OPTIMIZATION OF THE BRASS PLAYING BREATHING PROCESS IN ACCORDANCE WITH THE PHYSIOLOGICAL PROCESSES OF NATURAL BREATHING

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Abstract
In brass playing pedagogy the most essential and simultaneously the most difficult element to teach is the process of breathing. The analysis of viewpoints on breathing presented in popular textbooks on brass instrument playing and their comparison with physiological processes of natural breathing reveal essential discrepancies, which actually make instrument playing difficult, create muscular tensions and even health problems undesirable for the musicians. To avoid using quite inadequate but by generations inherited approaches to teaching/learning breathing during playing, it is essential to know physiological processes of natural breathing and try to maximally approximate the brass playing breathing process to them. Such optimization of breathing provides an opportunity to increase the volume of the air used during playing, to reduce the tension of the thoracic (chest) and other muscles involved in playing and to improve the possibilities of musical expression.

Key words: brass playing pedagogy, breathing, diaphragm, breathe support, physiology of breathing.

Introduction
When comparing the physiological processes of natural breathing with methods of teaching/learning breathing patterns used in brass playing, we have to acknowledge that the pedagogy of brass playing is often based on concepts and ideas contradicting the processes of natural breathing. According to B. Frederiksen (2006), regarding to breathing during wind instrument playing, conceptions about the diaphragm, breath support or methods of contracting the abdominal muscles borrowed from vocalists have traditionally dominated in wind instrument playing for many years, but they contradict the process of natural breathing and do not contribute to efficient use of breath during playing wind instruments. Even today, when physiology and regularities of the respiration process have been thoroughly studied, we frequently
encounter myth-based expressions and understandings which do not reflect the real nature of breathing.

When analysing the physiological processes of natural breathing and volumes of different breathing phases, it becomes clear that in the brass playing the traditional conceptions and methods of breathing should be abandoned and a new methodology of learning breathing based on nature-corresponding principles of humanistic pedagogy should be developed. By optimizing the brass playing breathing process (i.e. – approximating it to the physiological model of natural breathing) it is possible to simplify the process of the teaching/learning, to make the process of gas air exchange in the lungs easier during the play, to reduce muscular tension and to delay onset of muscle fatigue, which frequently interfere with brass playing. Besides, an increased volume of the air available for use may leave a positive impact on both the quality of sound and the capacity of musical expression. Moreover, avoidance of breathing actions which contradict laws of nature during playing wind instruments is a vital prerequisite for preventing breathing-related occupational diseases.

**The research aim** is to offer recommendations for optimizing the brass playing breathing process.

**The research task** is to study the correspondence of methods used in brass playing pedagogy for teaching/learning breathing with the processes of human natural breathing, to de-construct myths and misconceptions in understanding breathing and offer solutions for optimizing the breathing process when playing.

**Methods and Methodology**

In the research, the analysis of theoretical conceptions on brass playing and methods for improving breathing has been done (Stamp, 1978; Quinque, 1980; Sandoval, 1991; Frederiksen, 2006 a. o.). The viewpoints on wind players’ breathing and methods for its development widely spread in literature and practice are compared with respiration mechanisms and processes reflected by the research in anatomy and physiology of respiration (Carola & Harley, 1990; White, 2005; Parker, 2007; Valtneris, 2012 a. o.). During the analysis, the most logical pedagogical solutions for teaching/learning breathing of wind instruments play are sought for.

Traditionally, brass playing pedagogy has borrowed much from vocal pedagogy, this concerns specifically the problem of how the breathing process is understood and trained (Frederiksen, 2006). Unfortunately, the uncritical approach to sources has created a situation, when for more than a century methods of brass playing breathing which teach to breathe contrary to natural breathing processes of a human body have been cultivated, thus creating stress and undesirable muscular tension in the body as well as decreasing the respiratory volume to be used, which in turn negatively influences the quality of sound. M. White (2013), the researcher of human breathing, points out that as far as human daily breathing is concerned, there exist numerous theories, applications and exercises – almost every well-known spiritual trend includes some covert knowledge about breath and how it is used. However, the various breathing techniques often have specific aims and they frequently contradict to the principles of natural breathing, therefore uncritical application of these techniques may create minor or major problems in life of their users (White, 2005).
Sometimes wind instrumentalists, too, try to include in their training process elements of breathing techniques seen somewhere else, but this often does not produce positive effect.

