A FUNCTIONAL ANALYSIS OF THE WONG-BAKER AND FPS-R FACES PAIN SCALES: MAKING GROUND FOR DEVELOPMENTALLY-BASED METRICS

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Abstract

The developmental suitability of facial pain scales for children below 8-years-old has been under question. This study assumes that any valuable pain metrics is at least interval level. It uses integration tasks and FM methodology to examine how children of 6-7 years-old integrate pain related information. In one experiment, the WB and the FPS-R pain scales were taken as factors, with their constituent faces as levels, in a factorial design. Participants were presented with pairs of faces (one from each scale), said to represent the pain of two children, and evaluated the overall amount of pain in each pair. Virtually every child used an extremity weighting averaging rule for the integration. In two further experiments, inner features (eyes, eyebrows, mouth) of the hand drawn faces composing each scale were used as factors (varied along three levels). For most children, these features were integrated according to an averaging rule.

The developmental suitability of facial pain scales for children below 7/8 years old has been recurrently called into question (Campbel and Tuck, 1995; Champion, 2006; Stanford et al., 2006; Stinson et al., 2006; Ducruynaere, Tonnard, & Plaghki, 2009). This objection is more fundamental than the one concerning the uncertainty of their metrical properties, since it consists in denying that children at younger ages may make any metric sense of these tools.

Information Integration Theory offers an interesting way to address this issue. If (1) such scales can be made to operate as factors (information dimensions, with each component face as a factor level) in an integration task, and (2) children are shown capable of producing integrated responses using the constituent faces as informers, this entails that consistent metrics are actually infused by children in those scales. Contrary to the common unidimensional use of those scales, its multidimensional use in integration tasks provides a criterion for the consistency of responses, given by the integration patterns: if these happen to obey an algebraic model – in particular, the more simple one of adding – that, by virtue of a number of theorems (see Anderson, 1981; 1982), allows to validate the response scale as a linear one (meaning an equal-interval, non-distorting scale). On the other hand, in order to provide a continuous (expressing in degree) consistent response, children have to find a way of distributing a quantitative value to the informers: the integration rule carries implicitly this underlying metrics, which can then be derived, on the basis of the algebraic model, through Functional Measurement (see Anderson, 1981; 1982).

Two interrelated benefits can thus be expected to arise from using an IIT approach. First, to be able to establish that children do make metric sense of the faces pain scales. This offers a straight answer to the question raised. Second, to establish further the concrete metric properties of those scales through deriving them from the integration model. Because they actually rest on the integration operation performed by children, these derived metrics will be by definition age-suited, and may of course be different for different ages, or for distinct subgroups within a given age range.

Experiment 1

Participants

30 children aged 6-7 years (7 M; 13 F).

Stimuli

Hand drawn schematic pain faces taken from the WB and FPS-R scales.

Design and procedure.

The experiment obeyed a factorial 6 (WB) × 6 (FPS-R) repeated measures design. Children were presented with pairs of faces (one from each scale), said to represent the pain of two distinct children, and were required to evaluate the overall amount of pain in each pair. Response consisted in pressing a button for the time needed for a magic character (fairy or magical dog) to transfer the pain away from the suffering children into a glass, which was shown on the screen being steadily filled while the button was pressed. For the first 3000 ms the glass was shown empty (which allowed the children to stop pressing before any pain was transferred, meaning "no pain") and it become full at 13000 ms.

Results

Figure 1 presents the factorial plots for two clusters of children. The strong upper right convergence of lines in the major cluster (CL1: left panel) illustrates a differential weighting averaging rule, with increasing weight (importance to the final judgment) of the more intense pain expressions, such that, for the most extreme levels of each factor, the levels of the other factor virtually have no effects.

