Patterning of Affective Responses During a Graded Exercise Test in Children and Adolescents

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Past studies have shown the patterning of affective responses during a graded exercise test (GXT) in adult and male adolescent populations, but none have explored the patterns in adolescent girls or younger children. This study explored the patterning of affective responses during a GXT in adolescents and younger children. Forty-nine children (21 male and 28 female) aged between 8–14 years (10.8 ± 1.8 years) completed a GXT. Ventilatory threshold (VT) was identified. At the end of each incremental step, participants reported affective valence. Results revealed that affective valence assessed by the Feeling Scale (FS) significantly declined from the onset of exercise until the point of VT in the younger children, but remained relatively stable in the adolescents. Exercise above the VT brought about significant declines in affective valence regardless of age or sex, but the decrease was significantly greater in adolescents. Results suggest it may be preferable to prescribe lower exercise intensities (below VT) for children, compared with adolescents, to ensure a positive affective response.

National reports have highlighted the increasing levels of inactivity in children in the UK (7) therefore; understanding the determinants and correlates of physical activity (PA) in children and adolescents is critical (37). A quantitative review (42) indicated that PA interventions with children are seldom successful, highlighting the need to explore other methods of increasing PA participation. Research suggests that maintaining a positive affect (feelings of pleasure) during exercise may be the solution with recent evidence from studies with adults indicating that affect may be the first link in the exercise adherence chain (41,43,44).

Affect is a generic term that characterizes the subjective experience of any valenced (pleasant or unpleasant) state (13). Evidence indicates that a positive affective response experienced during exercise may lead to greater enjoyment.
of an exercise session and could ultimately play a significant role in predicting exercise adherence (11,32,44). Reviewing literature in leisure-time PA settings, the Surgeon General’s Report (1996) reported a consistently positive association between enjoyment and levels of PA in children and adolescents, a finding supported by Sallis et al. (31) across multiple PA domains (e.g., physical education classes, leisure time PA etc.). Raedeke (26) suggests that enjoyment and positive affect are related, reinforcing the idea that positive affective responses and enjoyment can lead to greater exercise adherence. In support of this, there is increasing evidence to show that affective judgments regarding exercise are a strong correlate of PA behavior in adults (27) and in adolescents (33) and may influence future attitudes toward PA behavior (18).

The relationship between the intensity of exercise and affective responses is complex. Ekkekakis (9) developed the dual-mode theory (DMT: an evolutionary adaptive theory) that can explain individual differences in affective responses at different exercise intensities. The theory suggests that affective responses are influenced by the interplay of two general factors: 1) cognitive processes (e.g., personality variables, goals, expectations, exercise -efficacy that require frontal cortex activation); and 2) interoceptive cues (e.g., signals from baroreceptors, thermoreceptors, visceroreceptors in the heart, lungs and muscle). While it is argued that both factors are important in determining affective responses to exercise, the balance between the two is hypothesized to shift as a result of the exercise intensity domain (moderate, heavy or severe (15)). In the moderate intensity domain (below ventilatory threshold (VT)), exercise is likely to produce primarily positive affective responses, with low interindividual variability where cognitive processes have a low-to-moderate influence on affective responses (16). At heavy intensity (between VT and Maximal Lactate Steady State (MLSS)), affective responses are likely to vary greatly between individuals. While some individuals may report changes toward pleasure, others may report the opposite: feelings of displeasure. Ekkekakis (9) suggests that this marked interindividual difference is a result of cognitive processes being the over-riding factor in determining affective responses at this intensity. At a severe intensity (above MLSS), interoceptive cues bombard the system, and the DMT proposes that the frontal cortex is bypassed (negating cognitive process involvement) to avoid physiological harm and it is the interoceptive cues that dictate affective responses. At this intensity, affective valence responses are homogenously negative as the cues signal physical harm (8).