Two concepts used least justifiably in pedagogy of wind instrument playing are diaphragm and breathe support. To understand the process of breathing elementary knowledge about the anatomy and physiology of breathing is needed. The only and single place where breathing occurs is in the lungs, but the breathing movements are provided by the bodily muscles around the lungs – neck, intercostal, abdominal and spinal muscles, as well as the diaphragm, which all, mutually interacting, coordinate different phases in a breathing process. During inhaling the thoracic cage expands, the air pressure in the thoracic cage becomes smaller than the atmospheric pressure and – according to Boyle’s law when the pressure of gas in two joint compartments should equalize – the air from outside flows into the lungs. This takes place due to the activity of the diaphragmatic muscles when, at contracting, a dome-shaped diaphragm goes downward. At the same time the abdominal muscles relax, while the external intercostal muscles lift the ribs by the so called bucket-handle movement, which enlarges the diameter of the thoracic cage cross-section (Carola & Harley, 1990). Actually, the thoracic cage goes upwards due to the interaction between the air pressure and external intercostal muscles. As the ribs are attached to the backbone, their front rises upwards and expands the lung volume like a bucket handle (Frederiksen, 2006).

As we know it, the diaphragm is a thin dome-shaped muscle which separates the thoracic cage from the abdominal cavity and on contracting downwards expands the lung volume, thus making the inspiratory process possible. During the expiratory process it relaxes and returns to its initial – dome-shaped – position (Hall, 2011). As the sound formation on wind instruments is directly influenced by the expiratory process, we can infer that the diaphragm actually does not play any role in forming a sound, and such encouragements like “play on the diaphragm,” “use the support of the diaphragm” and the like do not have any rational base. C. Gordon, a trumpeter, and L. Miller, a specialist in pulmonary diseases, have proved it by exploring the activity of a professional trumpeter’s diaphragm in different situations and applying the method of fluoroscopy in their research (Gordon, 1987). The musicians had to perform different tasks during which the activity of their diaphragmatic, abdominal and intercostal muscles was observed:

   a) they had to play a long note (G in the staff) with crescendo until the breath had finished;
   
   b) they had to play a triad from C in the staff to the high-C above staff in half-notes, playing four additional high-C in conclusion;
   
   c) the musicians were asked to consciously move the diaphragm;
   
   d) the musicians were asked to tense the abdominal, thoracic and spinal muscles as it takes place on intensive exhalation and then consciously change the position of the diaphragm.

Tasks c) and d) proved that professional trumpeters are not able to consciously affect and control the activity of the diaphragm; during task d) the movement of the
diaphragm was observed only in relation to the activity of abdominal, spinal and thoracic muscles. But tasks a) and b) proved that actually the diaphragm does not have any impact on the process of exhaling. On inhaling the diaphragm tenses and moves downward, thus increasing the lung volume and reducing the air pressure in the lungs, and the inhalation occurs when the air pressure in the lungs and the pressure in the atmosphere equalize. At producing the first sound and continuing to play, the diaphragm does not change its position (while respiration muscles – abdominal, spinal and intercostal muscles – gradually contract and start pushing the air out of the lungs), until at some moment it relaxes upwards while the expiratory muscles continue to tense and push the air out of the lungs. When the whole air is exhaled and the expiratory muscles have relaxed, the diaphragm immediately goes down and takes its initial position. When playing the C major triad upward in the high register (according to many educationalists’ and musicians’ opinion, playing in the high register requires the largest diaphragm force), at G above staff the diaphragm relaxes and occupies its upper position, thus taking no part in the process of exhalation even at a heavier load when the high-C above staff is played repeatedly, while the expiratory muscles continue to contract (Gordon, 1987). During this experiment C. Gordon observed another aspect which contradicts the opinion of many teachers, stating that on exhaling the abdomen should be thrust forward. On the contrary, the stomach of all participants of the experiment had been pulled in and its perimeter had not become larger either (Gordon, 1987).

