Université de Franche-Comté

U.P.F.R Sport Besançon

Mémoire pour l'obtention du Diplôme de MASTER 2 Spécialité

APAS : Activité Physique Adaptée et Santé

Reactivation of the parasympathetic System with pursed lips after physical exercise

Garzon-Perez Laura Vanessa

Directeur : Dr. MOUROT Laurent

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TABLE OF ABBREVIATIONS

RSA= Respiratory Sinus Arrhythmia

HR= Heart Rate

RR = Interval between successive Rs

HRV= Heart Rate Variability

PLB= Pursed Lips Breathing

LF= Low Frequency

BF= Breathing frequency

RMSSD = Root Mean Square of the Successive Differences

COPD= Chronic Obstructive Pulmonary Disease

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SUMMARY

Reactivation of the parasympathetic System with pursed lips after physical exercise

Background: Pursed Lips is a maneuver frequently used in respiratory rehabilitation programs, aiming to improve respiration efficacy and provide better control of dyspnea during the performance of activities of daily living. Respiratory sinus arrhythmia, is used often to assess vagal tone as it increases and decreases the parasympathetic influence when the autonomic nervous system is adequately balanced. In the exercise, the cardiac parasympathetic reactivation is the main determinant of the immediate fall of the heart rate when it ceases or the intensity diminishes. The purpose of this work was to investigate the influence of respiratory frequency in the reactivation of the parasympathetic system after a physical effort.

Methods: We evaluated the variables respiratory rate (BF), heart rate (HR) and the mean root chart of successive differences (Rmssd) using a protocol in two different conditions, spontaneous condition and Pursed lips condition in 6 physically active young adults of the university Franche comté, France.

Results and conclusion: The results showed that there is no clear effect of the pursed lips maneuver at group level due to the high intra-individual variability, which did not significantly alter any of the variables BF, HR, RMSSD after a physical effort.

Key words: Pursed Lips, reactivation of the parasympathetic system and heart rate.

Réactivation du système parasympathique avec les lèvres pincées après l'exercice physique

Contexte : Les lèvres pincées est une manœuvre fréquemment utilisée dans les programmes de réadaptation respiratoire, visant à améliorer l'efficacité respiratoire et à mieux contrôler la dyspnée lors de la réalisation des activités de la vie quotidienne. Arythmie du sinus respiratoire, est souvent utilisée pour évaluer la tonalité vagale à mesure qu'elle augmente et diminue l'influence parasympathique lorsque le système nerveux autonome est suffisamment équilibré. Dans l'exercice, la réactivation parasympathique cardiaque est le déterminant principal de la chute immédiate de la fréquence cardiaque quand elle cesse ou l'intensité diminue. Le but de ce travail était d'étudier l'influence de la fréquence respiratoire dans la réactivation du système parasympathique après un effort physique.

Méthodes : Nous avons évalué les variables du taux respiratoire (BF), de la fréquence cardiaque (HR) et du diagramme racinaire moyen des différences successives (Rmssd) en utilisant un protocole dans deux conditions différentes, une condition spontanée et une condition de lèvres pincées chez 6 jeunes adultes physiquement actifs Université Franche comté, France.

Résultats et conclusion : les résultats ont montré qu'il n'y avait pas d'effet clair de la manœuvre des lèvres frisées au niveau du groupe en raison de la grande variabilité intra-individuelle, qui n'a pas modifié de façon significative les variables BF, HR, RMSSD après un effort physique.

Mots clés : Lèvres pincées, réactivation du système parasympathique et fréquence cardiaque.

Introduction.

The respiratory system has a direct effect on Heart Rate Variability known as Respiratory Sinus Arrhythmia (RSA). During inspiration both the heart rate and the venous return increase. The opposite happens during expiration, a lower venous return and therefore a lower filling atrial and a reduction of the Heart rate. (Yasuma F, Hayano J,2004).

Previous work has shown plays the major role in the genesis of RSA such as the direct modulation of cardiac vagal preganglionic neurons by central respiratory unit and inhibition of cardiac vagal efferent activity by pulmonary inflammation, indicating a biological phenomenon that may have a positive influence of an efficient ventilation / perfusion in gas exchange at Lung level. (Yasuma F, Hayano J,2004).

The Breathing pattern manipulation may help to provide beneficial effects not only in ventilation efficiency but also in cardiovascular and respiratory control in physiological and pathological conditions. An example of this is increased venous return due to breathing that can help maintain blood pressure during unemployment in critical situations. (Bernardi L. et al,2001).