Ekkekakis and Petruzzello (13) have suggested that the assessment of affect is best measured by taking a dimensional approach. Specifically, they recommend employing a circumplex model (29) to measure affect along two dimensions: affective valence (pleasure/displeasure) and activation (low to high arousal). The circumplex is divided into sections to reveal 4 quadrants, each characteristic of different affective states: 1) unactivated pleasant affect, which is characterized by contentment, calmness and relaxation, 2) unactivated unpleasant affect, characterized by lethargy, boredom or fatigue, 3) activated unpleasant affect, characterized by tension, stress or nervousness and 4) activated pleasant affect, an affective state characterized by excitement, enthusiasm or happiness (16). The Feeling Scale (FS: 17) has been used consistently to assess affective responses, while the Felt Arousal Scale (FAS: 39) has been used to assess activation levels (9,41). Taking a dimensional approach to the measurement of affect can, theoretically, capture the
full range of basic affective response to exercise. Previous research assessing patterning of responses has typically assessed FS, FAS, ratings of perceived exertion (RPE) and heart rate (HR) across a Graded Exercise Test (GXT) to capture a full picture of individuals’ responses across exercise intensities. Most research exploring affective responses to exercise has been conducted with an adult population, and while this has proven useful in understanding the relationship between affective responses to exercise and different intensities in adults, it is not known if the same pattern of affective responses exists in adolescent girls and younger children. Studies with adults show a uniform pattern of decline in affect after VT (16,43), but interindividual differences exist before VT. For example, inactive women show a quadratic decline in affect from the start of exercise (43), whereas active university students report stable, positive affective responses before VT (16). Sheppard and Parfitt (35) compared affective responses across a Graded Exercise Test (GXT) between low-active men and low-active adolescent boys. In both groups, affect declined rapidly after VT. However, in the adolescent boys, there was no significant decline in affect before VT in contrast to a rapid, quadratic decline in affect before VT in the men. The relatively stable positive affective responses of the adolescent boys before VT, with no significant differences between time points, suggest that exercise performed at this intensity may elicit positive responses and may therefore encourage positive attitudes to exercise and not have a detrimental effect on future PA participation. Recent studies with adults have reported that activation levels decline significantly after VT (16,43), indicating that this is a relationship that needs to be explored with children and adolescents.

The precise patterning of affective responses, at various exercise intensities are unknown in children and girls, although acute studies do indicate that we may know what happens at discrete intensities (33,38), there is limited evidence to indicate where the decline in affective responses start.

The aim of this study was to investigate affective responses to a maximal incremental exercise test to volitional exhaustion in children and adolescents. It was hypothesized that affective valence (FS) would decline significantly after VT had been reached in both age groups. Given the inconsistency of literature with regard to affective responses before VT, no a priori hypotheses were formulated regarding how affect may differ across age and sex before VT. Children and adolescents were therefore grouped separately to explore any possible sex or age effects. Based on previous studies with adults, it was also hypothesized that activation levels would decline significantly after VT had been reached.

**Methods**

**Participants**

Forty-nine children and adolescents (21 males and 28 females; (23 children; school years 4–6, age: 8–11.8 years, 26 adolescents; school years 7–9, age: 11.9–14 years) from schools in the South West of England were recruited for this study. All participants, as well as their parent/guardian, read and signed informed consent forms approved by the Institutional Ethics Committee before participating. Participants completed a child-specific Physical Activity Readiness Questionnaire (PAR-Q) and were healthy and free from muscular-skeletal injury.
Measures

**Affect.** Affect was measured from the perspective of the circumplex model, using two independently validated single-item scales: The Feeling Scale (FS) and the Felt Arousal Scale (FAS).

**The Feeling Scale (FS).** Affective valence (pleasure/displeasure) was measured using the FS (19). Participants rated their current feelings on an 11-point bipolar scale ranging from +5 to -5, with verbal anchors of very good (+5), good (+3), fairly good (+1), neutral (0), fairly bad (-1), bad (-3), and very bad (-5). The FS has been found to correlate between 0.51 and 0.88 with the valence scale of the Self Assessment Manikin (SAM; 19), and from 0.41 to 0.59 with the valence scale of the Affect Grid (41), and has been used successfully with child and adolescent populations previously (33–35).

**Felt Arousal Scale (FAS).** Activation levels were measured using the Felt Arousal Scale (FAS). The FAS of the Telic State Measure (38) is a single-item measure of perceived activation, with participants asked to rate themselves on a 6-point scale ranging from 1 to 6, with anchors at 1 ‘low arousal’ and 6 ‘high arousal.’ The FAS has been found to exhibit correlations ranging from .45 to .70, with the arousal scale of Lang’s (17) self-assessment Manakin, and from .47 to .65 with the Arousal Scale of Russell et al. (30) Affect Grid (41).

Participants were given standardized instructions on how to use the scales and had time to practice during the familiarization stage.

Instruments

**K4 Breath Analyzer.** The K4 Cosmed Breath analyzer (Cosmed K4, Italy), with a junior face mask, head net and harness, was used to measure breath by breath expired gases throughout the duration of the testing. The K4 has been shown to provide valid measurements of oxygen uptake across a range of exercise intensities (21). The K4 was calibrated before every test in accordance with manufacturer’s guidelines against known concentrations of cylinder gases and a 3-L syringe (for flow volume).