It is quite obvious that during the breathing process the activity of the diaphragm applies only to the inspiratory process and its efficiency. Contrary to the assumption about the great role of the diaphragm and its provided air support, so popular among wind instrumentalists and vocalists, physiologically the diaphragm does not play any role in either creating the so called stamina (German – Stütze) or controlling the expiratory process (Gumm, 2009; Alcantara, 2009). In fact, it is possible neither to consciously feel and control the muscle of the diaphragm nor to specially train it, and it has no impact on the improvement of skills of exhalation either. Too intense concentration on breath support and the activity of the diaphragm may entail greater tension of expiratory muscles (abdominal, spinal, intercostal muscles) and thus create reflexive resistance in the pharynx and the tongue muscle, thereby provoking the so called Valsalva maneuver which is naturally needed in the process of the child-birth and defecation, but creates only problems in wind instrument playing (Howland, 2013).

Knowing the mechanisms and principles of the diaphragm activity, it is clear that a pupil learning to play wind instruments does not need to be told about the diaphragm and its activity, or to be made to breathe from the diaphragm and play on the diaphragm support even more so, because this has little to do with how we feel breathing and even less with how it actually occurs.

The next issue that creates quite a considerable confusion to understand the breathing process is the division of breathing into chest, diaphragmatic and combined types of breathing, which has been borrowed from vocal pedagogy, though actually in any of these variants the breathing process occurs only in the lungs. This division into types of breathing indirectly indicates that part of the lungs which is more involved in the process of breathing. A full breathing is recommended to be the most effective type of breathing for the brass instrumentalists, though the diaphragmatic breathing also
ranks high, while the chest breathing is often considered too shallow and lacking sufficient diaphragmatic support for wind instrument playing, thereby creating a careless attitude to the upper or chest breathing. Unfortunately, a lot of musicians use only the abdominal or the so called diaphragmatic breathing, neglecting the upper chest breathing. However, "...a full breath cannot be taken without expanding the lungs in the upper chest" (Frederiksen, 1996, 104-105). Though the greatest lung volume is formed by the lower lobes of the lungs, to achieve the maximum of the lung capacity the upper lobes of the lungs should also be used effectively. As large amount of the air is essential for brass playing, especially for low brass instruments, the ability to use a full lung capacity - both the upper and the lower lobes of the lungs - would be physiologically grounded.

Many teachers of wind instruments do not allow their pupils to lift the shoulders on inhaling, thereby stimulating the use of the lower part of the lungs and abdominal muscles (diaphragmatic breathing) while playing. However, physiologically this restricts the expansion of the chest and the flow of the air into the upper lobes of the lungs, due to which the lung potential is not being used fully. On the other hand, when only the upper or chest breathing is used, the potential of chest expansion is being used fully, but the lower lobes of the lungs, which are much more capacious than the upper lobes, are not used: "Most players would benefit from having a larger quantity of air to spend while playing" (Wekre, 1994, 46). The skill to efficiently use both breathing types simultaneously (i.e. - a full breath) is an important factor for improving both breathing and all other parameters of playing.

With regard to these three breathing types, physiologically two movements could be singled out in the inspiratory process (see Figure 1):

1. the diaphragm contracts downward and pulls the upper part of the lungs with it, thereby increasing their volume and allowing the air to flow into the upper part of the lungs;

2. external intercostal muscles lift the ribs up and thus expand the chest (the bucket-handle principle).

The movement of the diaphragm downwards corresponds to the diaphragmatic type of breathing, while lifting the chest upwards – to the chest type of breathing. If both movements are produced simultaneously, the combined inhalation is implemented.

The analysis of physiological processes of breathing shows that the chest and the diaphragmatic breathing are the two extremes of the breathing process:

1. during the process of breathing the expansion and contraction only of the stomach are apparent (so called baby or diaphragmatic breathing);

2. during the process of breathing only the chest expands and contracts (chest breathing).

When speaking about the breathing types and belonging of musicians to any of them, the question essentially is about which part of the lungs is being used more actively or about the dominant expiratory movement: the diaphragm downwards or the chest upwards. The inhalation is most efficient if both types of breathing are used
simultaneously: “We need both of these extremes in breathing and many variations in between at different times in the music” (Werke, 1994, 46).  

