

ORAL CONTRACEPTIVES AND ELITE VOCALISTS IN TRAINING; PERSPECTIVES FROM THE VOICE ACADEMY

Imelda Drumm

Introduction

Training a classical vocalist, as with any musical instrument, is passed down from a master teacher to pupil. Student and teacher must maintain good communication and trust is essential in the relationship. According to Davidson (2002), success in training involves, repetition, requiring traits of persistence, mental flexibility and a willingness to accept correction.¹ Acquiring a classical vocal technique is a cerebral and corporal pursuit. Pabon et al. (2013) comment that among the goals of voice training is to produce an equalised, consistent, and conventional quality of vocal production. As a result of training voice range profile (VRP) can change in shape, size and quality.²

Procedure

The observations from the teaching academy occurred during term time, were briefly recorded as part of the weekly lesson plan by the author who is the vocal teacher of both singing students whose adverse reactions to HC's are described in this paper. Student A is referred to as Darcy and Student B is identified as Lucy.³ Both students have submitted written accounts and given full permission for their experiences to be used for illustrative purposes.

Vocal effects of cyclical endogenous fertility hormones

Vocal harmonics are hormonally dependant. This is illustrated by changes which occur in voice during male and female puberty. According to Brunings et al. (2013) there are significant laryngeal differences between males and females.⁴ Kajantie and Phillips (2006)

¹ Jane Davidson, 'Developing the Ability to Perform', in John Rink, *Musical Performance* (Cambridge: Cambridge University Press, 2002), 89-101.

² Peter Pabon et al., 'Effects on Vocal Range and Voice Quality of Singing Voice Training: The Classically Trained Female Voice', *Journal of Voice* 28 (2013), 36.

³ At the time of writing this paper Lucy is a 27 year old light lyric coloratura soprano top range high F (she has discontinued the oral contraceptive pill for two full years), and Darcy is a 30 year old light lyric soprano at the time of writing she is a couple of months after discontinuing the oral contraceptive pill.

⁴ Jan W. Brunings et al., 'The expression of Estrogen and Progesterone Receptors in the Human Larynx', *Journal of Voice* 27 (2013), 376.

state the variations in the level and status of reproductive hormones are different between the sexes, (men being regulated by testosterone)⁵ and in women, levels of oestrogen and progesterone depend on age and lifecycle, either phase of the menstrual cycle or menopausal status, with pregnancy having marked effects on the ability to deal with ordinary life stress.⁶ Although there are many more hormones in the body, Kadakia, Carlson and Sataloff (2013), emphasise that the voice is particularly affected by sex and thyroid hormones. There are thyroid receptors in the larynx. Thyroid secretions direct the process of vocal aging.⁷

Female singers according to Higgins and Saxman, (1989) can suffer significant vocal unreliability due to changes in levels of ovarian hormone over monthly ovulatory cycles.⁸ However the degree to which persons may be affected according to Hunter, Eric et al. (2011), is not the same, for reasons concerning sex, individual differences, genetics and personal levels of circulating hormone.⁹ Menstrual issues affecting the voice include laryngeal water retention, oedema of the interstitial tissue and venous dilation on the vocal chords, as identified by Abitbol et al. (1989).¹⁰ Oestrogens have a hypertrophic and proliferative (thinning) effect on mucosa. Progesterone is released later in the monthly cycle, this steroid hormone is interdependent on oestrogen. Progesterone effects according to Del Rio et al. (2018) depend on previous excitability from the effects of oestrogen.¹¹ Just as oestrogen increases capillary permeability and allows the passage of fluids to the interstitial space, progesterone decreases and inhibits permeability, trapping fluid, causing congestion in the body. In the vocal folds Abitbol et al. (1999) found this can cause swelling of folds, thickening of mucosa and contribute to premenstrual dysphonia (hoarseness).¹² According to Behr Davis and Lee Davis (1993), with the menstrual phase comes abdominal bloating, cramping, oedema, in some instances laryngeal joint stiffness, vocal fatigue, a loss of high

⁵ Testosterone is produced in the testes. Its production is relatively stable, except in cases of dysfunction or disease and declines gradually with age.

