The effect of pictorial face images for observational rating of perceived exertion

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ABSTRACT

The aim of this study is to determine the correspondence between realistic exertional human faces and pictorial faces and to redefine the pictorial faces on the FPRPE scale for observation of perceived exertion. 44 participants were recruited to observe exertion faces and estimate perceived intensity through pictorial face expression. The results suggest that facial expression plays an important part not only in perceiving the intensity of emotion and pain, but also in encoding and distinguishing the perceived exertion of others. This study was hypothesized that pictorial faces chosen by the observers corresponded to RPE estimated by the observers, and the chosen faces and RPE estimated by the stimulators would be positive correlated. The curvilinear change of facial pictorial expressions may present a more appropriate prompt to reflect the observation of perceived exertion.

Keywords: Rating of perceived exertion, Face scale, observe exertion

1. Introduction

Many various face scales were developed and validated for pain management and other clinical use. Some researchers have indicated that face scale was also good for perceived exertion and workload. These face scales be available in some special cases because it can assess those who cannot comprehend the written words used for the scale. We developed a facial pictorial RPE (FPRPE) scale which has a category rating format that contains both pictorial and verbal descriptors positioned along a comparatively narrow numerical response range, namely 0–10. The pictorial descriptors correspond to six possible responses ranging from a neutral face to a face showing extreme exertion. The exertional meaning of each pictorial descriptor is constant with its corresponding verbal descriptor, similar to that in the adult OMNI-cycle scale (Robertson et al., 2004). The number of pictures and their positions were selected with reference to the Faces Pain Scale-Revised (Hicks et al., 2001) and placed in intervals along a horizontal line. The concurrent and construct validation of FPRPE scale was conducted and the evidence supported the use of the FPRPE scale by female and male adults to estimate overall and peripheral RPE during an incremental cycling ergometer task (Huang et al., 2013).

Besides exertion assessment by workers on their own, levels of forceful exertions can sometimes be estimated through observations by others. Robertson et al. (2006) suggested that the mode-specific pictorial RPE scale is good for observation perceived exertion because the cognitive image of the pictorial descriptors on the scale likely provided the observer with a level of “prior learning” that sharpened the vividness of the exertional perception. Robertson et al. (2006) suggested that exertional observation by the OMNI RPE scale provides perceptual estimates of exercise intensity and could be applied to physical activity assessment for children. The findings of Robertson’s study indicated that observation of kinematics by the OMNI scale is an effective tool for assessing comparative intensity of perceptual exertion corresponding to the ventilator breakpoint during graded treadmill exercises. Goss et al. (2014) used the OMNI RPE scale for direct observation to provide estimates of ratings of perceived exertion during fire suppression training.

The pictorial faces descriptor on the FPRPE scale is similar to a faces pain scale. Many previous studies indicated FPS could be used to estimate others’ pain for observers. The FPRPE has shown that it also could be used by observers to estimate others’ exertion as FPS is based only on static or dynamic exertional faces in the two preliminary investigations. However, the correlation between observers’ estimated RPE and subject self-reported RPE was significant but lower than previous
studies and facial images in previous studies were redrawn with artistic skill and cannot be standardized. Therefore, the aim of this study is to determine the correspondence between realistic exertional human faces and pictorial faces and to redefine the pictorial faces on the FPRPE scale for observation of perceived exertion

2. Method

In order to modify the facial pictorial scale for observing perceived exertion, we adapted the methods used by (Hicks et al., 2001) in the creation of the Faces Pain Scale–Revised (FPS-R) and the methods used by (Baxter et al., 2011) in the creation of the Baxter Retching Faces (BARF) scale. In our study, six pictorial faces with the identified features of exertion from the Facial Pictorial RPE scale (FPRPE), and one investigator converted these into 101 smoothly morphing pictorial faces ranging from neutral (no exertion) to maximum exertion. These pictorial faces were integrated into a PC-based data collection program displaying a horizontal bar continually showing a single animated face that changed expressions ranging from 0 (no exertion) to the face 101 (maximum exertion) when the computer cursor was moved forwards and backwards (Figure 1).