Figure 1. Directions of breathing movements. Inhalation occurs in two planes – the diaphragm pulls the lungs down while the intercostal muscles raise the chest up (Parker, 2007, 136)

“Although the increase in size of the rib cage during inspiration requires muscular effort, the decrease during expiration is merely an elastic recoil, produced by the lungs and costal cartilages” (Carola & Harley, 1990, 279). On intensified exhalation, required by speaking, singing or wind instrument playing, the exhalation is controlled by the muscles – abdominal, spinal and intercostal muscles, and the air pressure in the lungs, thus, becomes even lower than that in the atmosphere. Contractions of the abdominal and spinal muscles push the diaphragm upwards while internal intercostal muscles lower and make the chest narrower, thereby pushing the air out of the lungs (Frederiksen, 2006). An intensified exhalation is especially needed, if inspiratory reserves and respiratory volume have been spent but the musical phrase still requires additional air flow. Consequently, a musician is forced to use the expiratory reserve volume. This expiratory phase consumes much energy and creates fatigue. A physiologically logical solution for this fatigue problem would be to avoid using the expiratory reserve volume as much as possible. On playing wind instruments, this problem can be resolved by increasing the efficiency of inhalation and simultaneously avoiding the use of expiratory reserve volume in the process of playing.

After a deep inhalation, when the diaphragmatic and external intercostal muscles have created a negative pressure in the lungs and have relaxed, the air pressure in the lungs under the pressure of abdominal cavity organs and weight of the chest has become greater than the external one – the air pressure in the atmosphere. During the expiratory process the diaphragm relaxes and under the pressure of abdominal cavity organs rises upwards taking its original position, but the chest deflates and goes down taking the low position. Consequently, the lungs decrease their volume and equalize the air pressure between the lungs and the atmosphere. Normal or calm exhalation is a passive process, for it the relaxation of respiratory muscles is enough: "A deep
Problems in Music Pedagogy, Vol.13(2), 2014

exhalation is an active process which occurs due to the contraction of the accessory expiratory muscles – internal intercostal and abdominal muscles” (Valtnar is, 2012, 72). During a normal daily breathing regime (see Figure 2) the expiratory muscles work minimally. During an intensified exhalation, required by speaking, singing or playing the wind instruments, the exhalation is controlled with the help of muscles – the abdominal, spinal and internal intercostal muscles, due to which the air pressure in the lungs becomes even lower than that in the atmosphere. Contractions of the abdominal and spinal muscles push the diaphragm upward while the internal intercostal muscles lower the chest and make it narrower, thereby pushing the air out of the lungs (Frederiksen, 2006). If inspiratory reserves and breathing volume have been spent during playing but the musical phrase still requires an additional flow of air, a musician is compelled to use the expiratory reserve volume, which involves a rapid growth of tension in expiratory muscles.

![Figure 2. Respiratory volumes and their proportions](image)

1 – tidal volume (resting breathing), 2 – inspiratory reserve volume, 3 – expiratory reserve volume, 4 – vital lung capacity

There are always 1000 ml of air left in the lungs after maximum exhalation, which is called residual volume. Assuming that the total lung capacity of an adult is 5000 ml, only 10% of this volume or 500 ml of the tidal volume are being used during the process of normal daily breathing. 50% of lung vital capacity or 2500 ml constitute the inspiratory reserve volume which can be inhaled in addition to the tidal volume. It is possible to exhale 20% or 1000 ml of expiratory reserve volume in addition to the exhalation of the inspiratory capacity by maximally contracting the expiratory muscles. As it is impossible either to completely compress or completely empty the lungs, about 20% of the total lung capacity – 1000 ml or the residual volume - remains in the lungs. The positive air pressure zone in the lungs is designated by 0 up to +100%, the negative pressure zone in the lungs – by 0 up to -100% (adapted according to Valtneris, 2012, 74).

In pedagogy of wind instrument playing, it is important to distinguish two diametrically opposed phases in the process of breathing – when the air in the lungs is either with a higher or with a lower pressure than the air pressure in the atmosphere. The moment, when the air pressure in the process of breathing equalizes and is the same in both the lungs and the atmosphere, may be called a zero point. The positive
air pressure zone in the lungs is from 0 up to +100%, the equalized air pressure zone is a zero point, and the negative air pressure zone is from 1 up to -100%. In nature, breathing approaches the position of zero when a human is in a rest state and breathes very quietly. When speaking in a low voice, too, human’s breath is close to the zero position.

