

# Morphology of PPGI Signals upon Stimulation

Sebastian Zaunseder\*, Vincent Fleischhauer

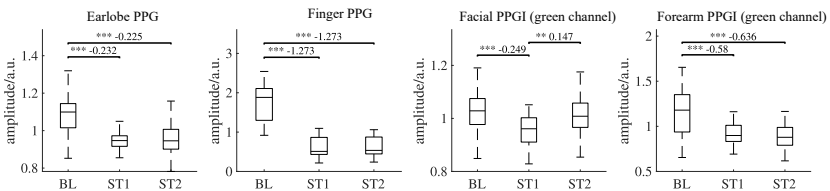
University of Augsburg, Augsburg, Germany

**Aims:** Photoplethysmography imaging (PPGI) can yield far-reaching statements on the health state in a convenient way. While investigations on the heart rate using PPGI are common, fewer works studied the morphology of PPGI signals. The presented work investigates the morphology of PPGI signals upon stimulation in comparison to the behavior of contact PPG signals.

**Methods:** We use own experimental data of 39 healthy volunteers recorded during a cold pressure test (CPT). We analyze PPGI signals from the face and from the forearm together with contact PPG from the finger and the earlobe. Signals' morphology is assessed by means of four common features from time intervals taken 40s before (BL), 20s after (ST1) and 40s after (ST2) immersion of the hand into cold water. For each signal and each single feature, we analyze the features' behavior over time by repeated measure ANOVA, paired t-tests and Hedges'  $g$  to quantify effect sizes between intervals.

**Results:** Our results show significant differences upon stimulation, i.e. from BL to ST1, for most features from finger and earlobe PPG ( $p < 0.001$ ). Even PPGI signals show significant differences upon stimulation, though forearm signals' analysis is hampered by a lower signal quality. Beyond a general effect of stimulation, there are differences in the signals' behavior according to the recording setup. E.g., finger and forearm signals show stronger effects upon stimulation than earlobe and facial signals. Further, particularly the facial PPGI signal recovers to baseline values while the effect of CPT on the finger and forearm signals is more persistent.

**Conclusions:** Our study highlights the importance to consider the recording setup when analyzing photoplethysmographic signals. According to our results, care must be taken when knowledge or methods are transferred from contact PPG to PPGI. However, the found behavior also opens novel analysis opportunities if multiple PPG signals are available.



Behavior of the pulse amplitude over the experiment (numbers indicate Hedges'  $g$ ; \* for  $p < 0.05$ , \*\* for  $p < 0.01$  and \*\*\* for  $p < 0.001$ )