PERSPECTIVES

Exercise: One size does not fit all

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Chronic exercise training evokes significant physiological adaptations that are dependent on the 'specificity of training'. This fundamental tenet is easily described by comparing the contrasting effects of endurance *vs.* strength training adaptations. Endurance exercise evokes improvements in aerobic capacity ($\dot{V}_{O_2 peak}$), not strength or power. Conversely, strength training improves muscular strength but, in general, does not improve aerobic capacity.

Although specificity for training adaptations is well known, the heterogeneity to which individuals respond differently to the same type of training is of great interest, particularly for maximizing the therapeutic effects of exercise to treat disease. Cross-sectional studies suggest that both genetics and environmental conditions contribute to heterogeneity of exercise responses. However, cross-sectional studies can be misleading and are impacted by individuals self-selecting their favourite exercise, which may impact volume and intensity over time. Moreover, a lack of adaptation or enjoyment for one type of exercise may push individuals to switch to a different modality, an effect that may result in reverse causation. This issue highlights another question. Do those who experience high responsiveness for improving aerobic capacity to endurance exercise also experience large improvements in strength following strength training? What about low responders: are they poor responders to both modalities of exercise? Finally, does genetics and environment influence concordant or discordant responses to either mode of exercise?

A new innovative study reported by Marsh *et al.* (2020) in *The Journal of Physiology* has significantly advanced our understanding of exercise adaptations on several fronts. Marsh *et al.* (2020) used a prospective, within-subject, cross-over design to test the degree to which endurance and strength training exercise adaptations were modality-specific and whether individuals display a concordant or discordant response to both forms of training. Subjects completed training for one exercise modality (endurance and strength) for 3 months before going through a 3 month washout period and then returning to engage in the opposite modality. To further understand the role of genetics and environmental factors on these outcomes, they recruited and enrolled twins (monozygotic or dizygotic) to take part in the study. Pairs of twins trained together in both forms of exercise largely controlling for environmental and genetic influence on adaptations.

The primary findings indicate that poor responders to one modality of exercise (i.e. barely increase aerobic capacity in response to endurance exercise) can be robust responders to the alternative modality (i.e. increased muscular strength after strength training) or vice versa. This suggests that low responders can be 'rescued' by switching to an alternative exercise mode. Another major finding was that genetics weakly predicted training adaptations, unlike what the previous cross-sectional studies had indicated.

So, what do these findings mean? First of all, we should be careful with any interpretation of responder *vs.* non-responder. Any form of exercise probably provides benefits (vascular function, energy expenditure, neurogenesis, etc.) even if a primary outcome does not improve. We still do not know enough about the benefits of exercise in people who do not adapt according to the primary outcomes that are expected. Before we decide to shift non-responders to a different modality, we would need proof that the initial mode provides no benefit. In addition, in some settings, improved aerobic capacity may be what is needed and moving to a different mode would be illogical. In addition, there is evidence that low responders may just require a higher volume or intensity before they respond (Montero *et al.* 2015).

Second, because genes appear to moderately influence the individual response to exercise training, environmental and lifestyle factors must be critical. Habitual levels of physical activity, sedentary behaviours, diet, sleep pattern, smoking habits and alcohol consumption are health behaviours that can potentially contribute to the idiosyncratic response to exercise. In the future, we may also find that mood and psychological health modulate exercise adaptations. It is possible that a change in one health behaviour may synergize with others. Although research on this topic remains scarce, recent studies are showing how health behaviours are linked. For example, daily levels of light physical activity (i.e. any body movement of daily life) were shown to predict individual variation for improved $\dot{V}_{O_2 max}$ after training (Hautala *et al.* 2012). By contrast, habitual high volumes of sedentary time (too much sitting) and inactivity (not enough exercise) can diminish positive effects of exercise on metabolic health (Akins *et al.* 2019). These studies suggest that everyday life activity impacts 'trainability'. Habitual diet is also highly variable and can modify exercise adaptations. High content of proteins, omega 3 and omega 6 lipids, and some micronutrients positively impact or synergize with increased muscle mass and strength. The timing between food consumption and a bout of activity may further influence adaptations. Timing of exercise (morning

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vs. night) in accordance with the individual circadian rhythm probably also influences the health outcomes. In conclusion, future research should investigate the intertwined relationship between exercise training adaptions and a myriad of other factors (diet, timing, mood, etc.) to better understand the environmental and physiological conditions required to optimize the health-enhancing effects of exercise. Finally, getting people to start and maintain an active lifestyle is critical as the world becomes more sedentary. Further research is needed to determine whether those with greater exercise adaptations have a greater probability of sustaining that activity in the long term. Because carrying out any form of exercise is better than nothing, it will be critical to know how to help individuals find the type of exercise they enjoy, with the hope that it will be a sustained behaviour leading to great health and protection from disease.

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Additional information

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