Pursed lips is a maneuver frequently used in respiratory rehabilitation programs, with the aim of improving respiration efficiency and providing better control of dyspnea during the performance of daily life activities, that favors a respiration with a longer expiration and a decrease of the pulmonary volume at the end of the expiration, leading to a lower respiratory rate and a higher tidal volume since the expiratory resistance applied by the lips determines an important change in the temporal variables of the ventilatory pattern and a better respiratory muscle recruitment contributing to an increase in the tidal volume, better gas exchange and an improvement in respiration efficiency. (Fregonezi et al, 2003).

According to (Ramos et al, 2013) Pursed lips Breathing (PLB) promotes the increase of vagal modulation, which may be related to the decrease in RR and an intensification of arrhythmia of the respiratory sinus.

In patients with COPD, PLB is a technique used during exercise or even at rest, since it induces similar changes to what is observed in respiratory sinus arrhythmia, cardiorespiratory phenomenon due to interval fluctuations that are in the inhalation / exhalation phase.

Respiratory sinus arrhythmia is frequently used to assess vagal tone as it increases and decreases parasympathetic influence when the autonomic nervous system is adequately balanced. According to (Holnloser,1998) inspiratory / expiratory variations greater than 9 bpm show that vagal functioning is intact.

Respiratory rate and rhythm not only affect respiratory systems also exert a direct effect on the cardiovascular system, as it activates the arterial baroreceptors, chemoreceptors and cardiopulmonary receptors that are linked with the central nervous system. Leading to responses caused by activation of the autonomic nervous system, which regulates heart rate (HR) and blood pressure.

In the prescription of exercise, the objective of the training is to generate desirable physiological adaptations that improve the capacity of physical work. The autonomic nervous system regulates these physiological processes to varying degrees through the alteration of the secretory activity of the hormonal glands and heart muscle (Stanley et al, 2013).

To quantify parasympathetic reactivation after exercise, the time course of HR recovery and HR variability, the simplest and most widely used index is the number of heart beats recovered within 60 s after the cessation of exercise. (Cole et all, 1999).

Regarding HRV, it is the vagal-related indexes, such as the root mean square of successive differences of R-R intervals (RMSSD) or the power density in the high-frequency range obtained by spectral analysis, that are the most widely used methods.

The acute effects of a single exercise bout on HRV have been placed into long- and short - term categories. From 24 to 48 h after exercise, a rebound of parasympathetic activity, which seems independent of the exercise type undertaken, has often been described.

Concerning the short-term evolution of autonomic activity, an initial decrease in HRV and vagal-related indexes has been observed within minutes to hours after exercise.

Moreover, vagal restoration has been shown to be more delayed after intense [80% peak oxygen uptake (VO2peak)] than after moderate-intensity exercise (50%VO2peak). (Buchheit et Gindre,2007).

Therefore, cardiac parasympathetic reactivation is the principal determinant of the immediate heart rate fall when exercise ceases or intensity drops. During this period, there is a coordinated cardiac vagal–sympathetic interaction that ensures that there is sufficient cardiac output to prevent circulatory collapse while the vascular beds of dilated muscle of recover. This is probably enabled by slow reduction of sympathetic nerve activity and by the slow clearance of circulating catecholamines. (Coote, 2009)

Recovery involves an integrated response of various systems that cause homeostasis in the body through acute adaptations. An example of this is the return of heart rate to its original level before an effort through the combination of a Reduction in sympathetic tone and a reactivation of parasympathetic tone. (Illou et Cristofini. 2001)

There are different forms of recovery to parasympathetic activity such as the results of investigations on the effects of water immersion, where Heart Rate (HR) and Heart Rate Variability (HRV) return to lower values after one minute. (Almeida et al, 2015).

Similarly, the massage helps to improves the cellular recovery and the return to the parasympathetic activity. (Portia et al, 2016). Finally, the supine of the body position gives a decrease in the RR, LF and LFn compared to a vertical position. (Eckhardt et al, 2016).

The purpose of this work is to investigate the influence of the pursed lips breathing maneuver on the reactivation of the parasympathetic system after a physical effort. In the present study, these hypotheses would be tested if using pursed lips breathing, increases the parasympathetic activity.

Methodology

The study was carried out with 6 physically active young adults aged 28 years old, students of the university Franche Comté Besançon France in the laboratory EPSI Plateforme (Exercice,Performance, Santé, Innovation) room of exploration throughout the day. Participants were advised not to exercise vigorously for 24 hours before and abstain from drinks and stimulants containing caffeine and any other supplement.