Forty-four university population students, including 22 male and 22 female participants, were recruited as observers. Seated in front of a computer which displayed the PC-program, each observer was asked to scroll back and forth through the facial expression so that they (a) became comfortable with how to change the face, and (b) indented the range and endpoints of the scale.

For each trial the observer was shown a photographic human face on left side of the program and asked to adjust the facial expression of the pictorial face until it was perceived to correspond to the same exertion intensity between human and pictorial face. Then the number of selected face would automatically record in the excel file. The selected number of pictorial face would divide by 10 in order to directly compare with the RPE. The human faces were snapshots from subjects (called stimulators) who performed cycling exercise during the last 30 seconds of each of six different exercises of varying intensities (For detail protocol and procedures please see 5.1.2, the method of study 5). All the human faces were shown in random order. Each observer assessed 20 different male human faces from stage 1-5 and one from stage 6, and assessed 10 different female human faces from stage 1-5 and one from stage 6, resulting in 32 trials for each observer. The mean, median, and SEM values of the above data were calculated.

The single measure intraclass correlation coefficient (ICC) was calculated to assess inter-rater agreement coefficient across the entire set, using a two-way mixed-effect model and a consistency definition.

3. Results

Figure 2 (A) shows that the self-reported RPE and HR of male stimulators was highly correlated (r=0.947) and progressively increased as exercise intensity increased. The pictorial faces determined by observers were correlated with the stimulators’ self-reported RPE (r=0.686) and HR (0.623) and curvilinear increased through exercise intensity. Figure 2 (B) shows the result of females, where the self-reported RPE and HR of stimulators were also correlated (r=0.728) and progressively increased as exercise intensity increased. The pictorial faces determined by observers were not strongly correlated with
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Table 1. The mean, median, and SEM of the choice of the pictorial face and self-report RPE for each target % of male observers.

| Exercise Intensity | Self-reported RPE of Stimulator Mean | Median | S.E. | Target RPE % | Pictorial face selection of observers Mean | Median | S.E. | n |
|--------------------|------------------------------------|--------|------|-------------|--------------------------------------------|--------|------|----|
| Stage 1            | 0.51                               | 1.00   | 0.04 | 0% (0–1)    | 3.39                                       | 2.70   | 1.49 | 174|
| Stage 2            | 2.26                               | 2.00   | 0.08 | 20% (1–3)   | 3.46                                       | 2.80   | 1.48 | 174|
| Stage 3            | 4.52                               | 5.00   | 0.07 | 40% (3–5)   | 4.49                                       | 4.65   | 1.60 | 174|
| Stage 4            | 6.28                               | 7.00   | 0.11 | 60% (5–7)   | 5.44                                       | 5.40   | 1.44 | 174|
| Stage 5            | 8.52                               | 9.00   | 0.09 | 80% (7–9)   | 7.05                                       | 7.10   | 1.30 | 174|
| Stage 6            | 9.00                               | 9.00   | 0.00 | 100% (9–10)| 9.64                                       | 9.80   | 0.77 | 42 |

Table 2. The median, mean, and SEM of the choice of the pictorial face and self-reported RPE for each target % of female observers.