⁶ Eero Kajantie and David I.W. Phillips, 'The effects of sex and hormonal status on the physiological response to acute psychosocial stress', *Journal of Psychoneuroendocrinology* (2006), 151.

⁷ Sameep Kadakia, Dave Carlson and Robert T Sataloff, 'The Effect of Hormones on the voice', *Journal of Singing* 69 (2013), 571.

⁸ Maureen B. Higgins and John H. Saxman, 'Variations in Vocal Frequency Perturbation Across the Menstrual Cycle', *Journal of Voice* 3 (1989), 233.

⁹ Eric J. Hunter et al., 'Gender differences affecting vocal health of women in vocally demanding careers', *Logopedics Phoniatrics Vocology* 36 (2011), 128-136.

¹⁰ Jean Abitbol et al., 'Does a hormonal Vocal Cord Cycle Exist in Women? Study of Vocal Premenstrual Syndrome in Voice Performers by Videostroboscopy-Glottography and Cytology on 38 Women', *Journal of Voice* 3 (1989), 157.

¹¹ Del Rio et al., (2018), 7.

¹² Jean Abitbol et al., 'Sex Hormones and the female voice', *Journal of Voice* 13 (1999), 431.

notes and sometimes other vocal problems relating to pitch, volume, quality and flexibility.¹³ In addition, the vessels in the nasal passages can dilate, according to Kadakia, Carlson and Sataloff (2013), resulting in changes in patency influencing the singer's perception of her voice. Reflux symptoms can increase, and as previously stated increases in progesterone cause glandular secretions to become more viscous leading to a decrease in vibratory efficiency.¹⁴ Lã et al. (2012) describe professional voice problems including difficulties singing pianissimo, loss of control of vibrato and errors with intonation. Acoustically, vibrato corresponds to a low frequency modulation of the fundamental frequency (F0) at a rate of about 5-7 Hz. The pitch perceived corresponds to the (F0) mean, Sundberg (1978).¹⁵ Intonation involves at least three different types of simultaneously activated mechanisms. The first involves preplanning and prephonatory tuning using laryngeal, oropharyngeal, and respiratory muscles. The second is auditory feedback. The third is kinesthetic feedback based on neuromuscular memory allowing adjustments in response to preplanning and auditory feedback. According to Lã et al. (2012) changes in neural functioning, perceptual and sensory thresholds and motor skills have been found to be related to hormonal variations.¹⁶

Emotional effects of endogenous hormones

Premenstrually women may also experience alterations in mood Choi (1999) including depressive symptoms and alterations in behaviour.¹⁷ According Meurer et al. (2009) the most common mental symptoms of PMS in adolescents were: pronounced anxiety, sensitivity, agitation, nervousness, emotional instability, depressed mood, feelings of uselessness, greater self-censorship, and increased conflicts with others.¹⁸ Weis et al. (2011) reports changes in functional brain organisation in women during the menstrual Cycle.¹⁹ Ossewaarde et al. (2013) discovered increased grey matter volume in the brain during the premenstrual phase compared to the late follicular phase of the menstrual cycle. This volume increase was positively correlated with a premenstrual increase in stress induced negative affect. The

¹³ Clarissa Behr Davis and Michael Lee Davis, 'The effects of Premenstrual Syndrome (PMS) on the Female Singer', *Journal of Voice* 7 (1993), 337.

¹⁴ Sameep Kadakia, Dave Carlson and Robert T Sataloff, (2013), 571.

¹⁵ Johann Sundberg, 'Effects of the vibrato and the 'singing formant', on pitch', *Journal of Research on Singing* 5 (1978), 5-17.

¹⁶ Filipa M. B. Lã et al., 'Effects of the Menstrual Cycle and Oral Contraception on Singers' pitch Control', *Journal of Speech, language, and Hearing Research* 55 (2012), 247-248.

¹⁷ Precilla Choi, 'Why I study the menstrual cycle', *The Psychologist* 12 (1999), 388.

¹⁸ Elisea M. Meurer et al., 'Menstrual Cycle influences on Voice and Speech in Adolescent Females', *Journal of Voice* 23 (2009), 110.

