Effect of conversation on rate of perceived exertion and physiological responses during exercise

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Abstract

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Aim The purpose of this study was to investigate the effect of exercising with conversation on rate of perceived exertion (RPE) and physiological responses. **Methods** Ten healthy college students performed pedaling exercise on bicycle ergometer with and without conversation. At this time, oxygen consumption (VO2), heart rate (HR), and RPE were measured during these exercises and were compared between the exercises with and without conversation. **Results** Resting VO2 was significantly higher with conversation than without conversation (p = 0.037). There was no significant difference in resting HR, exercise VO2, HR, and RPE between with and without conversation. **Conclusion** These results suggest that conversation induces feeling of shorter exercise time while RPE and physical responses were not influenced by conversation.

会話が運動時の主観的運動強度と生理学的応答に及ぼす影響

本研究の目的は、会話を伴う運動が主観的運動強度(RPE)と生理学的応答へ与える影響を調査することであった。健康な大学生１０名が自転車エルゴメーターによる運動を行った。この時会話ありと会話なしの場合の酸素摂取量（VO2）や、心拍数（HR）、および RPE を比較した。安静時の VO2 は会話なしよりも、会話ありの方が有意に増加した（ｐ＝０．０３７）。安静時の HR、運動時の VO2 と HR、RPE において、会話ありと会話なしの場合の間に有意差はなかった（ｐ>0.05）。これらの結果から、運動時の会話は RPE や生理学的応答は変化させないが、運動時間を短く感じさせることが示唆された。

El efecto de la conversación sobre el RPE y las respuestas fisiológicas durante el ejercicio

El objetivo de este estudio ha sido investigar el efecto de hacer ejercicio con conversación sobre la tasa de esfuerzo percibido (RPE) y las respuestas fisiológicas. Diez estudiantes universitarios sanos realizaron ejercicios de pedaleo en bicicleta ergómetro con y sin conversación. El consumo de oxígeno (VO2), la frecuencia cardíaca (HR) y el RPE se midieron durante estos ejercicos y se compararon entre los ejercicos con y sin conversación. El VO2 en reposo fue significativamente mayor con la conversación que sin la conversación (p = 0,037). No hubo diferencias significativas en el HR en reposo, el VO2, el HR y el RPE del ejercicio entre los casos con y sin conversación (p> 0,05). Estos resultados sugieren que la conversación durante el ejercico induce la sensación de un tiempo de ejercico más corto, mientras que el RPE y las respuestas físicas no se vieron influenciadas por la conversación.

Abbreviations:

VO2: oxygen consumption, HR: heart rate, RPE: rate of perceived exertion.

Introduction

In recent years, the world is aging rapidly (Cabinet Office. 2018). According to the Ministry of Foreign Affairs (MOFA), there are 611.9 million older people around the world, and Japan has the highest average life expectancy in the world, and the population is aging internationally (MOFA. 2021). As of October 1, 2018, the total population of Japan is 126.44 million, and the population aged 65 and over is 35.58 million, so the ratio to the total population (aging rate) is also 28.1% (CAO. 2018). According to the Cabinet Office (CAO), it is important for people to live long and healthy because the aging of Japan causes social problems such as economic growth and social security system (CAO. 2018).

Therefore, according to Raven et al. (2013), exercise is effective for a healthy and long life (Raven et al., 2013). In general, the positive effects on mental health, cognition and brain activity as a result of exercise programs are very clear (Rimes et al., 2015). Many exercise physiologists are beginning to apply the concept of facilitating exercise training programs, which improve an individual's physical activity and athletic performance, help prevent illness, and improve physical fitness and athletic performance (Raven et al., 2013). It is said to improve and recover from injuries and illnesses (Raven et al., 2013). Consequently, all adults, including older people, need to having exercise habits. For substantial health benefits, adults need to perform at least 150 minutes of moderate or 75 minutes of intense aerobic exercise per week, or a combination of equivalent moderate and intense aerobic activity (Department of Health and Human Services. 2008). According to a survey by the Japan Sports Agency (JSA), 62% of both men and women having habits of walking in one year, while 20% of men and 7% of women having habits of running. The study shows that running is not preferred, as the number of people running marathons is overwhelmingly less than those walking (JSA. 2019).

Moreover, high-intensity exercise increases subjective exercise intensity. According to Raven et al. (2013), the Borg ratings of perceived exertion scales, developed by Dr. Gunnar Borg, was developed to estimate intensity based on overall perception of physical cues such as breathing difficulty, heart rate, and muscle discomfort (Raven et al., 2013). Accordingly, since the Borg scale indicates how hard you are moving during exercise, it can be said that the higher the intensity of exercise, the higher the subjective exercise intensity.

Then in order to reduce the subjective exercise intensity, it is effective to distract. In a previous study of the interactive cycling games, which is a game whose contents change according to the player's operation, interactive cycling games have higher exercise intensity and energy consumption rate than conventional cycling (Monedero et al., 2015). The user of interactive cycling games has increased significantly (Monedero et al., 2015). On the other hand, heart rate and subjective exercise intensity did not change much. Therefore, it is possible to reduce the subjective exercise intensity by distracting. In another previous study, Virtual Reality (VR) was used during medical procedures to distract and reduce pain and anxiety (Arane et al., 2017). Distraction is a common non-pharmacological technique used by healthcare professionals to manage and relieve anxiety and, in some cases, pain during painful procedures in pediatric patients (Koller et al., 2012). The theory behind VR's role in reducing pain as well as anxiety is related to the limited attention that humans have. Pain requires attention, and if some of that attention can be distracted, patients are slow to respond to incoming pain signals (Hoffman et al., 2011). Virtual reality also does not interrupt pain signals, but acts directly and indirectly on pain perceptions and signals through attention, emotion, concentration, memory, and other sensations (Gold et al., 2007). By distracting in this way, discomfort such as pain and anxiety is reduced, so it is possible to reduce discomfort during exercise, that is, fatigue. Previous studies have shown that distractions during exercise have a positive effect, as watching television makes you feel more comfortable while exercising (Privitera et al., 2014). Distractions during exercise can enhance a comfortable mood and lead to continued training routines (Rocheleau et al., 2004). Consequently, distraction during exercise leads to habituation of exercise. Loneliness and depression are also particularly associated with the elderly (Abella et al., 2017). Rosenquist et al. (2011) suggested that individuals with fewer contacts had higher levels of depression (Rosenquist et al., 2011). It was also found that loneliness is a major risk factor for increasing mortality in older men (Holwerda et al., 2012). In addition, those suffering from both depression and loneliness had a 2.1-fold higher risk of death (Stek et al., 2005). In summary, emotional and social isolation have a clear impact on depression. Therefore, loneliness must be avoided in order for the elderly to live a healthy and long life. Thus, I thought that exercising while talking with people might have a positive effect on the health of the elderly. However, no studies have investigated the effects of conversation on psychological and physiological responses during exercise.

The purpose of this study is to clarify the effect of conversation on RPE and physiological responses during exercise. It was hypothesized that exercise with conversation reduced RPE and felt shorter than the actual exercise time. This hypothesis is based on studies using VR in the medical field and studies of time judgment (Arane et al., 2017, Wittmann, 2009). Studies have shown that the use of VR as a method of distraction during procedures such as vaccination and blood sampling reduces pain and anxiety in children, so distraction may reduce discomfort (Arane et al., 2017). In addition, we speculated that distraction can make time feel short because time judgment is emotional in nature, feeling slower in unpleasant situations and faster in fun situations (Wittmann, 2009). As a result, I think that participants will be able to continue exercising.

Materials and Methods / Measuring methods

Participants

Ten university students with no abnormalities in the lower limbs participated in this study. Participants gave informed consent for the study after receiving a detailed explanation of the purpose, potential benefits, and risk associated with participation in the study.