| Exercise Intensity | Self-reported RPE of Stimulator Mean | Median | S.E. | Target RPE % | Pictorial face selection of observers Mean | Median | S.E. | n |
|--------------------|------------------------------------|--------|------|-------------|--------------------------------------------|--------|------|----|
| Stage 1            | 2.00                               | 2.00   | 0.00 | 20% (1–3)   | 2.64                                       | 2.40   | 1.44 | 88.0 |
| Stage 2            | 4.00                               | 4.00   | 0.11 | 40% (3–5)   | 2.71                                       | 2.40   | 1.44 | 88.0 |
| Stage 3            | 5.00                               | 5.00   | 0.11 | 60% (5–7)   | 3.28                                       | 3.00   | 1.67 | 88.0 |
| Stage 4            | 6.48                               | 5.00   | 0.16 | 60% (5–7)   | 3.58                                       | 3.00   | 1.83 | 89.0 |
| Stage 5            | 6.98                               | 5.00   | 0.21 | 60% (5–7)   | 4.48                                       | 4.10   | 2.29 | 89.0 |
| Stage 6            | 7.00                               | 7.00   | 0.00 | 80% (7–9)   | 6.74                                       | 7.00   | 3.25 | 42.0 |

Figure 2. Increases in stimulators’ self-reported rating of perceived exertion, heart rate and in the observers’ RPE-related pictorial face chosen with incremental exercise for males (A) and females (B)

self-reported RPE (r=0.384) and HR (0.425) of the stimulators but still curvilinear increased through exercise intensity. For the entire set, Cronbach’s α value was 0.986 for assessing male faces, and the single measures ICC was 0.610 (95% CI: 0.450 – 0.798). For assessing female faces, Cronbach’s α value was 0.975, and the single measures ICC was 0.472 (95% CI: 0.295 – 0.738). The median, mean, and SEM of the choice of the pictorial face and self-reported RPE for each target percentage are shown in Table 1 and Table 2.

Table 1 and 2 also show that the mean of both genders’ stimulators’ RPE corresponded to the target RPE and the mean of the chosen face. The median face chosen for each target RPE percentage occupied the interior of the pictorial face RPE (Figure 3 and figure 4).

Figure 3. Modified FPRPE scale for observation male subject
This study aimed to determine a relationship between facial pictorial descriptors and exertion intensity using the FPRPE scale as a tool for observation of perceived exertion in others.

The results suggest that facial expression plays an important part not only in perceiving the intensity of emotion and pain, but also in encoding and distinguishing the perceived exertion of others. In the first experiment, it was hypothesized that pictorial faces chosen by the observers corresponded to RPE estimated by the observers, and the chosen faces and RPE estimated by the stimulators would be positive correlated. The findings supported the hypothesis that the chosen faces represent RPE estimated by the observers and were significantly correlated with RPE estimated by the stimulators. The coefficient correlations were not as high as previous observational studies (Ljunggren, 1986; Robertson et al., 2006) for both gender stimulators. There are multiple possible explanations for this result. First, there were only exertional faces to be observed in this study, while other studies used direct observation of not only facial expression but also body movement and breathing. More observational keys possibly have more information to perceive exertion. Second, the observers of previous studies were experts for that task or well-trained. In our study the observers were university population students who have no experience for perceiving exertion. Third, the selected female stimulators may not suitable to be observed because females are not as facially expressive as male subjects. Otherwise, the simulated faces that were shown randomly would not have the anticipated bias but may cause lower correlation. Although using only static facial expression to estimate RPE has a lower correlation between observers and subjects, exertion faces still offer sufficient information for RPE estimation especially for observing male faces. Therefore, the median face chosen for each target RPE percentage could be used to replace the original version of pictorial faces on FPRPE for observation of perceived exertion in adult males.

The facial pictorial expressions were curvilinear increased with exercise intensity for both genders. This result is in line with previous studies that the exertional related facial muscle activities was increased significantly only at high-level intensity workload (de Morree et al., 2012; Huang et al., 2014). The pattern was also the same as the ventilation (VE), and it has been suggested that VE is a central signal of exertion and that it displays a positively accelerating change above work rates of 60% of maximum oxygen uptake, and it follows that the RPE will also increase in a positively accelerating manner at high intensities (Eston et al., 2009). The curvilinear change of facial pictorial expressions may present a more appropriate prompt to reflect the observation of perceived exertion.

4. Discussion

References

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