¹⁹ Susanne Weis et al., 'Dynamic Changes in Functional Cerebral Connectivity of spatial Cognition During the menstrual cycle', *Journal of Human Brain Mapping* 32 (2011), 1551.

research by Ossewaarde et al., demonstrates how structural brain plasticity is associated with endogenous sex hormone fluctuation and stress sensitivity.²⁰ Tonn Eisinger et al. (2018), observe motivated behaviour and the female system is directly sensitive to levels of oestrogen.²¹

Sex steroids and the brain

Adult brain structure is not static. Steroid hormone research by Del Río et al. (2018) has evidenced that sex steroids are important brain regulators which influence cognition, recall, emotion processing, behaviour, personality and structural learning. For women, oestrogen and progesterone therefore are important steroid hormones affecting the central nervous system (CNS).²² Both the natural menstrual cycle and hormonal contraceptive use modulate human brain structure.²³ For these reasons it is not possible to isolate the aging process of the endocrine system from age related changes that occur in the CNS. As a consequence, abnormality observed within the ovarian function should be taken into account when a woman is being treated for a mental health problem.²⁴ It is suggested by Glover et al. (2015), that it is not the absolute levels of oestrogen but rather the fluctuations in supply that give rise to sex-specific susceptibility to mental illnesses.²⁵

Oestrogen and progesterone are potent regulators of cell survival, bio-energetic systems, and neurogenesis; the combination of oestrogen and progesterone is not synergistic, as naturally it is regulated to be released at interval. This is the reason why hormonal medications when administered in combination, at the same time, lead to a lower response compared to either hormone administered alone or in sequence. Also, synthesised hormones do not have the same chemical composition as hormones produced by the body. However, they do act to suppress the production of endogenous hormones. Reactions to these medications can vary from individual to individual and rely on numerous factors not least age and lifecycle, unique

²⁰ Lindsey Ossewaarde et al., 'Menstrual Cycle-Related Changes in the Amygdala Morphology are Associated with Changes in Stress Sensitivity', *Journal of Human Brain Mapping* 34 (2013), 1191.

²¹ Katherine R. Tonn Eisinger et al., 'Membrane estrogen receptor signalling impacts the reward circuitry of the female brain to influence motivated behaviors', *Journal of Steroids* 133 (2018), 53-59.

²² Juan Pablo del Rio et al., 'Steroid Hormones and Their Action in Women's Brains: The Importance of Hormonal Balance', *Journal of Frontiers in Public Health* 6 (2018) Article 141, 1.

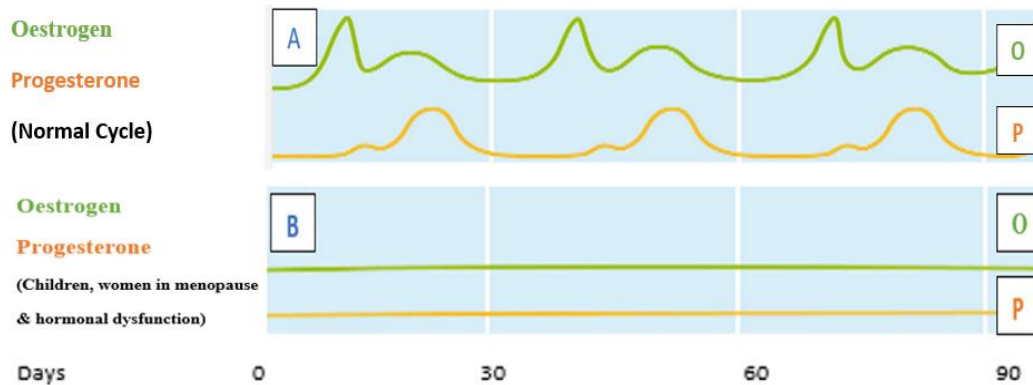
²³ Belinda Pletzer et al., 'Menstrual cycle and hormonal contraceptive use modulate human brain structure', *Journal of Brain Research* 1348 (2010), 55.

²⁴ Juan Pablo del Rio et al., 'Steroid Hormones and Their Action in Women's Brains: The Importance of Hormonal Balance', *Journal of Frontiers in Public Health* 6 (2018), 3.