Experimental design

In the experiment, we compared oxygen intake (VO2), heart rate (HR), and rate of perceived exertion (RPE) between the exercises with and without conversation. An incremental workload test was performed on the first day to determine the exercise intensity for the main experiment. On the second day, the participants performed pedaling exercise at the slight tightness exercise intensity. First, we took data for 5 minutes without conversation at rest. Next, we took date for 5 minutes with conversation at rest. Then, after warming up for 5 minutes and taking a 10-minute break, we took data of the participants performed pedaling exercise while having a conversation for 5 minutes. After a 10-minute break, we put a screen between the two and took data of the participants performed pedaling exercise without conversation for 5 minutes. As for how to instruct the conversation at this time, I prepared 19 questions on the paper and asked the two people to talk freely while looking at the paper. The content of the question was a topic that was easy to talk about. Contents of conversation are about hobby, favorite food, favorite movie, recently watched movie, hometown, club activities, part time job, a fun travel destination, a cat person or a dog person, favorite sport, the country which participants want to visit the most, favorite entertainer, favorite song, brothers, what want to do if participants win the lottery, favorite season, favorite oden ingredient, favorite YouTuber, and what want to do when COVID-19 pandemic ends (TOWNWORK. 2017). Immediately after the experiment, we asked the subjects which one felt shorter, with or without conversation. As a caveat, the ratio of the case of rowing an exercise bike while having a conversation with two people first and the case of rowing an exercise bike with one person first is planned to be the same, so the order of the experiment is different from the current explanation.

Exercise

The workload at first stage of incremental workload test was set at an intensity of 5METs based on the body weight of the subject. The following formula was used.

The formula used to determine the power.

5METs×3.5ml/kg/min = 17.5ml//kg/min

$$17.5\text{ml/kg/min} = 1.8\frac{\text{Power(kg・m/min)}}{\text{Weight(kg)}} + 7$$

$$\text{Watts} = \frac{\text{kg・m/min}}{6.12}$$

Then, a gradual load test was performed from the determined workload, and the workload at which the subjective exercise intensity was 13 indicating a little tightness was determined as the slight tightness exercise intensity for each participant. We increased workload of bicycle ergometer by 10W in 1 minute and cadence of pedaling was 60bpm. The main experiments with and without conversation were performed at the slight tightness exercise intensity. In this experiment, two bicycle ergometers （ETC163, AEROBIKE 75XLⅢ, CONAMI SPORTS & LIFE Co., Ltd. Tokyo, Japan, Lode Excalibur Sport; Lode Medical Technology, Groningen, The Netherlands） were used. They were placed next to each other so that participants could perform pedaling exercise in the same direction. Each exercise time was 5 minutes. This exercise time was determined from the fact that VO2 became steady 3 minutes after exercise (Robert, 2014).

Measurement of VO2

VO2 was measured using a breath gas analyzer (AE310S, AEROMONITOR, Minato Medical Science Co., Ltd. Osaka, Japan) covering the mouth and nose with a mask. VO2 at each exercise was determined by the average value obtained during the last 1 min. The data obtained at the time of measurement was synchronized with a personal computer using Lab Chart 8 software (ADInstruments, Melbourne, Australia). The stored data of VO2 were downloaded to a personal computer (PC) and used for analysis.

Measurement of Heart rate

HR was measured using an electrocardiogram (Central Monitor with Analysis Function DS-8600, Fukuda Denshi Co., Ltd. Tokyo, Japan), an electrocardiographic / respiratory transmitter (ECG & Respiration Transmitters, LX-8100, Fukuda Denshi Co., Ltd. Tokyo, Japan), and a magnerode (MAGNERODE, TE-18, Fukuda Denshi Co., Ltd. Tokyo, Japan). Before mounting the electrodes, the participant's electrode mounting site was wiped with alcohol disinfectant cotton (Sanicot EQ, Marusan Sangyo Co., Ltd., Ehime, Japan) to remove skin stains such as sweat and oil. The positions of the ECG electrodes were fitted according to the CC5 Holter ECG guidance method

(Guiteras et al., 1982). After that, an electrocardiographic / respiratory transmitter was attached to the electrodes. HR at each exercise was determined by the average value obtained during the last 1 min. The stored data were downloaded to a personal computer (PC) and used for analysis.

Measurement of RPE

RPE was measured using a Borg scale at 19 levels of subjective exercise intensity. We asked the participants for RPE in 4 minutes after the start of the experiment. At that time, we showed participants the Borg scale paper and asked him/ her to point his/ her finger at the current RPE.

Data analysis and Statistical analysis

We compared VO2 and HR during rest, exercise, with and without conversation. We used a delta analysis to determine the net difference between with and without conversation and the net difference between during exercise and during rest. In order to compare the effect of conversation on net VO2 and HR, the difference of VO2 and HR between with and without conversation at rest and exercise were calculated. Furthermore, similar to the method that analyzed the effects of conversation on net VO2 and HR, we analyzed the effects of exercise on net VO2 and HR.

Due to the small number of subjects, a nonparametric method was used for statistical analysis. VO2, HR, RPE, net VO2, net HR, and how to feel time compared variables between with and without conversation and between during exercise and during rest using Wilcoxon test. The level of statistical significance was set at $p < 0.05$.

All statistical analyzes were performed using SPSS software (SPSS version 25.0; SPSS, Tokyo, Japan).

Result

Resting VO2 was significantly higher during with conversation than without conversation ($p = 0.037$) (Fig. 1). There were no significant differences between with and without conversation in HR during rest ($p = 0.799$) (Fig. 2), VO2 during exercise ($p = 0.074$) (Fig. 3), HR during exercise ($p = 0.059$) (Fig. 4), and RPE during exercise ($p = 0.0751$) (Fig. 5). No significant differences were not observed in the value obtained by subtracting VO2 and HR at rest from VO2 and HR during exercise with and without conversation ($p = 0.074$) (Fig. 6) ($p = 0.092$) (Fig. 7). Significant difference was not detected in the value obtained by subtracting VO2 and HR without conversation from VO2 and HR with conversation during exercise and at rest ($p = 0.074$) (Fig. 8) ($p = 0.092$) (Fig. 9). Subjects felt that the time was shorter with conversation than without conversation (There is a significant difference, $p = 0.002$).

Discussion

In this study, we investigated the effects of conversation on VO2, HR, and RPE. Resting VO2 was significantly higher with conversation than with silence during rest and exercise ($p <0.05$) (Fig. 1). There were no significant differences in resting HR, exercise VO2 and HR, and RPE between silent and conversational cases ($p> 0.05$) (Fig.