Each individual participated in two sessions separated by a day for the analysis of three variables BF, HR and Root Mean Square of the Successive Differences (RMSSD) that is a mathematical range of variation in the parasympathetic nervous system. In the first session, spontaneous condition, subjects sat in a chair and they remained in rest for 15 min before starting the test. After that, they began recording the first 10 minutes (BASELINE) at rest and 2 min without recording. Then the exercise test was performed on the Ergomedic 828E static bicycle with a duration of 26 min, 3 minutes of warm-up and 3 of warm-down with an intensity between 60 and 70% of the maximum heart rate calculated using the reserve formula by karvonen and a resistance that maintained the intensity. Then they were requested to remain in seated for 30 minutes, divided in three 10-minute registers (PEX1-PEX2-PEX3).

For the pursed lips condition, the only change that was made in the protocol was in the second record of the last 30 min (PEX2) where subjects were requested to breathe slowly for 10 minutes after exercise through the nose and expire slowly and prolonged by the mouth with pursed lips.

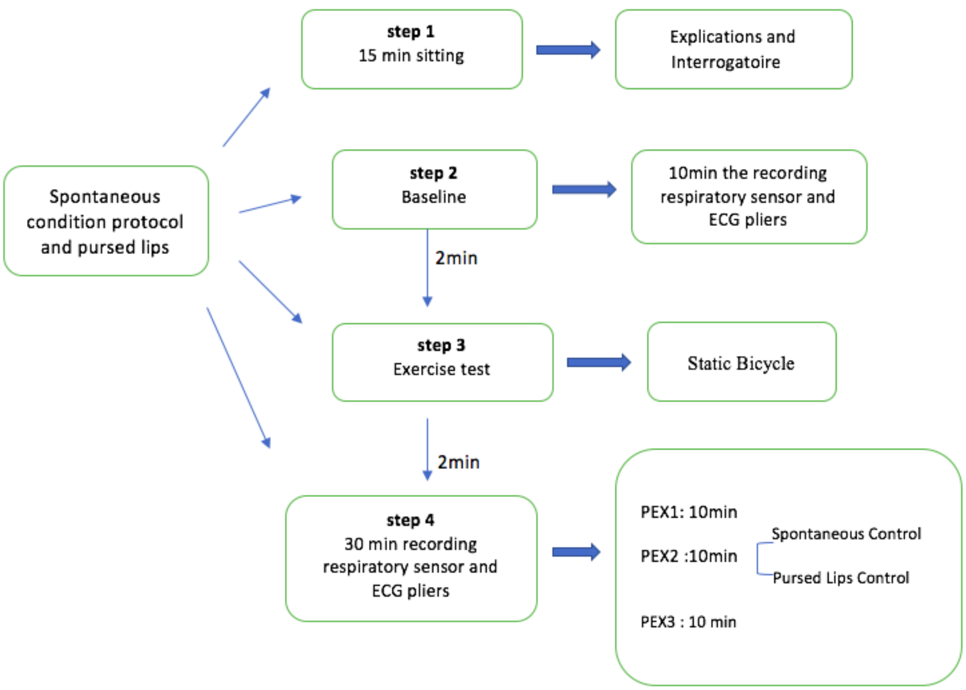

Figure 1. Schematic representation of the protocol design and data collection spontaneous and pursed lips.

HR was registered by to the heart rate monitor (Polar S800I) and the respiration pattern was recorded thanks to the Labchart power lab 26 T monitor during the whole test.

After extraction, the RR intervals were stored and analyzed using the HRV analysis software (Kubios version 2.2 heart rate variability software).

In the time domain RMSSD was used as an indicator of parasympathetic activity. Mean HR was also collected. In the case of respiratory rate, labchart Reader software is exported with a manual retrieval analysis. All the records were analyzed in a period of 5 minutes.

Statistical analysis

Excel was used for data collection: respiratory rate, heart rate and rmssd in each condition. For the analysis of the results, descriptive statistics and graphics were calculated for all variables mean and standard deviation and size of effect D, Cohen.

D Cohen, Represents the difference that there are typical deviations between the groups that are bought.

Results

The results presented in this study are descriptive and represented as mean, standard deviation and D Cohen in the following tables and graphs.

Breathing Frequency (BF)

For pursed lips, BF increase in Pex1 compared to baseline and spontaneous with variations between subjects thereafter. No clear differences were found between the two conditions. (Figure2, Table 1).