Inhalation with a positive pressure in the lungs (above zero) provides possibility for a free, relaxing exhalation, without involving expiratory muscles. The exhalation takes place when the difference between the air pressure in the lungs and that in the atmosphere naturally equalizes. Certainly, wind instruments playing may require a stronger expiratory air flow than that ensured by a natural exhalation; in such case exhalation has to be strengthened by means of expiratory muscles. However, the rule is simple – the deeper the inhalation, the higher the pressure in the lungs, and the less of the force of expiratory muscles is needed to create expiratory air flow. The more the breathing process is in the negative zone of the lung pressure, the greater efforts and muscular force are required to provide the expiratory air flow. In fact, any exhalation below a zero position is forced, because in a geometric progression it activates expiratory muscles and creates muscular tension, which is undesirable in the brass playing process.

Practice shows that students usually do not give full attention to full inhalation and often play by using air reserves available in a negative pressure zone. This leads to creating an unnecessary tension and stress in the body, because the natural inspiratory reflex (so-called Herring-Breuer reflex) is not implemented (White, 2005), and also contributes to the expiratory muscle fatigue and rapid decrease of the physical endurance – general for the body, because the body is not supplied with oxygen, as well as embouchure, which receives a reduced amount of air for creation of a sound and has to compensate it by pressing the mouthpiece against the lips.

For wind players, the recommendable working area of breath is a positive pressure zone – when the air pressure in the lungs is higher than the atmospheric air pressure and the air freely and effortlessly flows into the instrument. “In the positive pressure zone, when breathing out normally, large quantities of air naturally and easily flow from the body to the lower pressure outside the body. To play an instrument, this is the ideal range in which to work” (Frederiksen, 2006, 117). Such breathing does not wear a musician out and produces a relaxing effect on respiratory muscles and a nervous system, as well as creates basis for producing a relaxed, flowing sound. Playing an instrument in a negative pressure zone, a disproportionately great muscular force is needed to push the air out of the lungs, which progressively grows as the difference between the pressure in the lungs and in the atmosphere becomes larger. “Jacobs encourages his students to breathe deeply and frequently and avoid dipping below the point of zero pressure where they would have to work too hard and use more effort to move the air” (Frederiksen, 2006, 118). Additionally, B. Fredriksen also points out that “most wind players use less than one-half of their vital capacity when playing their instrument” (Frederiksen, 2006, 116), but the insufficient inspiratory amount, in its turn, is compensated by a forced exhalation.

Unfortunately, observations from practice show that the majority of students - wind instrumentalists use inspiratory reserve volume incompletely and therefore they often find themselves in the zone of expiratory reserve volume or negative air
This manner of breathing consumes much energy and soon wears a performer out, which in its turn makes a real impact on the quality and durability of the performance.

One way how to train exhalation, often mentioned in brass playing pedagogy, is training of expiratory muscles (Quinque, 1980; Gordon, 1987; Sandoval, 1991). Another option is to increase elasticity of the chest not only in the direction of expansion, but also in the direction of the contraction, i.e., to allow chest and shoulders to go down even lower and reduce lung volume with the help of minimal muscle effort, therefore delaying the activation of inspiratory reflex and reducing the level of muscle tension and fatigue, thus at the same time increasing the expiratory volume.

The third possibility becomes quite evident after studying the proportions of the volume of respiratory phases (see Figure 2). It is obvious that the inspiratory reserve volume has a much greater potential for playing than the skill of pushing the air out of the expiratory reserve volume. Besides, the air of the inspiratory reserve volume is under the pressure needed for playing even without the exertion of muscles, while this pressure in the expiratory reserve volume has to be created by means of expiratory muscles, with the force growing in a geometrical progression (Frederiksen, 2006). From the viewpoint of the physiology of respiration, the most logical solution for this in wind instrument playing would be using the zone of inspiratory capacity or a positive air pressure as much as possible, and avoiding the use of the zone of expiratory reserve volume or negative air pressure. This means that in pedagogy of wind instrument playing a greater attention has to be consciously given to the inhalation process and the efficiency of inhalation has to be increased, simultaneously avoiding the use of expiratory reserve volume during the process of playing. Students’ playing skills would essentially improve, if they made greater use of the inspiratory volume available in the positive pressure zone. This implies that good inspiratory skills need to be developed by using a full inspiratory capacity, and the flexibility of intercostal and spinal muscles is to be developed as well.