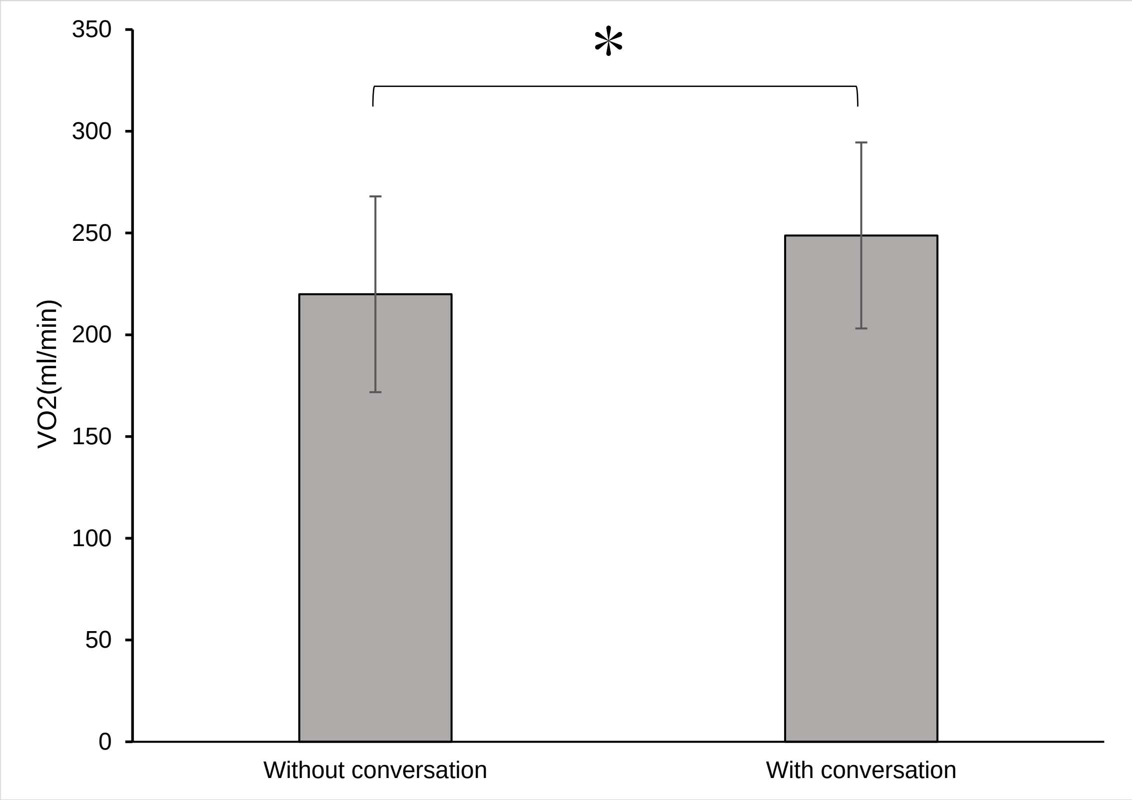

Fig. 1 Mean VO2 between with and without conversation during rest (*$p < 0.05$ between with and without conversation).

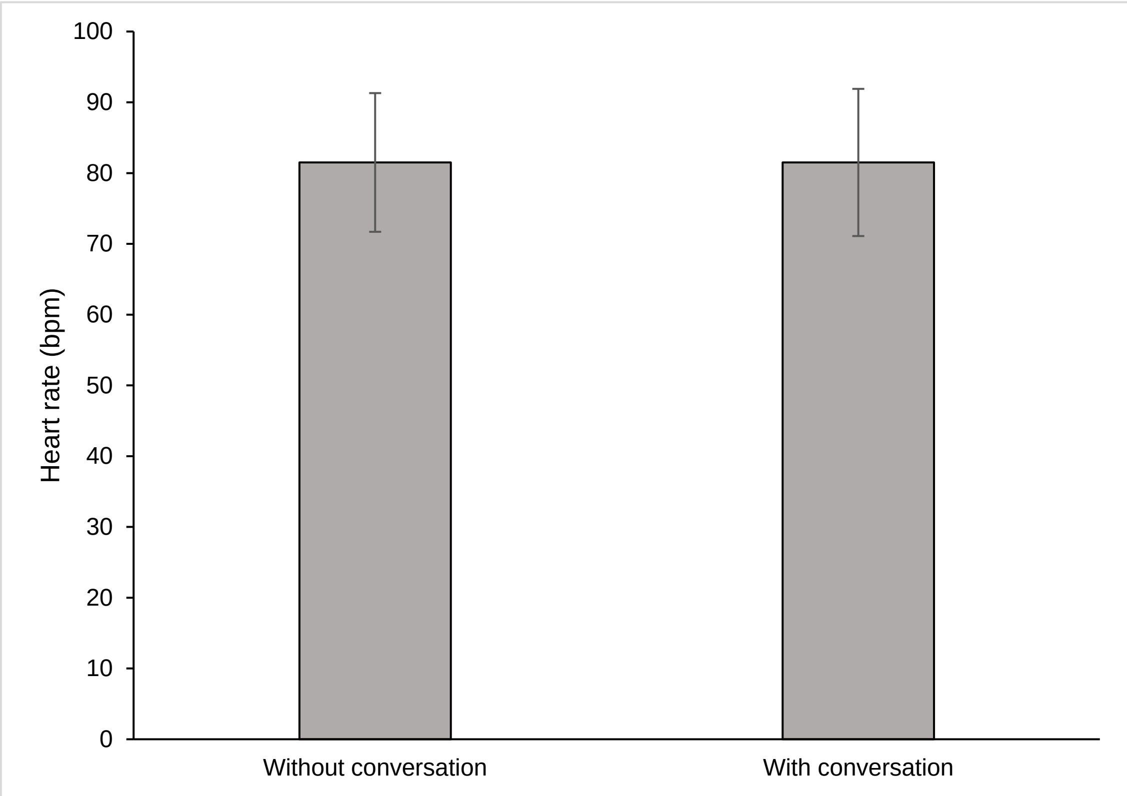

Fig. 2 Mean HR between with and without conversation during rest.

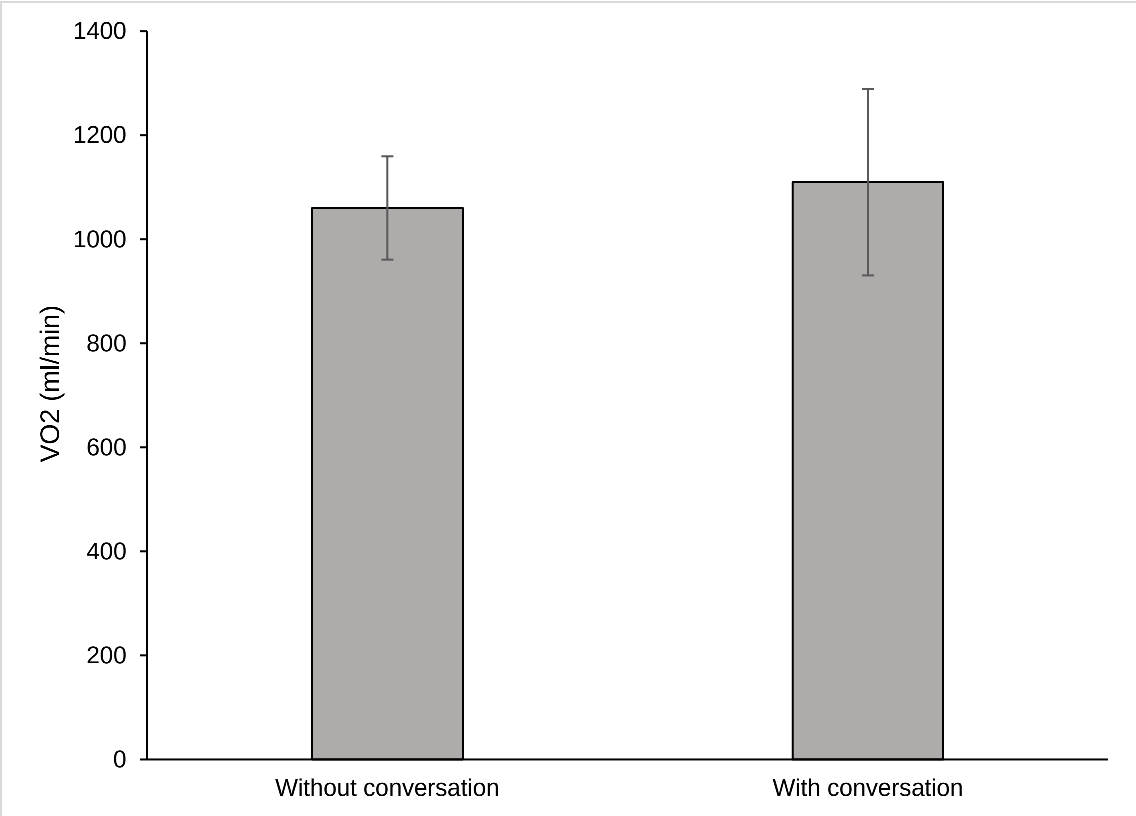

Fig. 3 Mean VO2 between with and without conversation during exercise.