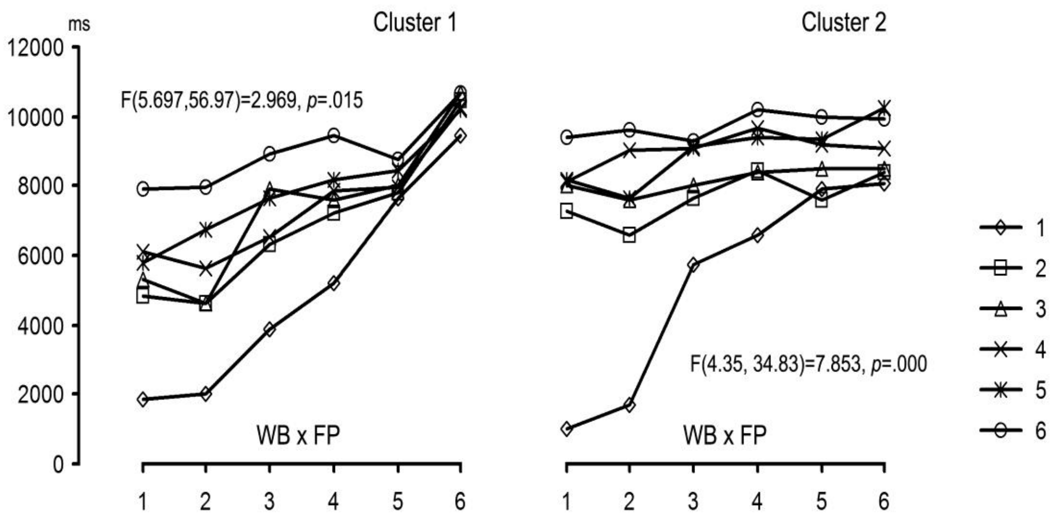

Figure 1: *Lef Panel:* Cluster 1 (n=11; differential weighting averaging); Cluster 2 (n=9; dominance rule). Mean time of button press (in *ms*) in the ordinate.

Children in Cluster 2 take this trend further, to the point of no-integration of the factors. The graph illustrates a dominance rule, whereby the factor in the abscissa (the scale WB) can only work when the other factor (the FPS-R scale) is at its least intense level (level 1). After that, the slope of lines, reflecting the effects of the factor in the abscissa, becomes essentially flat.

The fact that Cluster 2 does not integrate does not mean that these children cannot work out a metric for the scales. It simply means that, for some reason, they cannot integrate them. More significant is the fact that children in Cluster 1 can indeed integrate the two information dimensions according to an algebraic-type rule. This is enough for the envisioned purpose, even if Cluster 2 constitutes a warning that not all children at these ages can be used to study the metric properties of theses scales under this approach (again, this thus not means that no such properties are available to them).

Figure 2 presents the functional metrics derived for the WB and the FPS-R from the averaging rule found in Cluster 1. Estimation was performed with the R-Average program (Vidotto & Vicentini, 2007). These functional values correspond to scale values estimated independently from their weight importance for the judgments, and are on an interval scale, with a common unit. As such, comparisons of intervals and ranges across the two scales can be legitimately done.

The two first levels of the WB scales, involving smiling faces, are clearly below the point where pain starts to build up in the "glass". They are thus not informative regarding expressed pain. A larger dynamic range for the expression of pain seems nevertheless to be offered by the WB scale, as well as a better discrimination between levels (confusion between levels 2 and 3 of the FPS-R are indicated by the superposition of the two corresponding faces). In both scales, the sampling of pain is better for the higher than for the lower levels. However, again, the WB scale appears to offer a more even coverage of this range of pain than the FPS-R.

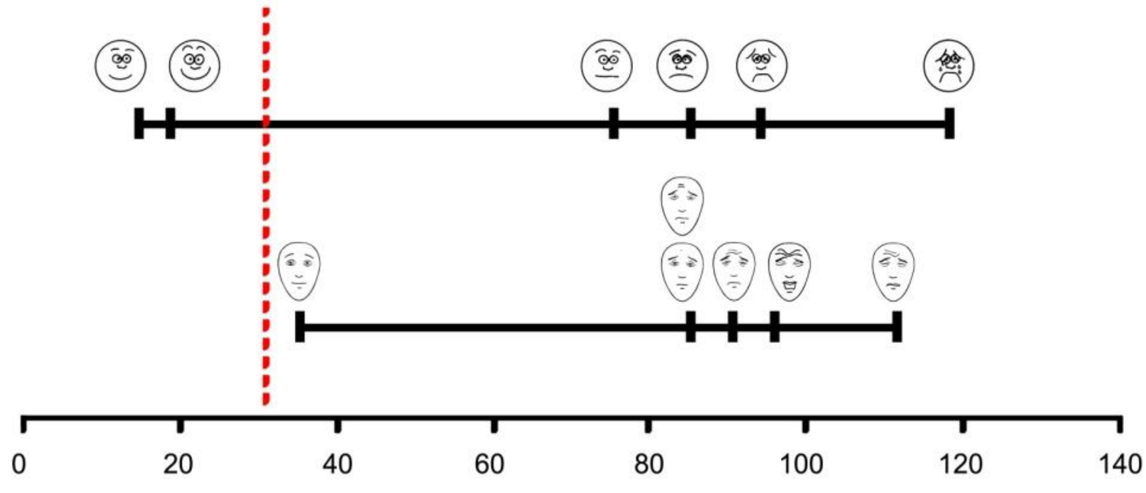

Figure 2. Functional scales of the stimuli factors (facial pain scales) derived from Cluster 1. Scale values were independently estimated from weight–importance. Estimates are given in 1/10 *sec*. The dashed line signals the moment where the glass starts to be "filled in with pain".