**Polar Heart Rate Monitor.** A Polar heart rate monitor (Polar Electro, Finland) was used to measure heart rate throughout the duration of the testing. Heart Rate (HR) was recorded continuously using a wireless chest strap telemetry system with a watch worn on the right wrist.

**Ratings of Perceived Exertion (RPE).** Perceived exertion was assessed using the Eston-Parfitt (E-P) curvilinear Ratings of Perceived Exertion Scale (14). This scale depicts a character at various stages of exertion on a concave slope with a progressively increasing gradient at the higher intensities. The distance between each numbered increment on the horizontal axis (0–10) is increasingly reduced in relation to its antecedent. The area under the curve is also progressively shaded from light to dark from left to right, respectively. The E-P scales has verbal anchors from ‘very, very easy’ (0), ‘easy’ (2), ‘starting to get hard’ (4), ‘very hard’ (7) up to ‘so hard I am going to stop’ (10). Strong linear ($R^2 = .93$) and curvilinear ($R^2 = .94$) relationships between RPE from the E-P Scale and work-rate in children.
aged 7–11 have confirmed the robustness of the E-P Scale (14). The same verbal instructions were given to all participants before undertaking any exercise, and participants were given several minutes to familiarize themselves with the scale. (For full instructions see 14).

**Procedures**

Height, seated height, and mass, using Tanita BIA BF-350 body composition analyzer (foot to foot) scales, (Tanita UK Ltd., Middlesex, UK) were measured upon arrival at the laboratory and body mass index (BMI) was calculated. Before testing each individual was fitted with a Polar heart rate monitor and a K4 Cosmed Breath analyzer complete with a face mask.

Participants were briefed on the procedures for the Graded Exercise Test (GXT). The GXT was completed on a Woodway PPS 55 Sport slat-belt treadmill (Woodway GmbH, Weil am Rhein, Germany) in 1-min stages at a comfortable, self-selected running speed, increasing the gradient by 1% every minute. The test was continued until the participant reached volitional exhaustion. During the test, at the end of every incremental step (last 20-s of every period) FS, FAS and RPE scores were collected.

**Data Reduction and Analysis**

VO$_2$peak, the greatest amount of oxygen consumed during strenuous aerobic exercise, was calculated for all participants. Research has indicated that many children may not be able to attain a plateau in VO$_2$, which is necessary to calculate VO$_2$ max, despite a maximal effort (22). VT was determined from the GXT data as the first disproportionate increase in carbon dioxide output (VCO$_2$) relative to the increase in VO$_2$. This was achieved from visual inspection of individual plots of VCO$_2$ versus VO$_2$ by two independent assessors. Breath-by-breath data from each test were smoothed to average every 10 s, to make visual identification of the break point clearer. This point was verified by plotting ventilatory equivalents of CO$_2$ (VE/VCO$_2$) and O$_2$ (VE/VO$_2$) against time, and identifying the point at which VE/VO$_2$ systematically increased, independent of an increase in VE/VCO$_2$ (4). VT was independently identified by two assessors.

Given that the duration of the GXTs varied among participants and following the method of data reduction and analysis used in Hall et al.’s (16) study, exercise data for all dependent variables (HR, RPE, FS and FAS) were standardized following the identification of VT. The following time points were used: the first minute (Min 1), the minute of VT (VT), the first minute after VT (VT+1) and the last minute (End); a similar pattern to that used by Sheppard and Parfitt (35).

A series of Two-factor ANOVAs were run on descriptive data (height, mass, BMI, waist, VO$_2$ Peak and VT). Three factor mixed-model analyses of variance (ANOVAs) with repeated measures across time were conducted to examine differences between age group (children: school years 4–6, aged 8–11 and adolescents: school years 7–9, aged 11–14) sex (boys, girls) and time points (min1, VT, VT+1, end) on each dependent variable: HR, RPE, FAS and FS. Where sphericity was violated, Greenhouse-Geisser was used to adjust the degrees of freedom and these
are reported. Post hoc Tukeys tests were carried out on significant interactions to examine where differences lay. FS and FAS responses were plotted within the affective space of the circumplex model (29) to identify the patterning of the data.