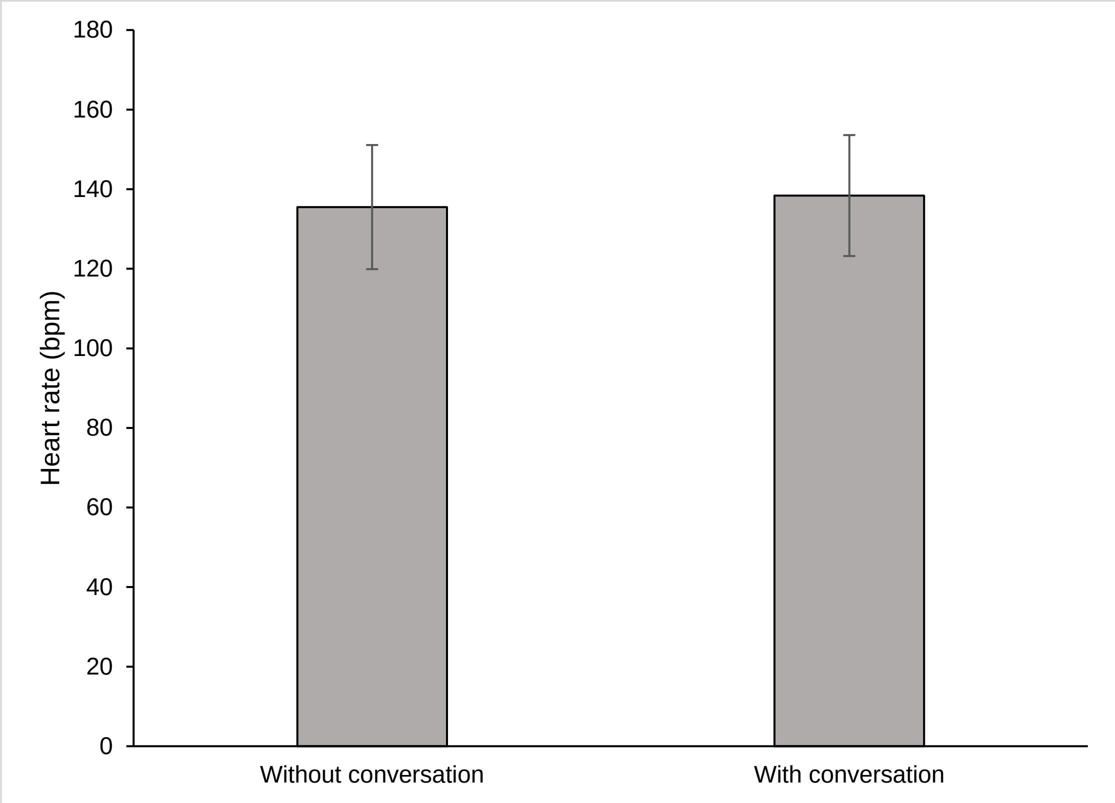

Fig. 4 Mean HR between with and without conversation during exercise.

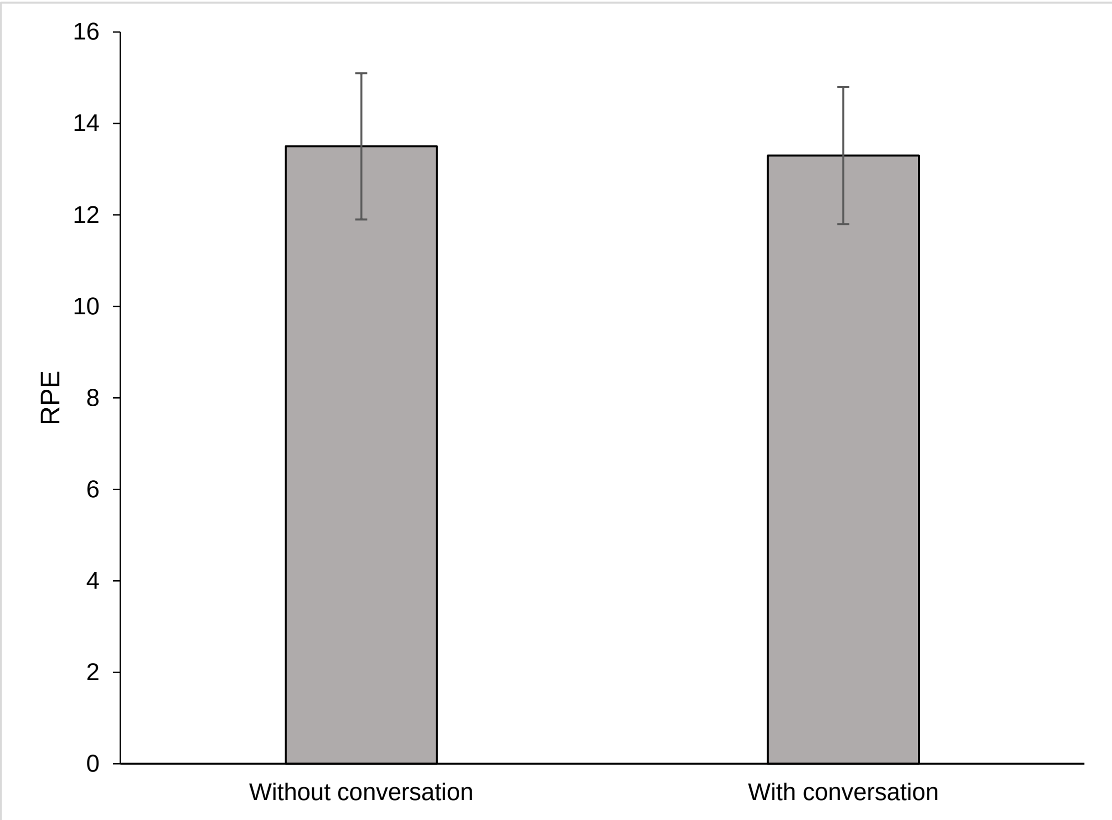

Fig. 5 Mean RPE between with and without conversation during exercise.

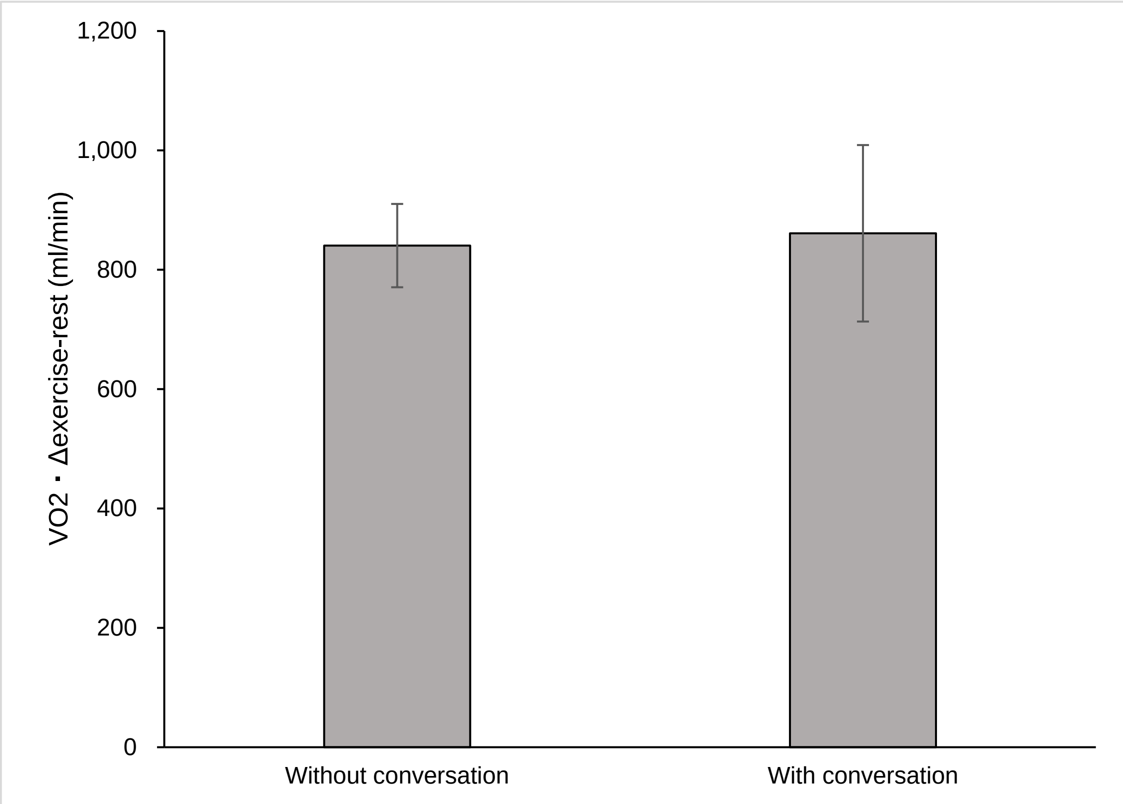

Fig. 6 Mean data obtained by subtracting VO2 at rest from during exercise for the exercises with and without conversation.