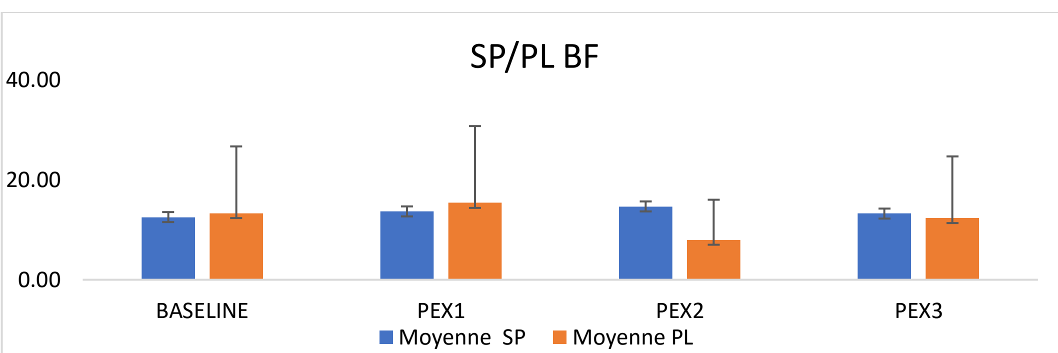

Figure2. Mean and standard deviation in breathing frequency, condition spontaneous and pursed lips.

	BASELINE	PEX1	PEX2	PEX3
D COHEN	-0,80	-1,70	6,67	0,90
	0,99	1,760345432	2,206196589	1,347682664
	-0,8	-1,0	3,0	0,7

Table 1. D Cohen in breathing frequency, condition spontaneous and pursed lips.

Heart Rate (HR)

In both the PLB and spontaneous conditions, HR increased in PEX1 compared to baseline and decreased thereafter. No clear difference was observed between the two conditions. (Figure 3, Table 4).

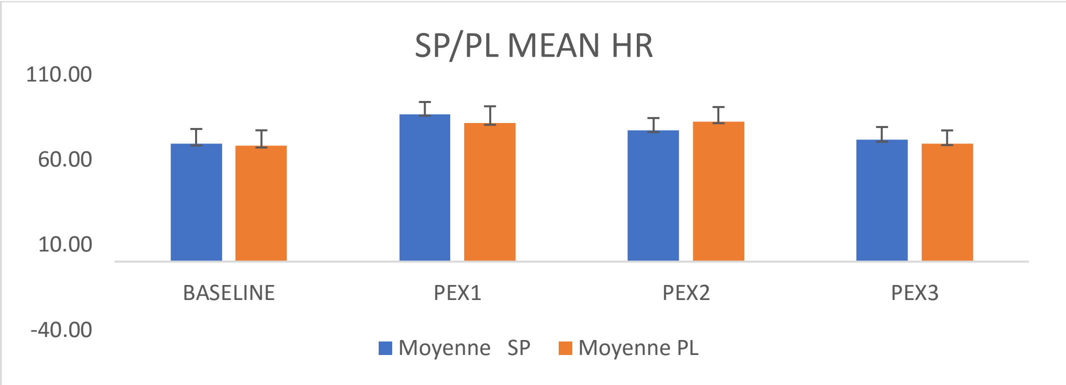

Figure 3. Mean and standard deviation in heart rate, condition spontaneous and pursed lips.

	BASELINE	PEX1	PEX2	PEX3
D COHEN	1,18	5,33	-5,24	2,03
	8,92	8,481556262	7,878207549	7,63136899
	0,1	0,6	-0,7	0,3

Table 2. D Cohen in Heart Rate condition spontaneous and pursed lips.

Root Mean Square of the Successive Differences (Rmssd)

Both for pursed lips and spontaneously, no clear differences were found between the two conditions since they had a high intra-individual variability. (Figure 4, Table 3).