Experiment 2 (A and B)

Participant

Exp 2A: 33 children aged 6-9 (19F:14M); Exp. 2B: 30 children aged 6-7 (18F; 11M).

Stimuli

Two sets of schematic faces embodying the factorial combination of three levels of *Eyes*, *Eyebrows* and *Mouth* used as inner features of the WB faces (Exp. 2A), and of three levels of *Wrinkles*, *Eyes/Eyebrows* and *Mouth* used as inner features in the FPS-R faces (Exp. 2B). Figure 3 indicates the three faces in each scale from which the three levels of inner features were extracted. The overall shape of both the WB and the FPS-R faces was preserved.

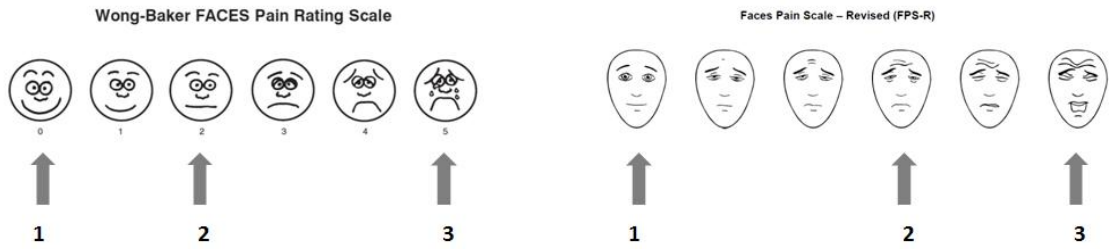

Figure 3. The arrows indicate the faces from which the inner features used as factor levels in Experiments 2A and 2B were extracted. Faces 1, 3 and 6 of the WB scale provided levels 1, 2, and 3, respectively, for the factors *Eyes*, *Eyebrows* and *Mouth* in Exp 2A. Faces 1, 4, and 6 of the FPS-R scale provided levels 1, 2 and 3, respectively, for the factors *Wrinkles*, *Eyes/Eyebrows* and *Mouth* in Exp. 2B.

Design and procedure

Experiments 2A and 2B corresponded both to a main factorial 3 (inner feature 1) × 3 (inner feature 2) x 3 (inner feature 3) repeated measures design. Each of the 27 resulting faces, randomly presented, was evaluated by children as to the degree of conveyed pain. The same procedure as before was used for response (button press). Besides the main design, faces where only one of the features was visible (corresponding to isolated presentations of the levels of each feature) were also presented (interspersed) and evaluated likewise.

Results

The top row of Figure 4 presents the factorial plots for experiments 2A (involving the WB inner features) and 2B (involving the FPS-R inner features), respectively on the left and right panels. Deviations from parallelism, supported by a number of significant first order interactions, together with the clear crossover produced by the dashed line (isolated presentations of the levels of the factor in the abscissa) are consistent with an averaging model with differential weighting (Anderson, 1981; 1982). Plots for Exp 2B actually correspond to a major cluster of 18 children (a second cluster of 11 children complied with an additive-type rule, consistent with an equal-weight averaging model).

The bottom row in Figure 4 presents the functional estimates of scale value and weight/importance derived from the differential weighting averaging model (valid for Cluster 1 in Exp 2B). Scale values are on an interval scale with common unit across features (factors).