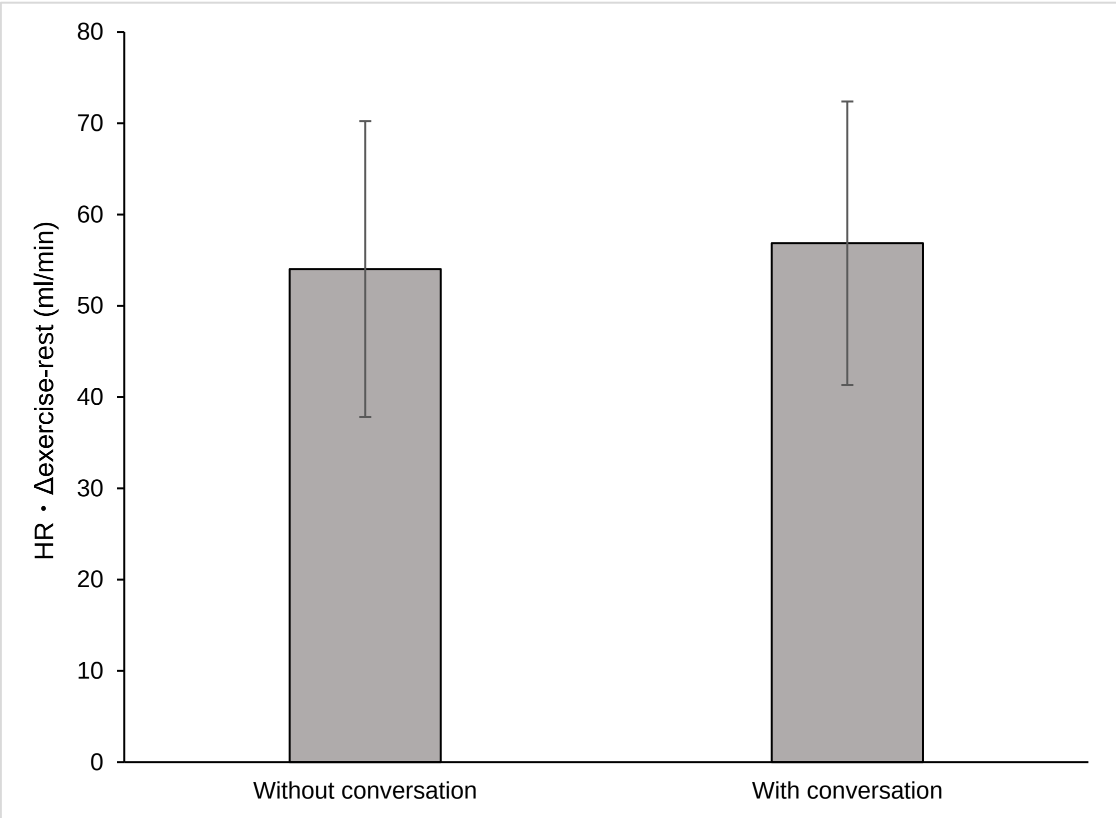

Fig. 7 Mean data obtained by subtracting HR during rest from during exercise for the exercises with and without conversation.

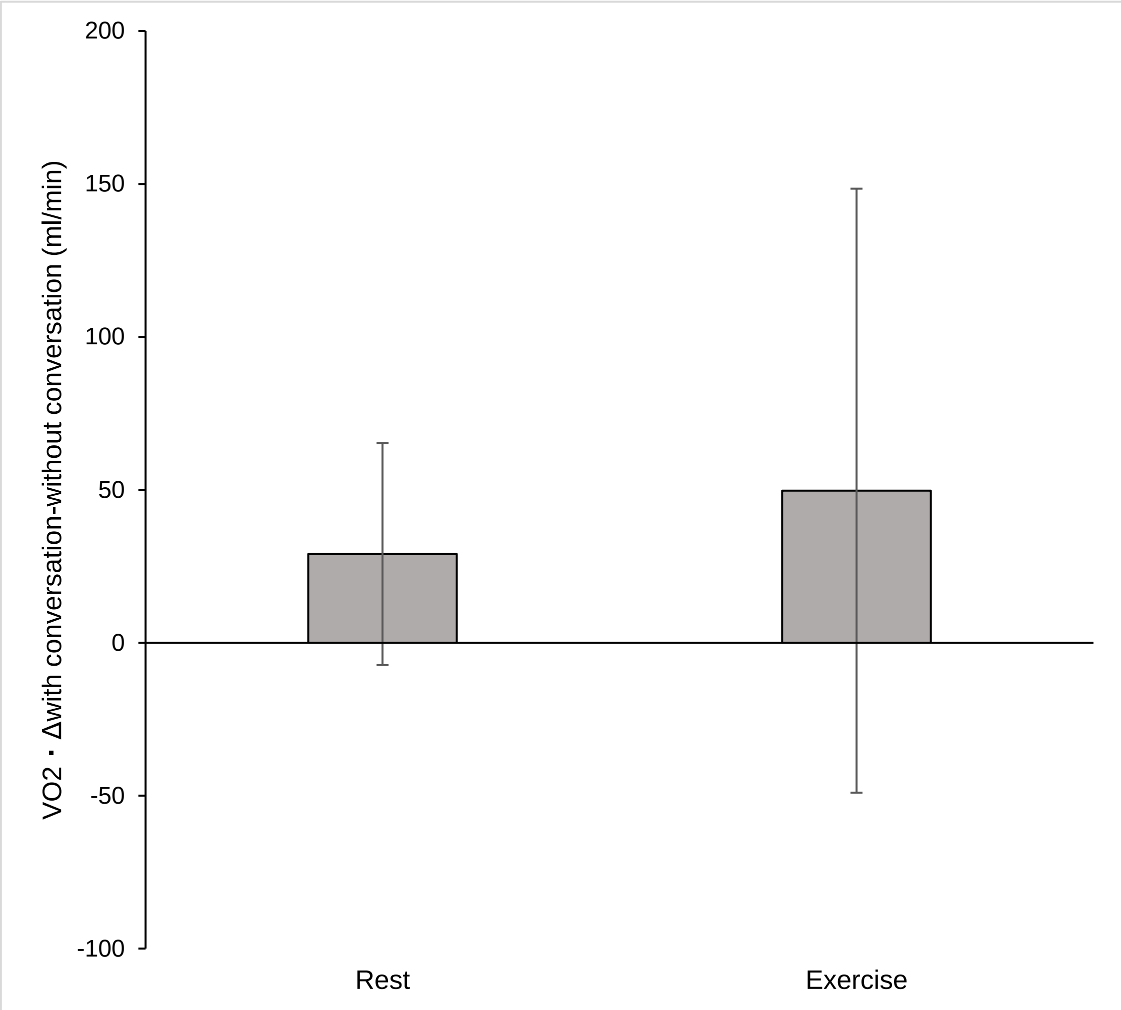

Fig. 8 Mean data obtained by subtracting VO2 without conversation from with conversation during rest and exercise.