²⁵ E. M. Glover et al., 'Estrogen and Extinction of fear memories: Implications for posttraumatic stress disorder treatment', *Journal of Biological Psychiatry* 78 (2015), 178-185.

personal levels of circulating hormone, but also, are further influenced by either absence or presence of disease. Patterns of estrogen and progesterone in normal and menopausal ovarian cycles over a duration of 90 days are illustrated in Figure 1.

Figure 1. Normal cycle (A) and Menopausal (B) (low) hormonal conditions



Plasma oestrogen (green) and progesterone (orange) values Normal Cycle and Menopausal Cycle over three months or ninety days. (Figure 1A) depicts (normal) fluctuating ovulatory cycles with adequate luteal phases, hormonal balance between estradiol and progesterone. (Figure 1B) depicts cycles with no ovarian activity, as is found in children and women in menopause. It can also be found in cases of anorexia and hormonal dysfunction. In contrast see (Figure 2, C, D, and E) which shows the different actions of hormonal contraceptives HC's and hormonal therapy HT medications over the same period three months or ninety days.

Figure 2. Hormonal contraceptives and hormonal therapy

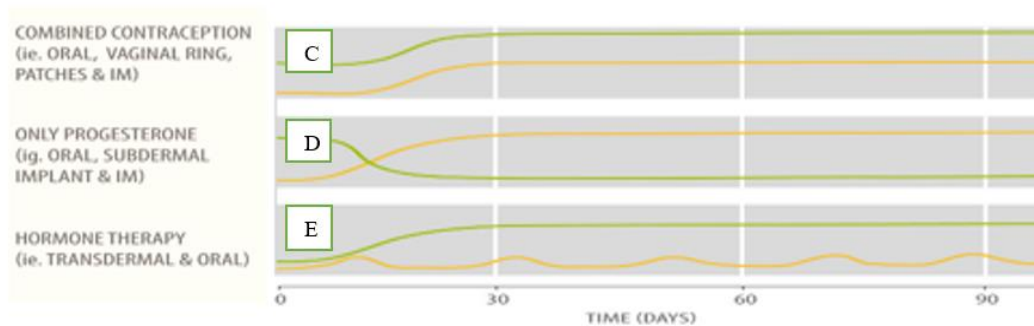


Figure 2 depicts three different forms of exogenous (synthetic) hormone administration (C, D, and E), (Figure 2, C), describes combined contraceptive, using one of two types of

oestrogen and one of eight different progestin compounds either in monophasic or multiphasic combination. (Figure 2, D) describes a progesterone only contraceptive and (Figure 2, E) depicts hormonal replacement therapy. As is apparent, HC's and hormone therapy HT behave differently compared to 'levels' and 'fluctuations' in endogenous hormone as described in (Figure 1 A) and (Figure 1 B), the naturally occurring hormone conditions in NC women and women who are in menopause.²⁶

Research on the brain, Mc Ewen et al. (2012) revealed the connection and function of oestrogen receptors and oestrogen actions on processes related to cognition, mood, autonomic regulation, pain, and neuroprotection, amongst other important brain functions. The identification of the influence of sex steroids on the brain has revolutionised how we understand how the brain regulates the body.²⁷ In women, ovarian steroids are implicated in the extinguishing of fear, which is a form of learning that is involved in the suppression of learned responses, Nagaya and Maren (2015).²⁸ Meurer et al. (2009) point out that fine motor control, fluency, mood, aggressiveness, behaviour, concentration, mental alertness and well-being in women are influenced by the secondary effects of oestrogen.²⁹ According to Weis et al. (2011) there are dynamic changes in functional cerebral connectivity during the menstrual cycle.³⁰

Puts et al. (2013) and describe a pattern of oestrogen and progesterone driving changes in increased attractiveness in women at peak fertility during the ovulatory cycle.³¹ Shoup-Knox and Pipitone (2015), observe differences in perceptual ratings from listeners evaluating the vocal attractiveness between normally cycling women when compared to women taking HC's, this implies the action of HC's may exert changes on subtle human interactions which

²⁶ Note other ovarian conditions such as polycystic ovary syndrome, returning fertility after breastfeeding, perimenopause, and hypothyroidism for example display different relationships between oestrogen and progesterone along the ovarian continuum. See Juan Pablo del Rio et al., 'Steroid Hormones and Their Action in Women's Brains: The Importance of Hormonal Balance', *Journals of Frontiers in Public Health* 6 (2018) Article 141, 4.