Results

Two-factor ANOVAs were run to determine any significant differences between age and sex on the descriptive data (Table 1). The adolescents were significantly taller ($F_{1,45} =44.7, p < .001$) and heavier ($F_{1,45} =16.9, p < .001$) than the children, but there were no differences between boys and girls or age X sex interactions. BMI did not differ significantly across either age-group or sex. VO$_2$ peak was significantly higher in the adolescents ($F_{1,4.2} = 376.4, p < .05$) and the boys ($F_{1,9.8} = 879.9, p < .01$, but no interactions were evident. VO$_2$ at VT was also significantly higher in the adolescents ($F_{1,9.3} =822.4, p < .01$) and the boys ($F_{1,4.4} = 390.9, p < .05$), but there were no significant differences in the % of VO$_2$ max at VT for age or sex.

HR and RPE

The HR and RPE ANOVAs revealed significant main effects for time ($F_{1.6, 52.4} = 102.4, p < .01; F_{2.2, 96.2} = 120.7, p < .01$ respectively), with significant increases between each time point for both physiological variables (Table 2). No further significant main effects or interactions emerged.

Table 1 Mean Descriptive Characteristics of Participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sex</th>
<th>Years 4–6</th>
<th>Years 7–9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>Boys</td>
<td>9.3 ± 1.0</td>
<td>12.2 ± 0.8</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>8.9 ± 0.8</td>
<td>12.4 ± 0.9</td>
</tr>
<tr>
<td>Height (cm) a**</td>
<td>Boys</td>
<td>140.6 ± 10.2</td>
<td>157.2 ± 10.9</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>137.8 ± 10.0</td>
<td>158.4 ± 7.8</td>
</tr>
<tr>
<td>Mass (kg) a**</td>
<td>Boys</td>
<td>35.4 ± 6.8</td>
<td>42.4 ± 6.9</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>34.3 ± 7.9</td>
<td>48.6 ± 11.5</td>
</tr>
<tr>
<td>Body Mass Index (BMI; kg.m$^{-2}$)</td>
<td>Boys</td>
<td>17.9 ± 1.9</td>
<td>17.1 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>18.1 ± 3.1</td>
<td>19.3 ± 3.4</td>
</tr>
<tr>
<td>VO$_2$ Peak (mL.kg$^{-1}$.min$^{-1}$) a*</td>
<td>Boys</td>
<td>46.7 ± 12.8 b*</td>
<td>51.5 ± 6.7 b*</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>37.0 ± 9.0 b*</td>
<td>43.7 ± 8.8 b*</td>
</tr>
<tr>
<td>VT (mL.kg$^{-1}$.min$^{-1}$) a* b*</td>
<td>Boys</td>
<td>36.9 ± 10.5</td>
<td>41.3 ± 6.7 b*</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>27.2 ± 8.2</td>
<td>36.2 ± 6.5 b*</td>
</tr>
<tr>
<td>VT as a % of VO$_2$max (%)</td>
<td>Boys</td>
<td>79.1 ± 5.9</td>
<td>80.3 ± 10.0</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>73.0 ± 9.2</td>
<td>84.4 ± 14.6</td>
</tr>
</tbody>
</table>

a= age main effect *p <0.5 **p <0.01

b= gender main effect *p < 0.5 **p < 0.01
The FS ANOVA showed a significant main effect for time ($F_{2,3, 82.7} = 74.3, p < .01$, and a significant time by age-group interaction ($F_{2,3, 82.7} = 3.8, p < .05$), no further significant effects were evident (Figure 1). Post hoc tests confirmed that the main effect was due to significant changes in FS scores between each time point; from min 1 to VT, and from VT to VT+1 and then from VT+1 to the end of the GXT. For the interaction, post hoc tests revealed that the temporal patterns of FS scores differed between age groups with children reporting significant declines in FS responses from the onset of exercise, while the adolescents’ affective responses remained relatively stable and did not change significantly over time before VT. After VT patterns of FS responses were similar for both age groups until after VT+1 where significant group differences were evident. Differences between children and adolescents reached statistical significance only after the VT+1 to
end exercise period. End scores were lower in the adolescent group (-2.17 ± 0.5) than in the children (-1.31 ± 0.6).

**FAS**

The FAS ANOVA revealed a significant main effect for time \(F_{2.039, 73.411} = 13.40, p < .001\) but no other significant effects. Post hoc tests of the significant time main effect revealed that there were no significant changes in FAS scores from min 1 to VT or from VT to VT+1 but there were significant increases in FAS scores from min 1 to end, VT to end and VT+1 to end (Table 2).

