed to “raise their eye-brows”, showed correct wrinkling.

### 4. Conclusions

Our study has two major results: First, using a standardized semi-structured questionnaire, we were able to confirm that our own clinical observations of patients' ‘false’ reactions during testing of cranial nerve VII are shared by the majority of clinical colleagues at our center irrespective of level of expertise. Secondly, using a prospective single-center approach, we were able to demonstrate that our own as well as our colleagues' previous experiences are in line with observational data in our large ( $n = 113$ ) prospective cohort of unselected patients at a tertiary referral center. Specifically, we could show that, irrespective of gender, 54.9% of patients do frown when instructed “Please wrinkle your forehead”; of note, all of these “frowners” do correctly wrinkle when instructed to “raise their eye-brows”.

A few additional aspects deserve attention: Both study phases showed essentially the same result, with a more pronounced effect in favour of “false frowning” in the second phase. A possible explanation may be the larger number of “emergency” patients in phase 2; in fact, subgroup analysis of these patients showed a higher “error-rate”, possibly related to the subjectively stressful circumstances of an emergency visit. Further, the somewhat lower number of “frowners” in phase 1 may reflect the fact that the majority of patients in this phase were evaluated as part of a neurological consult with mostly “unspecific” complaints. Assuming that a high number of these patients are neurologically “normal”, the proportion of “frowners” in this subgroup might be an approximation of the rate of false frowning in “normal probands”—which were not examined in our study. Of note, we found no evidence of a higher error-rate in older patients.

*Strengths* of our study include the prospective design (comprising two study phases), the large number of patients included over a representative period of time, the involvement of several clinical examiners and analysis with respect to potential confounders. At the same time there are a few *weaknesses* (e.g. single-center design, enrichment of our clinical sample for mildly to moderately affected ambulatory patients). Patients with cognitive disturbances were not included,

however, since formal neuropsychological evaluation was not performed, we cannot exclude that some patients may have had mild cognitive deficits, causing problems understanding the instruction. Most importantly, we are aware of the fact that our finding is probably dependent on the specific language used by the patient and doctor (i.e. in the case of our study German) and thus cannot automatically be generalized to any given patient, e.g. English-speaking patients.

Irrespective of these issues, our observation has interesting implications: First, it does highlight the fact that patients during the neurological exam do not always strictly perform the task they are literally supposed to do, which by itself is interesting, although the precise mechanism underlying the phenomenon under discussion here is hard to explain; in this respect, our limited indirect data on level of education (as inferred from patients' education) do not suggest educational background as a major modifier. Obviously, complex social, cultural and psychological aspects (e.g. differential emotional connotation of wrinkling the forehead vs. frowning) are likely to play a role; detailed neuropsychological evaluation of probands (as well as functional neuroimaging) might help to further clarify these issues.

More importantly, from a practical perspective, it emphasizes the critical importance of using the correct wording during the neurological exam, since the substantial number of patients performing the task wrongly may necessitate further instructions, potentially adding up to some time loss. Finally, given the high prevalence, the described phenomenon (as well as other similar observations) should be paid attention to during teaching the clinical neurological exam to medical students [5,6].

*In summary*, based on the observations discussed here, we would like to encourage colleagues elsewhere to pay attention to this highly prevalent artifact of the clinical exam and, in order to streamline the clinical neurological examination, we would like to suggest using the

command “please raise your eye-brows” as a default in clinical routine when testing cranial nerve VII. An alternative pragmatic option (which we did however not assess systematically) would be to use a combination of verbal instruction plus pantomime. Possible directions for further research include follow-up on our findings in other languages or in different patient populations, e.g. children.

#### Conflict of interest

None.

#### Acknowledgments

We would like to thank all patients who participated in this study as well as all colleagues, who supported us by answering the semi-structured questionnaire.

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