²⁷ Bruce S. McEwen et al., 'Estrogen effects on the brain: actions beyond the hypothalamus via novel mechanisms', *Journal of Behavioral Neuroscience* 126 (2012), 4.

²⁸ Naomi Nagaya and Stephen Maren, 'Sex, Steroids and Fear', *Journal of Biological Psychiatry* 78 (2015), 152.

²⁹ Elisea M. Meurer et al., 'Menstrual Cycle Influences on Voice and Speech in Adolescent Females', *Journal of Voice* 23 (2009), 109.

³⁰ Suzanne Weis et al., 'Dynamic Changes in Functional Cerebral Connectivity of Spatial Cognition During the Menstrual Cycle', *Journal of Human Brain Mapping* 32 (2011), 1544.

³¹ David A. Puts et al., 'Women's attractiveness changes with estradiol and progesterone across the ovulatory cycle', *Journal of Hormones and Behavior* 63 (2013), 13.

may not be overt or immediately obvious. That is, these changes may not be apparent to women or those who are interacting with them. These subtle cues may operate subliminally.³²

Explanation of action and types of contraceptive medicines

Contraceptive medications depress the production of endogenous hormones and decrease the fluctuation of hormones over the menstrual cycle. This can be achieved through the progesterone component alone. However, the oestrogen component stabilises (negative side effects) such as minimising breakthrough bleeding and it also potentiates the progesterone component, allowing the dosage to be reduced. However, combined pills can increase the risk of cardiovascular and thromboembolic events. Pills are either monophasic or multiphasic. Monophasic have the same formulation for 21 days of the cycle, followed by seven placebo pills. Monophasic pills introduce the lowest levels of progesterone and oestrogen needed to inhibit ovulation. Multiphasic HC's (typically triphasic) follicular, ovulatory, menstrual, attempt to mimic the fluctuation of hormones over the menstrual cycle. This type of pill aims to lessen the metabolic effects which can include weight gain, acne and mood changes.³³

Hormonal contraceptives and singing

With so many women now taking hormonal contraceptives, the actions of these steroids on the voice and psyche have also begun to be considered. Not least, because of any effects HC use may exert on interpersonal relationships. The effects on voice according to Amir et al. (2002), begin with fundamental frequency differences between normally cycling women (NC) and those women taking the oral contraceptive (OC) pill.³⁴ Meurer et al. (2014) indicate the HC's may interfere with vocal range.³⁵ Kunduk et al. (2016), investigate the vibratory effects of the vocal folds with high speed digital imaging across the menstrual cycle and

³² Melanie L. Shoup-Knox and R. Nathan Pipitone, 'Physiological changes in response to hearing female voices recorded at high fertility', *Journal of Physiology & Behavior* 139 (2015), 386.

³³ Jennifer P. Rodney and Robert Thayer Sataloff, 'The effects of Hormonal Contraception on the Voice: History of Its Evolution in the Literature', *Journal of Voice* 30 (2015), 727.

³⁴ Ofer Amir, Liat Kishon-Rabin, and Chava Muchnik, 'The Effect of Oral Contraceptives on Voice: Preliminary Observations,' *Journal of Voice* 16 (2002), 267.

³⁵ Eilséa M. Meurer et al., 'Speech Articulation of Low-Dose Oral Contraceptive Users', *Journal of Voice* 29 (2014), 749.