Valence and activation responses during the GXT were plotted onto a circumplex model to further explore the differences in responses between boys and girls and the children and adolescents (Figures 2a and b). The boys reported pleasant feelings until after VT+1 when there was a shift into the activated/unpleasant domain. In contrast, the girls initially reported feeling unactivated/pleasant, with the older girls indicating that they felt unactivated until after VT+1 when there was a shift to the activated/unpleasant domain. The younger girls reported ‘unpleasant’ feelings immediately after VT at VT+1.

**Discussion**

The purpose of this study was to explore the patterns of responses in affective valence in boys and girls (ranging in ages from 8 to 14 y) to a GXT and to compare these results to those found in previous adolescent (35) and adult populations (16,35,43). Consistent with the hypothesis and previous literature (11,16,35,43), affective valence significantly declined after VT in both children and adolescents. However, affect did not significantly decline until after VT in the adolescents. In the children, similar to the pattern of responses found in sedentary men (35), there was
a significant decline in FS responses from the onset of exercise through to exhaustion. This decline before the VT highlights that even exercise at a lower intensity can represent a negative experience (23,35). It should be noted that, despite this decrease in affect from the start of exercise in children, differences between children and adolescents reached statistical significance only after the VT+1 exercise period. Previous studies exploring the temporal pattern of FS (35) have revealed results similar to those observed in the adolescents’ data: stable positive affective valence before VT followed by significant declines after VT. In the current study, the steep drop in affect between VT+1 and the end point (End) in the adolescents led to a significantly lower affect in the adolescents relative to the children. It should be noted that the duration of GXTs were substantially longer for the adolescents than the younger children, with the average length of the GXT at 6.3 min for the adolescents and only 5.3 for the children. Adolescents spent 26.4% of the GXT from Min1 to VT, 18.2% of time from VT to VT+1 and 37.3% of time from VT+1 to End, while the children spent 24.1% of the GXT from Min1 to VT, 21.2% of time from VT to VT+1 and 33.7% of time from VT+1 to End. These results indicate that the adolescents spent substantially more time from VT+1 to end than the children, suggesting that the adolescents have relatively longer for the interoceptive cues to be registered more acutely, hence the steeper drop in affective responses after VT+1. The continuous nature of the GXT may influence affective responses, particularly in the younger participants. Research suggests that children generally engage in short, sporadic bursts of activity (1,5), and is characterized by short, intermittent bouts of activity (36) rather than the continuous exercise bouts that were imposed in this study. As the GXT did not reflect the natural activity pattern of the children, it may have contributed to the decline in affective responses.

The pattern of decline in FS responses before VT in the children may be related to their lack of experience of continuous exercise and thus lack of cognitive cues to

**Figure 2** — a and b Valence and activation responses during GXT plotted onto circumplex space
draw upon. McAuley and Courneya (20) suggested that self-efficacy is an important factor underlying affective responses brought about by exercise, suggesting that the more positive one’s self-efficacy, the more positive affective responses one reports having. McAuley and Courneya (20) proposed that a highly efficacious person is expected to exhibit more positive affect compared with a less self-efficacious one. Given that the younger children had no experience of treadmill exercise, and will rarely have participated in long, continuous bouts of exercise it could be suggested that their beliefs in their own competence in this exercise would be relatively low and could contribute to this decline in affective responses from the onset of exercise. Welch at al., (43) found similar response patterns in their cohort of inactive woman who also revealed a continual, significant, decline in FS throughout the GXT, with significant differences in FS between each time point.

A mean decline in affective valence was observed much earlier in the children’s responses compared with those found in previous studies (16) with active university students. These results were similar to those found in sedentary women (43) and inactive men (35). The mean decline in affective valence that occurred before VT suggests that, for children, affective change is not as homogeneously positive within the moderate intensity domain as suggested by Ekkekakis et al. (10). These results are important because they indicate that more attention needs to be paid to exercise prescription with regards to intensity for children to avoid negative affective responses being reported. Children appear to report more positive affective responses below VT than above them, a result that needs to be considered when developing different exercise programs for children and adolescents. Caution needs to be taken, however, to not assume that below VT there is no variability in affective response. Stych and Parfitt (38) reported high variability in affective responses below VT, indicating that research needs to focus on individual differences alongside exercise intensity.