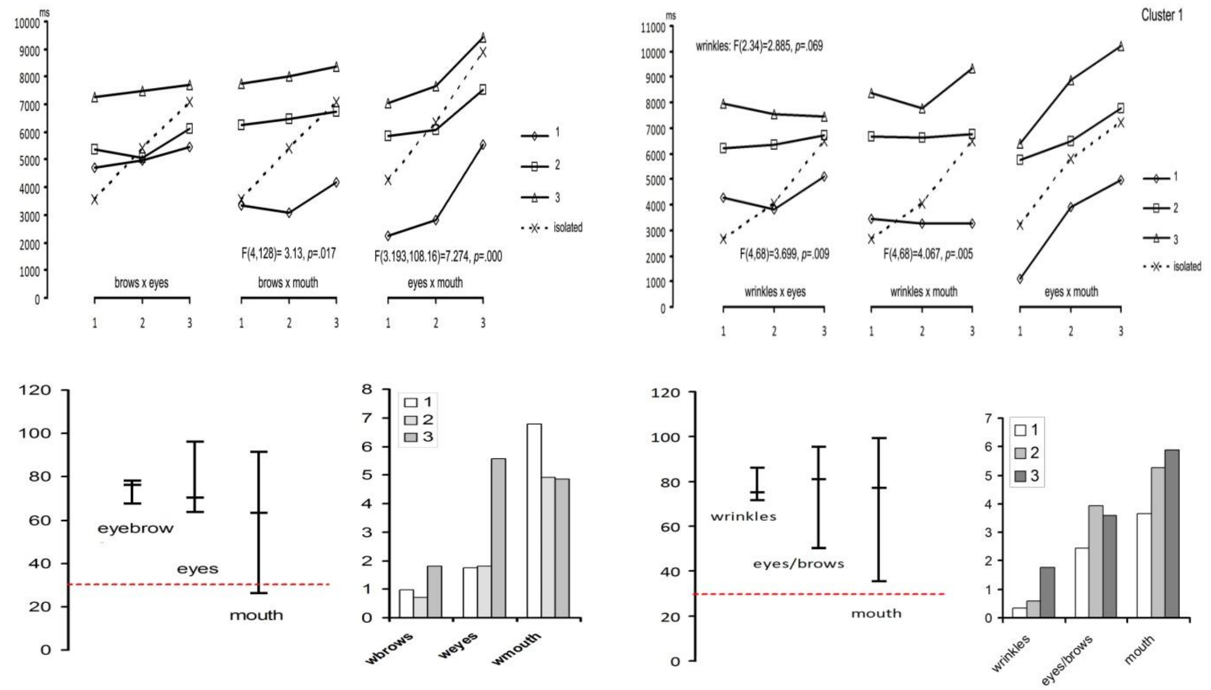

Figure 4: TOP ROW – *Left Panel:* Factorial plots for *brows* × *eyes* x *mouth* presented two-by-two (Exp 2A). *Right Panel*: Factorial plots for *wrinkles* × *eyes/eyebrows* x *mouth* presented two-by-two (Exp 2B). Dashed lines correspond to isolated presentations of the levels of the factor in the abscissa. BOTTOM ROW – functional scale values for the inner features of the faces estimated independently from weights on the basis of an averaging model (estimates given in 1/10 *sec*). Histograms depict the estimated weight/importance of each level of each factor. *Left panel*: Exp. 2A (WB scale); *Right panel*: Exp 2B (FPS-R scale).

The first level of mouth for WB is below the point (3000 ms) were the glass starts being filled in. Given that all other features score above that point, mouth can be held responsible for the uninformative character of the first face of the WB scale as regards expressed pain. The larger dynamic variation range among all features is offered by mouth in both scales.

Estimates of weight/importance for each level of the different factors can be read in the histograms, and are given on a ratio scale. *Mouth* is shown to be the most important factor overall, in both scales. A trend for more intense levels to carry greater importance (weight) to the overall judgment of pain is also apparent, more clearly for *eyes*, in the WB scale, but also for every feature in the FPS-R scale. *Wrinkles*, in the FPS-R scale, contribute little to children judgments, except for the most extreme level.

The lowest level of mouth in the WB scale (cf. histogram in the bottom left panel of Figure 4) presents a distinctive character, having the greatest absolute importance among all levels in the WB scale. This goes against the foregoing reported trend (higher levels have the highest weights) and it plausibly stems from the circumstance that this is the single level not conveying pain (thus, one which heavily determines a judgment of "absence of pain").

Provisional Conclusion

6 year-old children can make metric sense of facial pain scales widely used in pediatrics (WB and FPS-R). This is documented by the fact that children can use the constituent faces of those scales as informers in integration tasks.

This fact opens way for comparisons of the metric properties of faces pain scales, derived on the basis of the integration models via functional measurement. Overall dynamic ranges and the way information is sampled within those ranges can thus be sensible compared across distinct pain scales (due to the interval level of the functional estimates, with common unit across factors) and these comparisons used for scale selection oriented to specific assessment purposes/needs. These derived metrics are necessarily age-suited, since they flow from the conjoining of information sources performed by children themselves. Different metrics can thus in principle be obtained for different ages or for distinct clusters of subjects within and across age groups.

The same approach can be used to investigate quantitatively the constituent inner features of the schematic faces (eyes, mouth, eyebrows, wrinkles, etc.). Their relative importance appears as an important cue, which may even help in discarding useless information in the faces (*wrinkles* in the FPS-R appear to be one such case for the 6-7 age group). The importance of individual differences, which manifested chiefly at the level of clusters of subjects, must be kept in mind and accommodated in the approach.

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This research was funded by grant *PTDC/PSI-PCO/107910/2008,* from the Portuguese Foundation for Science and Technology.