found that HC use may have influence on the spectral richness of vocal fold vibration.³⁶ According to Rodney and Sataloff (2016), new evidence suggests that there may be medicated voice changes in regards HC's and connected speech. They note that previous research in the area of HC use and the professional voice may have failed to record many voice effects due to inconsistencies in research methods.³⁷ Although Lã et al. (2012), did find HC effects on pitch control over the soprano passaggio.³⁸ However, current research indicates that further longitudinal studies need to be done in this area. Certain progesterone only HC's for example *Depo-Provera* can cause a hypoestrogenic state and may cause voice changes similar to those encountered during menopause having androgenic/masculinising effects on the voice. This may cause permanent reductions in the (F0) Sataloff, (2006) and is not recommended for singers, particularly those with higher voices.³⁹ In a review of previous studies, Rodney and Sataloff (2016), observe that first generation pills did cause virilisation in voices however, second and third generation pills are of lower dosages and considered safer. Currently there is no vocal research comparing monophasic to multiphasic contraceptives. Previous research did not control for Fach, vocal ability, age or weight.⁴⁰ They note that hormone alterations in relation to auditory feedback and HC's have not as yet been fully examined.⁴¹ To date, the effects of emergency contraception on voices or neural pathways have not been investigated.⁴²

Hormonal contraceptives and the brain

Petersen et al. (2015) report that regions of the brain thought important for responding to rewards and evaluating internal states/incoming stimuli are smaller in women taking HC's.⁴³ According to Nielsen, Ahmed and Cahill (2014), by supressing the production of endogenous hormones, HC's alter the stress hormone interactions with sex hormones, and this is likely to

³⁶ Melda Kunduk et al., 'The Effects of the Menstrual Cycle on Vibratory Characteristics of the Vocal Folds Investigated with high Speed Digital Imaging', *Journal of Voice* 31 (2016), 182.

³⁷ Jennifer P. Rodney and Robert T. Sataloff, 'The effects of Hormonal Contraceptives and the Voice: History of Its Evolution in the Literature', *Journal of Voice* 30 (2016), 728.

³⁸ Filipa M.B. Lã et al., (2012), 247.

³⁹ Robert T. Sataloff (ed.), *Vocal health and Pedagogy* (San Diego: Plural Publishing 2nd edn 2006), 73.

⁴⁰ Some studies focused exclusively on Sopranos. Mastery of technique can disguise problems associated with physical indisposition across the menstrual cycle. Different singers have different mastery of singing skills which can confound results. The fat composition of individual's effects exogenous hormones as oestrogen production takes place in adipose cells.

⁴¹ A hearing deficit could affect the ability to control the voice.

⁴² Jennifer P. Rodney and Robert T. Sataloff, 'The effects of Hormonal Contraception on the Voice: History of its Evolution in the Literature', *Journal of Voice* 30 (2016), 728-729.

⁴³ Nicole Petersen et al., 'Oral Contraceptive Pill Use is Associated With Localized Decreases in Cortical Thickness', *Journal of Human Brain Mapping* 36 (2015), 2644-2655.

alter memory for emotionally arousing stimuli and events.⁴⁴ Pletzer and Kerschbaum (2014) warn that the effects of synthetic steroids which are understood to cause masculinising as well as feminising effects on the brain have yet to be established.⁴⁵ Pletzer, Kronbichler and Kerschbaum (2014) emphasise that the androgenicity of the progestin compounds in different contraceptive medications have different effects on the brain resulting in changes affecting different structural connections, which in turn, may influence behaviours.⁴⁶ Pletzer, Kronbichler, Nuerk and Kerschbaum (2013) suggest that women taking HC's are different from normally cycling (NC) women in the way they recruit their brains to solve challenges. That is, whilst taking HC they are observed to process and solve problems more like men.⁴⁷ Some progestins are anti-androgenic, others androgenic. The duration of use of the HC is important. Some combined pills according to Segebladh et al, (2009) are implicated in increased risk of mood disorders, with further risk associated with the previous use of a progesterone antagonist (such as in the abortion pill).⁴⁸ It is thought that use of the abortion pill Klein, (1991) may leave a permanent mark on the brain.⁴⁹ Androgenicity and duration of use of HC's cause significant alterations in brain structure and observable effects. For example, the results of the Pletzer et al. (2014) study found that facial recognition was significantly better in groups using anti-androgenic progestins.⁵⁰

In the CNS sex hormones act via steroid receptors and neurotransmitters such as GABA, serotonin dopamine and glutamate. Glutamate is the main excitatory neurotransmitter in the brain. It is involved in cognitive processes such as memory and learning. GABA is the most abundant inhibitory neurotransmitter. Since it has a fundamental role in balancing brain cell activity, alterations in these pathways can cause anxiety. GABA also contributes to motor

⁴⁴ Shawn E. Nielsen, Imran Ahmed and Larry Cahill, 'Postlearning Stress Differentially Affects Memory for Emotional Gist and Detail in Naturally Cycling Women and Women on Hormonal Contraceptives', *Journal of Behavioral Neuroscience* 128 (2014), 482.