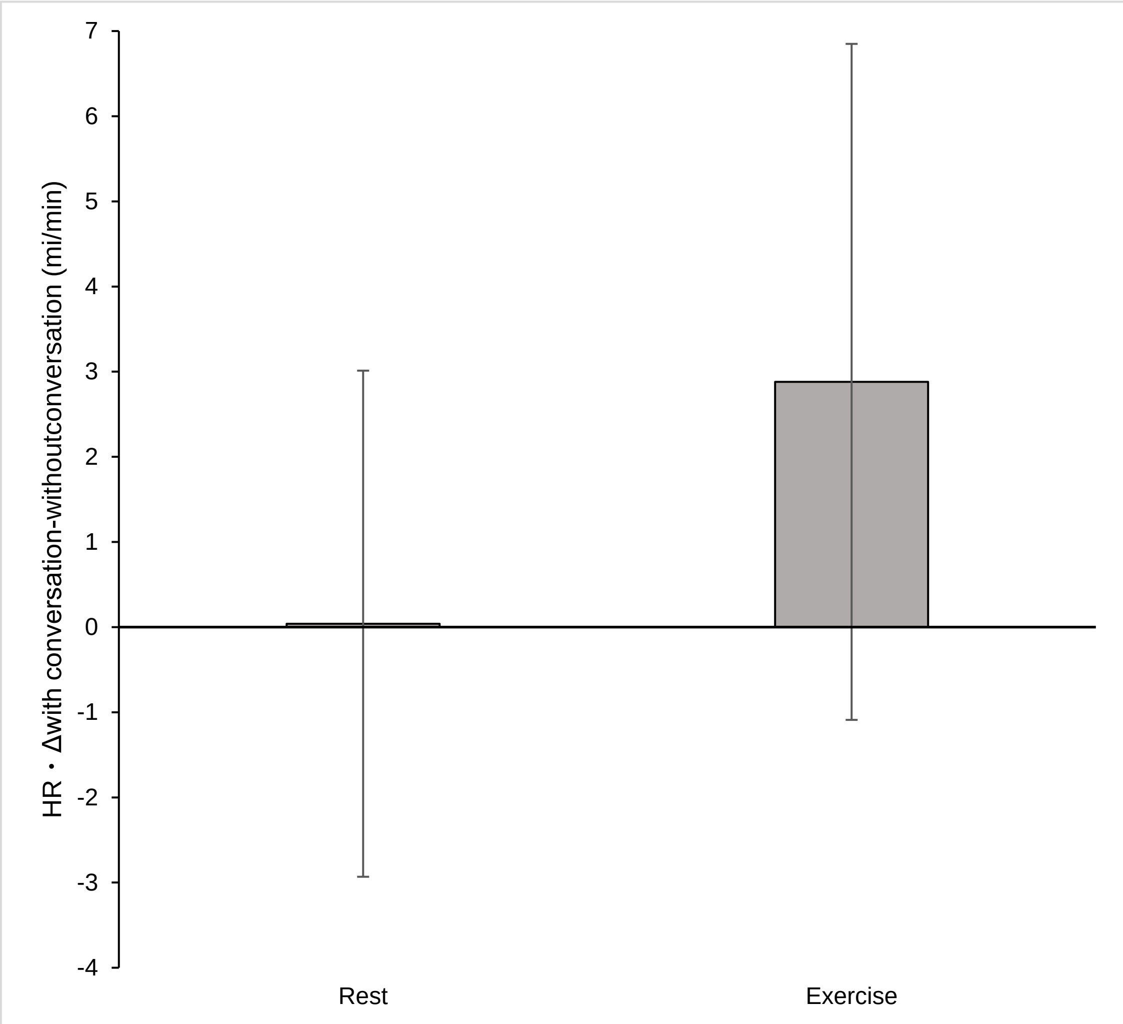

Fig. 9 Mean data obtained by subtracting HR without conversation from with conversation during rest and exercise.

2, 3, 4, 5). The subjects felt that the time was significantly shorter with conversation than without conversation ($p < 0.05$). These results support the hypothesis. Previous studies showed a significant increase in VO2 and no significant difference in RPE and HR (Monedero et al., 2015).

Although there were significant differences in VO2 changes due to resting conversation, there was no significant difference in VO2 changes due to exercise conversation (Fig.1, 2). Therefore, although the change in VO2 due to conversation at rest is large, I supposed that the effect of conversation on VO2 might be small in an environment where VO2 increases to some extent, such as during exercise. Therefore, we compared the values obtained by subtracting VO2 at rest from VO2 during the exercises with and without conversation using delta analysis. I assumed that VO2 would increase more without conversation than with conversation. However, there was no significant difference between VO2・△exercise-rest without conversation and VO2・△exercise-rest with conversation ($P > 0.05$) (Fig. 6). In order to confirm inter-individual differences in the subtracted VO2 between exercise and rest, the coefficient of variation (CV) was calculated. CV of VO2・△exercise-rest without conversation was 8.3 and CV with conversation was 17.2. Meaning that VO2 during conversation varies greatly among individuals (Fig. 10). In other words, some people had VO2 up during conversation. Using delta analysis, we compared the values obtained by subtracting VO2 without conversation from VO2 with conversation during exercise and during resting. There was no significant difference between them ($p > 0.05$) (Fig. 8). As same as

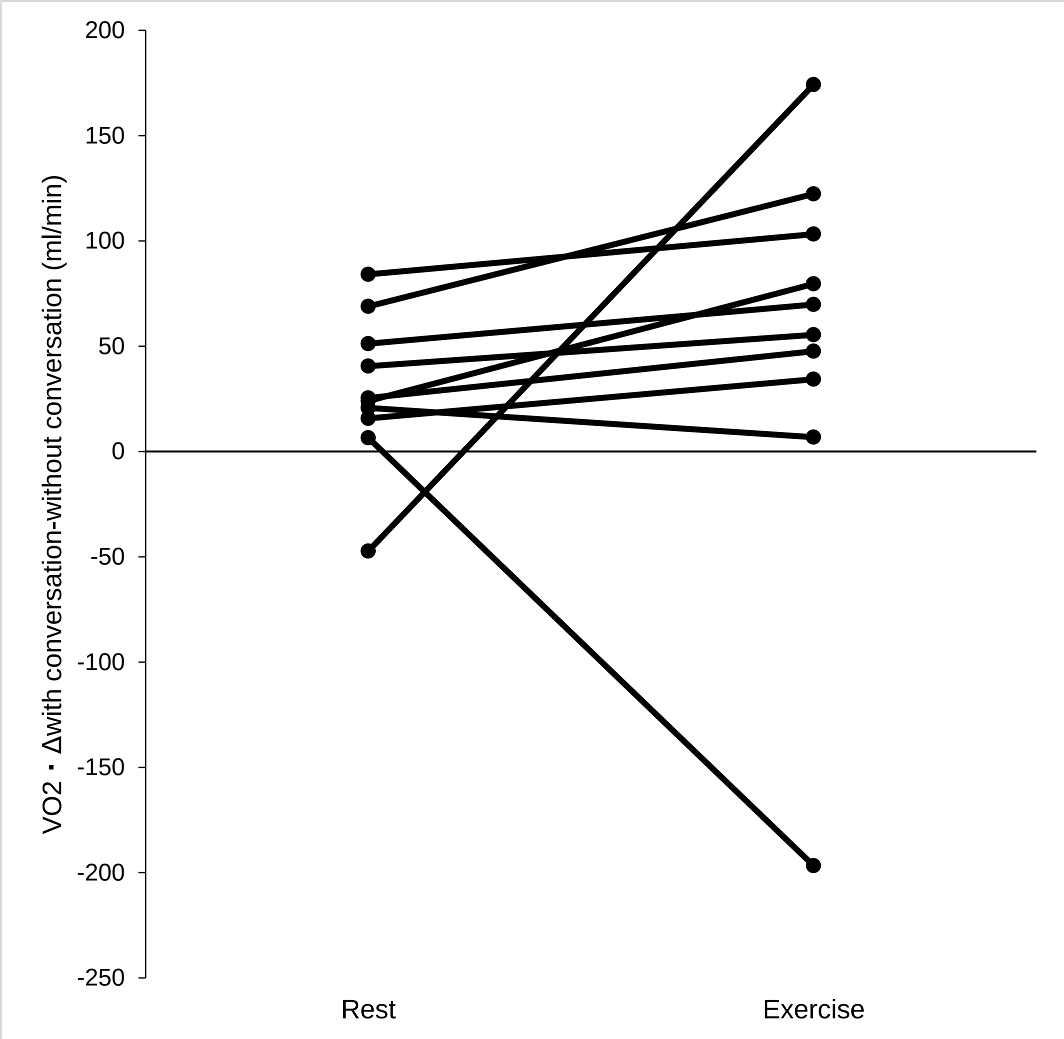

Fig. 10 Individual data during rest and exercise when VO2 with conversation minus VO2 without conversation.