If we mathematically compare the inspiratory reserve volume with tidal volume and expiratory reserve volume (see Figure 2), we get the following proportions: 5:1:2. Respectively, the proportion between the positive inhalation and the negative exhalation is 6:2. It is obvious that a much greater amount of the air for playing wind instruments is available when inspiratory reserve volume is used. In everyday life the majority of musicians and students are not accustomed to actively use inspiratory reserve volume, therefore during playing wind instruments, too, they most often tend to use the tidal volume and expiratory reserve volume. During the process of training wind instrument playing, it would be advisable for a teacher to direct full attention to the development of the inspiratory process and to a conscious use of the potential of the inspiratory reserve volume.

**Research Results**

The research revealed that there are essential discrepancies between the methods applied in wind instrument pedagogy for training breathing patterns and processes of natural breathing, determined by the human physiology (see Table 1).
Table 1. Aspects interfering with breathing during playing and aspects helping breathing during playing

<table>
<thead>
<tr>
<th>ASPECTS INTERFERING WITH BREATHING DURING PLAYING (−)</th>
<th>ASPECTS DEVELOPING BREATHING DURING PLAYING (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept of the diaphragm for exhalation</td>
<td>Use of natural breathing reflexes</td>
</tr>
<tr>
<td>Idea about the breath support or stamina</td>
<td>Exhalation as a flow created by the pressure of the inhaled air</td>
</tr>
<tr>
<td>Division into chest and diaphragmatic breathing</td>
<td>Use of a two-way expiratory movement</td>
</tr>
<tr>
<td>Constant contracting of the diaphragmatic and expiratory muscles</td>
<td>Relaxation of muscles uninvolved in the movement in order to rest and to be more relaxed</td>
</tr>
<tr>
<td>Maximal use of expiratory reserve volume</td>
<td>Use of inspiratory reserve volume</td>
</tr>
</tbody>
</table>

The left side column in the Table 1 includes techniques of breathing which create tension and limit the breathing process; the right side column shows breathing techniques which relax the respiratory system, increase the volume of breath and economize musician's physical resources.

The concepts of the diaphragm and breath support used for generations are in contradiction to the processes of natural breathing. For the sake of greater clarity, the idea about the chest, diaphragmatic and combined breathing has to be supplemented by the knowledge about the two opposite inspiratory movements – movement of the diaphragm downwards and movement of intercostal and chest muscles upwards. Besides, the research on the volume of various respiratory phases showed that it is the inspiratory reserve volume that has the greatest air volume potential for wind instrument playing.

Knowledge of physiology of respiration logically leads to the necessity of developing those parameters of breath in wind instrument pedagogy, which have greater potential for increasing player’s skills and abilities, namely – the inspiratory reserve volume. One of the developmental directions here is the optimization of the breathing process which would be based on processes of relaxed, natural breathing, increasing only the amplitudes of breathing movements. The second direction is awareness about inhalation as a complicated two-way movement and enhancing the efficiency of these inspiratory movements by facilitating the coordination and elasticity of muscles. It is recommendable to use both the above mentioned directions for the development of breathing.

This approach to mastering breathing patterns in wind instrument playing has several advantages:

1. the amount of the air to be used has been increased, which provides greater opportunities for musical expressiveness (quality and timbre of a sound, length of phrases, expression);
2. the zone of positive air pressure has been increased, which allows relaxing respiratory muscles and therefore also – a greater endurance, and a more resonant sound;

3. a more stable air flow which relieves work of the embouchure, thus increasing its endurance and working limits in ultimate registers.

**Recommendations to Optimize Breathing in Brass Playing**

During the research the procedural model for the improvement of breathing in wind instrument playing has been developed (see Figure 3), which can be used to develop a better coordination of breath and to increase the amount of the breath to be used.

As recommended by a breathing trainer M. White, the first thing to do in order to learn a correct inhalation would be to stabilize natural breathing reflexes:

1. to sit or stand straight, slowly exhale the air out of the lungs until it is no longer possible to exhale it;

2. to allow the air freely and effortlessly flow into the lungs, simultaneously feeling inhalation in the whole body (White, 2005).