Bandura (2,3) suggested that limited mastery opportunities will negatively influence a person’s cognitions, particularly with reference to task completion. Perhaps, given the age and limited experience of continuous exercise of the younger participants, it is unsurprising that they reported declines in affective valence even within the moderate intensity domain. Other than the familiarization period in the laboratory, none of the younger participants had ever walked or run on a treadmill which could be a contributory factor toward the continual decline in affective valence. Parfitt and Hughes (24) indicated that the previous activity history of the participant may influence affective responses during exercise and contribute to their perception of ability and perception of the intensity of the exercise (28) and thus their overall affective response. Parfitt and Hughes (24) also report that based on previous activity history, affective responses were universally more negative in less active individuals (30 min of activity less than once per week). This could link to the younger children in this study, as it may be appropriate to suggest that the younger participants’ previous experiences of continuous exercise history was not as extensive as that of the older participants hence the continual decline in affective responses from the beginning of the GXT in comparison with the stabilized affective responses seen over the same time-period in the older participants.

After VT has been reached there is a significant decline in affective valence in both the children and adolescents; an expected outcome. It has been theorized (8)
that as intensity increases above VT affective response will become much more negative and exhibit little variability due to the over-riding influence of interoceptive cues. This is because affective responses are no longer influenced by cognitive processes, such as exercise experiences and goals, but the actual physiological cues that are being experienced by the individual, which do not vary. This is an important result with relation to the exercise-adherence relationship. With exercise above the VT eliciting a uniformly negative response it suggests that exercise prescription should focus on identifying a level of intensity near the VT, at which participants can maintain a constant or improving (but not diminishing) level of pleasure (12) to ensure a positive affective response and thus encourage continued exercise adherence.

Using the circumplex model (6) helps to a) illustrate that affective responses change dynamically to changes in the intensity of exercise and b) highlight that the transition between exercise domains represents an inherently negatively-charged stimulus. Once exercise exceeded VT and entered the heavy domain there was a continued increase in perceived activation, accompanied by a progressive deterioration in valence. Described in terms of the circumplex model, the mean affective responses moved from the unactivated pleasant domain, via the pleasant activated domain into the activated unpleasant domain after VT+1. This pattern is similar to that found by Hall et al. (16), and Welch et al. (43).

Data from the circumplex model revealed apparent differences across all groups. The boys followed a similar pattern to that found in low active men (35), university students (16) and inactive women (43); moving from the unactivated pleasant domain, through the pleasant activated domain and ending in the activated unpleasant domain after VT had occurred. While the girls reported similar responses after VT, with activated unpleasant feelings, there were differences before this (Figure 4). Although these circumplex models suggest big differences between ages and sex, there were no statistical differences between groups in the separate FS (apart from between VT+1 and end exercise) or FAS responses (Table 2). The circumplex do show that feelings of pleasure clearly decreased across time continually from the onset of exercise and can be useful to highlight the dynamic changes in affect across different intensities and support the differential response of children to exercise compared with results found in previous adult studies.

**Conclusion**

The data fit the expected pattern of responses predicted by the dual-mode theory and demonstrate that exercise above the VT brings about significant declines in affective valence regardless of sex, but the patterning of affect differed across the age-groups. In children, affective valence declined significantly before VT whereas the decline in adolescents was not significant. The differences between boys and girls responses to the GXT plotted onto the circumplex model demonstrated that boys and girls responded differently during the GXT, while both groups finished the maximal test feeling ‘activated and unpleasant’, the different routes taken by boys and girls requires further exploration in terms of the individual differences that may influence these responses, an idea supported by qualitative analysis carried out by Stych and Parfitt (38).
These results may be important with regards to exercise prescription as acute affective responses have been shown to predict future exercise adherence. Results suggest the need to prescribe exercise intensities lower than VT for children to ensure a positive affective response

Limitations and Future Recommendations

Given that by its nature the GXT creates an unfamiliar and uncommon exercise experience for the children, it is not necessarily unexpected that a decline in affective response occurs from the onset of exercise. This bout of continuous exercise is not typical of children’s habitual activity and thus offers a considerable limitation to this study. Future research needs to explore affective responses to different intensity activities using activities that are more applicable and appropriate for younger children. Studies need to investigate affective responses to short bursts of different exercises and activities with varying intensities to give a more in-depth overview of the patterning of the affect and exercise relationship in children.

To establish a more complete picture of the changes in affective response across exercise domains future studies may consider recording FS responses more frequently so that once data has been standardized into time points more data are available to give greater insight into the patterning of affective responses across different exercise intensity domains in children and adolescents.

Future research should also consider recording individual’s past exercise experience and history along with qualitative interviews so that links can be explored further to establish whether one’s past experiences in an exercise environment contribute significantly to affective responses.

References