CV of VO2・Δexercise-rest, CV of VO2 ・ Δwith conversation-without conversation was also calculated, CV of VO2 ・ Δwith conversation-without conversation during rest was 125.3 and CV during exercise was 198.9. In other words, since the CV was larger during exercise than at rest, it was found that VO2 during exercise varies greatly among individuals (Fig. 11). I suppose that the reason why there are individual differences in VO2 changes is that there are various breathing methods and the effects of each breathing method are different. For example, according to Jeniffery et al.(2017), pranayama of yoga breathing methods has the effect of lowering blood pressure (Brandani et al., 2017). Also, according to Burtch et al. (2017), Controlled frequency breathing (CFB) is a common form of swimming training that reduces inspiratory muscle fatigue (Burtch et al., 2017). In this way, because there are various breathing methods, it is considered that the way of breathing differs depending on the individual, and the change in VO2 may also differ among individuals.

Significant difference was not found between the change in HR due to conversation at rest and the change in HR due to conversation during exercise ($p > 0.05$). Therefore, using delta analysis, we compared the values obtained by subtracting HR at rest from HR during the exercises with and without conversation. Since HR increases as exercise intensity increases, I thought that HR would be higher with conversation (Raven et al., 2013). However, significant difference was not seen in HR ($p > 0.05$) (Fig. 7). The changes in HR varied greatly among individuals (Fig. 12). Using delta analysis, we also compared the values obtained by subtracting the HR during silence from the HR during

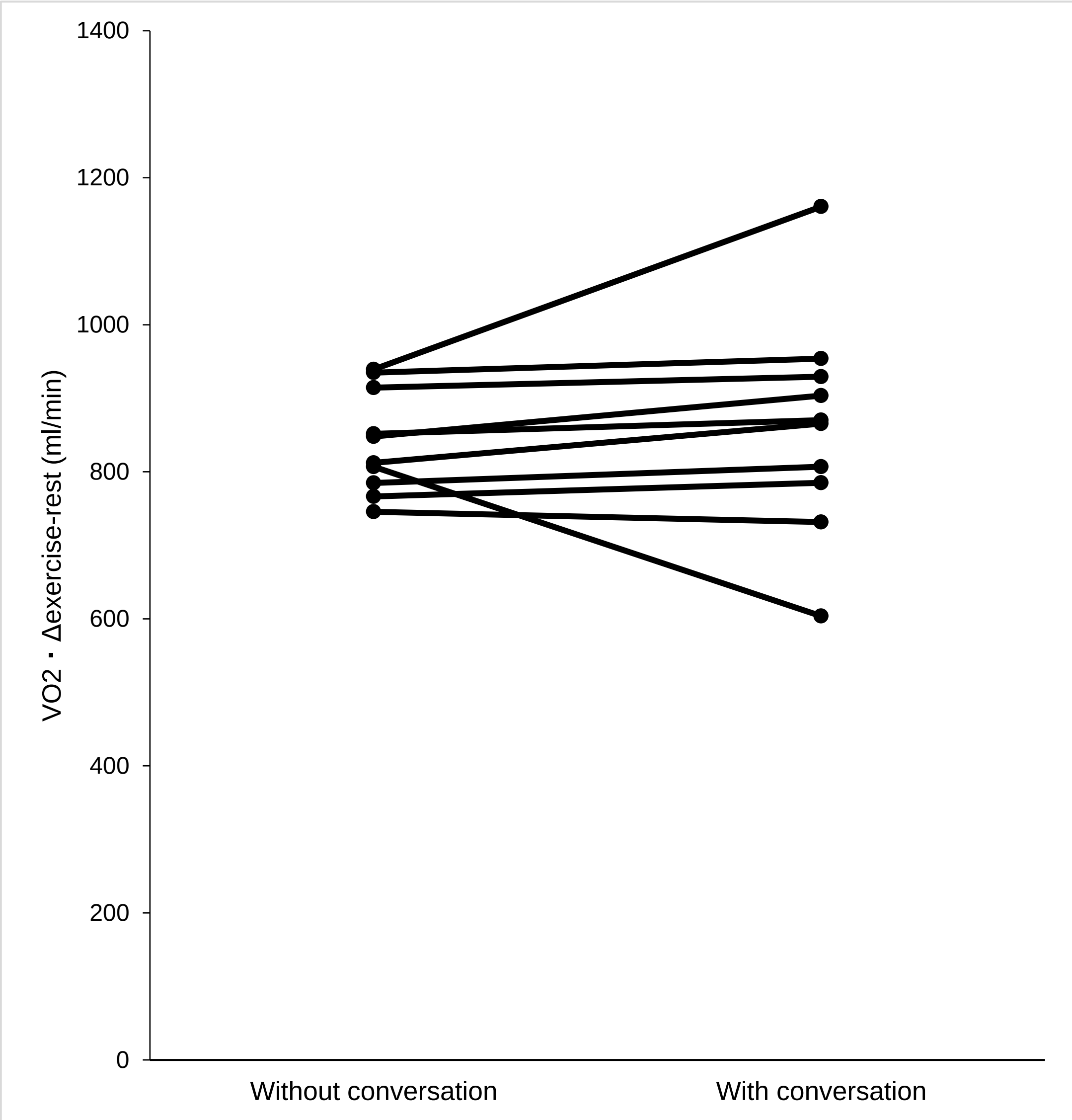

Fig. 11 Individual data without and with conversation when VO2 during exercise minus VO2 at rest.