This exercise makes it easy to understand where and how a natural, relaxed breathing occurs in the body, because in brass playing it is more efficient than overdone, tension limited inhalation which is often used by the students due to their misconception about diligence. M. White points out that practicing natural breathing or the renewal of natural breathing reflexes is good for all people, and it leads to the state of deep relaxation (White, 2005). Relaxation, as we know, is an important factor for increasing both the life quality and abilities to learn (Schachl, 2005).

When the skill to inhale and exhale freely – without any stress and tension - is acquired, the next step in the development of breathing is to show students how it is possible to increase the inspiratory volume by maintaining the feelings and principles of natural breathing – without forcing, strength and overdoing, only by means of increasing amplitudes of inspiratory and expiratory air amount:

1. to observe the process of natural breathing – to feel how the breath comes in and goes out;

2. to gradually increase breathing amplitude, maintaining feelings and working principles of natural breathing;

3. to consciously follow the movement of the air in the body and try to feel how much unused breathing space there is in your body, if you consciously relax it and allow it to expand.

This exercise enables us to demonstrate to the students the maximum of their inspiratory amplitude and help them to release the tension which blocks the inspiratory process long before the maximum of inhaling is reached.
While doing this exercise, it is advisable to mentally intensify the movements of air within the lungs by demonstrating it with hand movements in the area of the solar plexus (namely, on inhaling the space between the palms increases, on exhaling – decreases, the movements are up and down). Thus, a barely perceptible feeling of the air movement in the lungs is being intensified by the perceptions of visual and kinaesthetic senses (Gumm, 2009).

The ability to consciously relax specific muscles – antagonists, uninvolved in the breathing activity, can contribute much to increasing the efficiency of breathing movements. Namely, on inhaling expiratory muscles have to be maximally relaxed, but on exhaling – inspiratory muscles, so that breathing would not be based on isometric tensions, which actually are unable to influence the more efficient air movement either within musician’s lungs or in the instrument.

The next step towards expanding the respiratory volume in playing is the use a full inspiratory reserve volume. In order to do this, we have to be aware of the fact that a full inhalation is provided by two reverse movements – the movement of the diaphragm downwards and the movement of the chest upwards – and employ this physiological peculiarity to increase the air volume used in playing.

A higher level in the process of increasing the vital capacity of the lungs is the development of flexibility and coordination of thoracic muscles. For this purpose various exercises, designed for increasing flexibility of intercostal muscles in both directions - expansion and contraction - can be used, thereby extending the duration of exhalation in a positive air pressure zone.

Taking into consideration the fact that in case of children and teenagers, the training of muscular mass is comparatively ineffective and the increase in strength is more often achieved by improving the movement coordination (Jansone & Krauksts, 2005; Haywood & Getchell, 2009; Hall, 2011), for brass playing it is preferable to develop correct – close to a natural breathing process - breathing movements, as well as to

**Figure 3. Procedural model of increasing the respiratory amplitude and air volume during playing**
strengthen expiratory muscles and gradually, without overloading, to increase expiratory force and intensity. In such aspect, optimal breathing model designed by M. White, which contributes to developing and deepening a natural inspiratory reflex, in combination with exercises devised for increase of the amplitude of breathing, and the relaxation of muscles – antagonists, uninvolved in the activity, as well as the improvement of coordination of breathing movements, is the optimal solution for teaching brass players.

Conclusions

The research has revealed that in the pedagogy of brass playing, often teaching of breathing patterns is not based on knowledge about real, physiologically determined processes of natural breathing, because:

- the use of the concept of the diaphragm contradicts the physiological processes of breathing;
- the idea about the breath support is usually being related to this contradictory use of the diaphragm concept. Besides, it requires serious analysis and revision in order to avoid misconceptions about the necessity of isometric contractions of expiratory muscles to create breath support;
- the traditional division into chest (thoracic), diaphragmatic and combined breathing does not create a clear perception about breathing as a two-way movement, where the elevation of the chest on inhalation allows for the so called chest breathing type to dominate, the lowering of the diaphragm allows the diaphragmatic breathing type to dominate, but these two movements performed simultaneously create the so called combined breathing type;
- instead of working in order to increase the inspiratory volume which would resolve many problems of playing, the force of expiratory muscles is being developed, which provides lesser benefits and could create excessive muscle tension and entail risks for musician's health in addition.

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