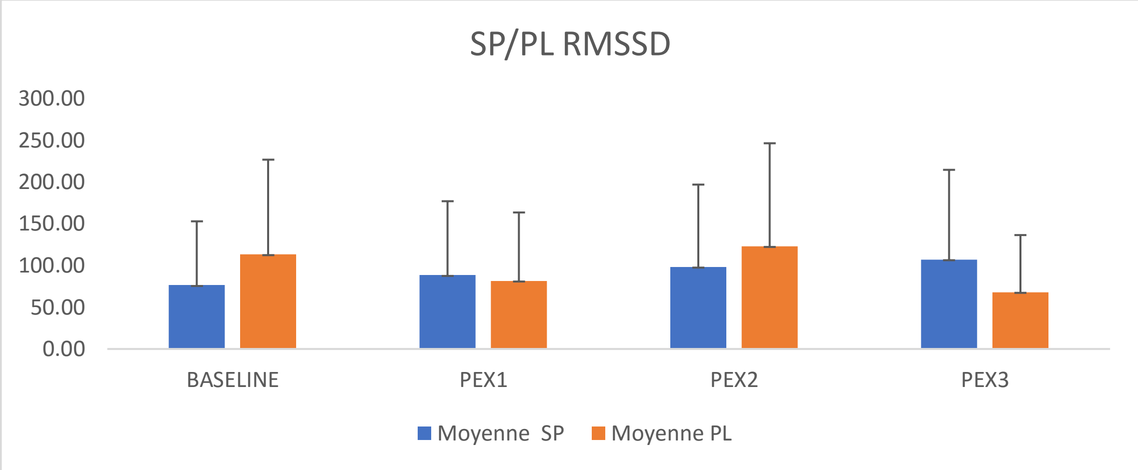

Figure 4. Mean and standard deviation in Rmssd condition spontaneous and pursed lips.

	BASELINE	PEX1	PEX2	PEX3
D COHEN	-36,93	6,74	-24,76	39,09
	75,96	119,8105193	108,7860789	80,82038994
	-0,5	0,1	-0,2	0,5

Table 3. D Cohen in Rmssd condition spontaneous and pursed lips.

Discussion

Pursed Lips is a maneuver frequently used in respiratory rehabilitation programs, with the aim of improving respiration efficiency and providing better control of dyspnea during the performance of daily life activities, associated with a major change in temporal variables of the ventilatory pattern and better respiratory muscle recruitment. (Fregonezi.F et al, 2003).

The objective of this study was to investigate the influence of the pursed lips breathing maneuver on the reactivation of the parasympathetic system after a physical effort with the hypothesis that using pursed lips breathing, increases the parasympathetic activity.

The results showed that there is no clear effect of the pursed lips maneuver at the group level versus the spontaneous condition, due to the high intra-individual variability. It was found that the majority of the subjects had a decrease in the respiratory rate applied by pursed lips determining a change in the temporal variables of the ventilatory pattern and a better respiratory muscular recruitment, but, the effect of pursed lips was not sufficient to induce a reduction significant increase in heart rate or a clear increase in Rmssd after physical exertion.

It has recently been shown that heart rate recovery after exercise is an important prognostic index. Parasympathetic activity has been shown to confer protection against arrhythmias in the establishment of exercise-induced ischemia (Billman. G and Hoskins.R, 1989).

Limited research in this area has revealed that the relationship of autonomic heart rate control seems to depend on exercise intensity.

(Parekh A and Lee M, 2005) performed a test on a treadmill at 50 and 80% of vo2, recording 30 minutes after exercise in supine position with 13 volunteers. The study showed that exercise at 50% intensity has a faster restoration of vagal modulation than Exercise at 80% and causes fewer changes in the autonomic heart balance.

In this case an aerobic test was used between 60 and 70% at a moderate intensity of maximum heart rate for 24 consecutive minutes. Leading to the conclusion that the response to exercise is very high in order to try to modify with a breathing maneuver a vagal recovery and restoration near the basal that can contribute to a better level of parasympathetic reactivation.

Similarly, the number of participants in the study was not sufficient to have a better sample and a comparative statistical analysis that would help to better explain each of the variables. Previous studies conducted their research with groups between 10 and 20 participants, which could suggest the number of subjects for an upcoming study.

In summary, the pursed lips maneuver did not significantly alter any of the variables BF, Hr and Rmssd after a physical effort, rejecting the hypothesis to investigate. It may be for reasons such as the time analyzed in all variables, whit a duration of 10 minutes, time taken by the literature on respiratory biofeedback and a constant time for the understanding of heart rate variability. Also, by the horizontal position of the body at the time of registration. Some studies such as (Eckhardt et al, 2016) show that compared to a supine position, there is a significant decrease in RR.

Also, the participants were not accustomed or trained to perform this type of maneuver, which may affect the sampling and analysis of the same. That is why it is suggested that the participants have a previous training.

According to (Bandy and Sanders, 2008) Pursed Lips training improves dyspnea in patients with COPD, suggesting to do two sessions of 10 to 15 minutes of training per day, 3 to 5 times per week with a gradual increase in session time. Although this is not the population with which this study was worked, it gives an important light in the implementation or improvement of the training with pursed lips with another type demonstrates.

To end. This study represents future research on the collection and analysis of data related to the variables analyzed in active, non-athletic men and is suggested to be implemented in the different population.

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