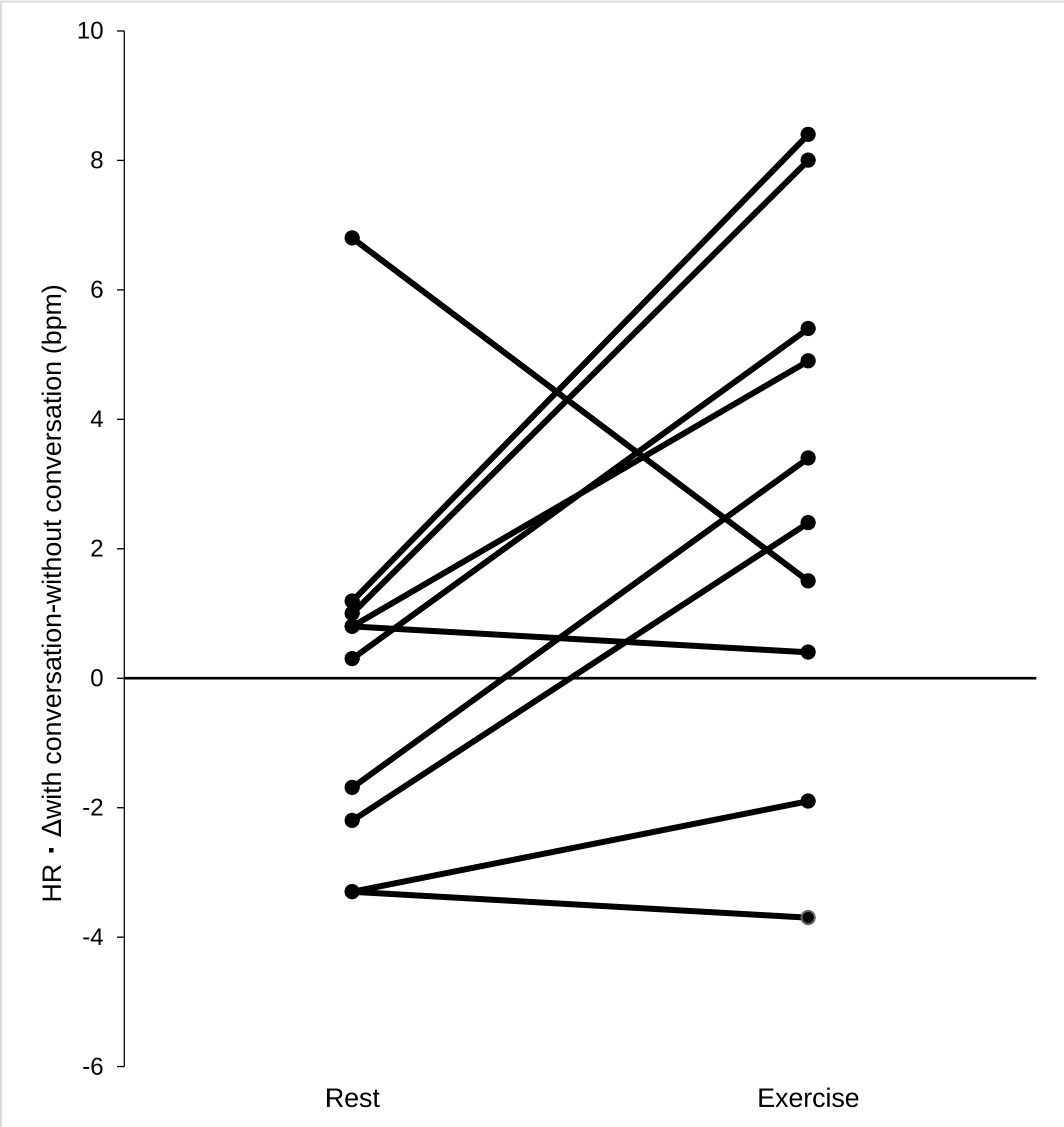

Fig. 12 Individual data during rest and exercise when HR with conversation minus HR without conversation.

conversation during rest and exercise. There was no significant difference ($p > 0.05$) (Fig. 9). The change in HR varied greatly among individuals (Fig. 13).

According to Raven et al. (2013), VO2 and HR are proportional to RPE and both of them should had increased (Raven et al., 2013). Similar to our experimental results, Monedero et al. (2015) found no significant difference in HR and RPE, despite a significant increase in VO2 (Monedero et al., 2015, Haddock et al., 2009). I think the reason why the reactions of VO2 and HR are different is that HR has a mental effect. Decreased heart rate variability (HRV) is caused by increased sympathetic nervous system activity (Wentzel et al., 2020). In other words, HR increases when the sympathetic nervous system becomes dominant (Wentzel et al., 2020). It is possible that relaxing when talking with a person and making the parasympathetic nerves significant suppresses the increase in HR (Gaffney et al., 2019, Song et al., 2019).

According to Raven et al. (2013), VO2 is proportional to exercise intensity, so an increase in VO2 means an increase in exercise intensity (Raven et al., 2013). Originally, RPE increase as exercise intensity increased, but no significant difference was found in RPE in this experiment (Fig. 5). This result supports the hypothesis that RPE decreases by exercising while talking with people. These results are based on previous studies in which VR is effective in distracting by directly and indirectly acting on pain perception and signals through sensations such as attention, emotion, concentration, and memory (Arane et al., 2017). Also, according to Takaishi et al. (1998), Pedaling skills that reduce muscle stress contribute to fatigue resistance despite increased VO2. That is, exercise

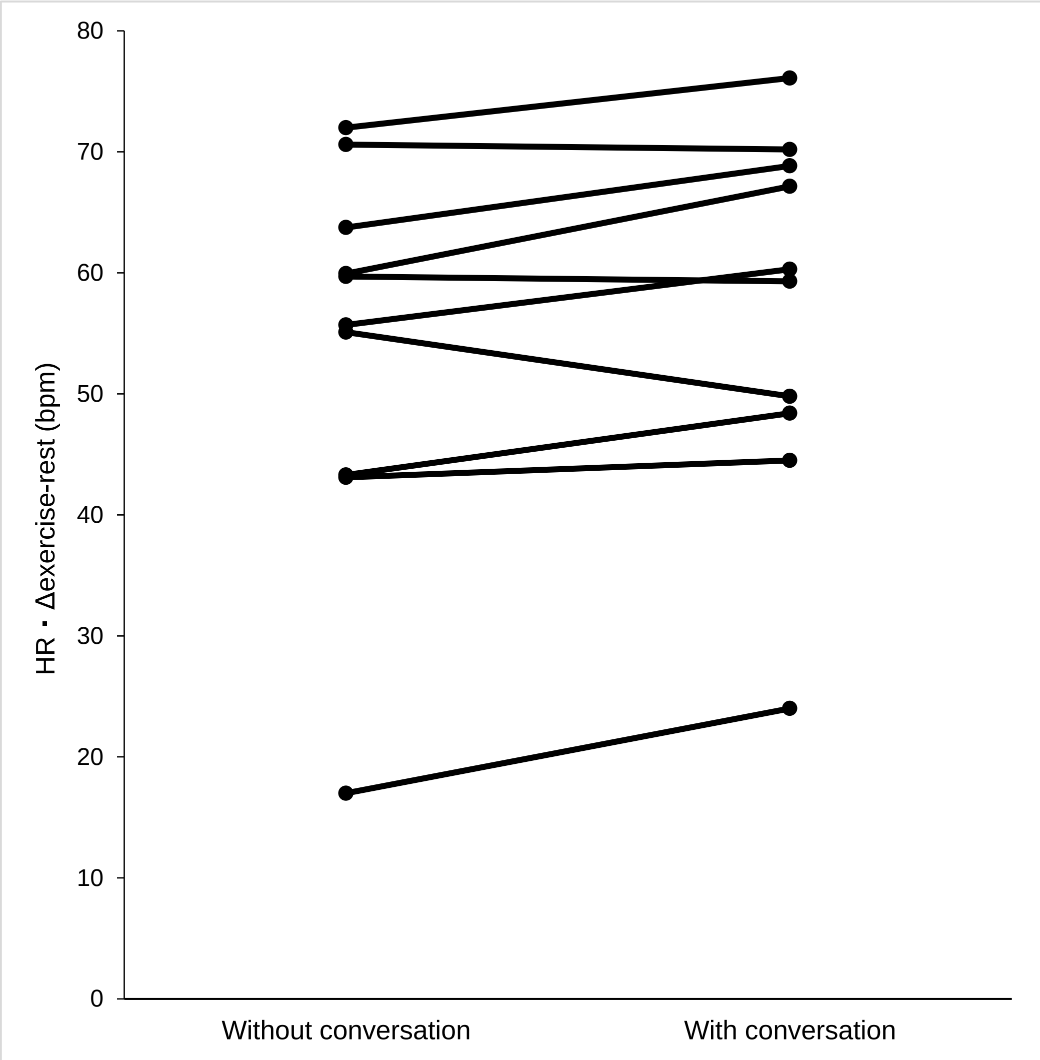

Fig. 13 Individual data without and with conversation when HR during exercise minus HR at rest.

intensity and RPE may not be matched (Takaishi et al., 1998). Also, according to Ekblom et al., RPE is associated with tension (Ekblom et al., 1971). These suggest that relaxing when talking with a person and increasing parasympathetic nerves may have suppressed the rise in RPE.

According to the post-experiment question, it can be said that the participants were distracted by the conversation because they felt that the time was significantly shorter with conversation than without conversation. This result supports the hypothesis that exercising while talking with people feels shorter than the actual exercise time. According to Wittmann, the perceived time represents a person's state of mind (Wittmann, 2009). Psychological research has shown that cognitive functions such as attention, working memory as well as long-term memory determines our temporal judgements (Brown, 1997, Zakay et al, 2004). Time judgements are inherently emotional. In unpleasant situations, such as when nervously waiting for something to happen, we experience a slower passage of time and overestimate its duration. By contrast, if we are entertained and focus on rewarding activities, time seems to pass more quickly and duration is more likely to be underestimated (Wittmann, 2009).

In conclusion, this study confirmed that conversation during exercise induces feeling of shorter exercise time while RPE and physical responses were not influenced by conversation. I suppose that it will be possible to continue exercising at medium intensity. This suggests that exercising with people has a positive effect on the health of the elderly.

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