⁴⁵ Belinda A. Pletzer and Hubert H. Kerschbaum, '50 years of hormonal contraception – time to find out, what it does to our brain', *Journal of Frontiers in Neuroscience* 8 (2014), Article 256, 1.

⁴⁶ Belinda Pletzer, Martin Kronbichler and Hubert Kerschbaum, 'Differential effects of androgenic and anti-androgenic progestins on fusiform and frontal gray matter volume and face recognition performance', *Journal of Brain Research* 1596 (2014), 108.

⁴⁷ Belinda Pletzer, Martin Kronbichler, Hans-Christoph Nuerk and Hubert Kerschbaum, 'Hormonal contraceptives masculinize brain activation patterns in the absence of behavioral changes in two numerical tasks', *Journal of Brain Research* 1543 (2013), 128.

⁴⁸ Birgitta Segebladh et al., 'Prevalence of psychiatric disorders and premenstrual dysphoric symptoms in patients with experience of adverse mood during treatment with combined oral contraceptives', *Journal of Contraception* 79 (2009), 50-55.

⁴⁹ Renata Klein et al., *RU486 Misconceptions, Myths and Morals* (Melbourne: Australia, Spinifex Press, 1991)

⁵⁰ Belinda Pletzer, Martin Kronbichler and Hubert Kerschbaum, 'Differential effects of androgenic and anti-androgenic progestins on fusiform and frontal gray matter volume and face recognition performance', *Journal of Brain Research* 1596 (2013), 108.

control and diminishes neuronal firing rates in the CNS. Serotonin (5-HT) has an important role in the limbic System. They are important contributors to a sense of well-being. Serotonergic pathways also modulate a wide range of autonomic functions, for example, they are involved in digestion, the sleep/wake cycle, sexual behaviour, affections, mood, and cognitive functions. Dopamine is known as the reward neurotransmitter, is responsible for regulating pleasure, addiction, decision making, motivation, motor control, and learning. Thus, the use of HC's may have influence on the functioning of other neuroactive steroids effecting the regulation and dysregulation of critical bodily systems.⁵¹

Hormonal contraceptives and well-being

There are millions of women prescribed hormonal contraceptives at a young age just after puberty when the brain has been stimulated into an active growing phase due to the release of endogenous fertility hormones (this is a crucial time in structural brain development when sex hormones have important organisational effects). Some women will continue taking hormonal contraceptive medications over prolonged periods. It is not known what the full impact on society is being experienced by the routine 'evening out' of the female natural response and behaviours.

There are other implications of HC use. Common side effects of HC's are irregular vaginal bleeding, problems with libido, headaches, weight gain, vaginal infections and depression. Serious health risks include blood clots, heart attacks and strokes. HC's are implicated in increased risk for breast and cervical cancer. Wiréhn et al. (2010), completed a large study in Sweden which reports that progesterone only users resort more often to anti-depressants than users of the combined pill.⁵² The author conducted a study of solo singers in relation to situational hormones, singing voice impairment and music performance anxiety, Drumm (2017). Findings suggest that those taking hormonal contraceptives feel a high degree of disruption from their hormones, they experience greater vocal impairment and levels of music performance anxiety than those singers normally cycling (NC) or those in the low hormone group, those either in Menopause or experiencing hormonal dysfunction.⁵³

⁵¹ Juan Pablo Del Rio et al., (2018), 6.

⁵² Ann-Britt Wiréhn et al., 'Use of Hormonal Contraceptives in relation to antidepressant therapy: A nationwide population-based study', *The European Journal of Contraception and Reproductive Health Care* 15 (2010), 41.

⁵³ Imelda Drumm, 'Roles for Leading Ladies: Investigating the influence of ovarian hormones on performance anxiety and vocal impairment in elite singing', (DMusPerf Dissertation, Royal Irish Academy of Music, Dublin City University, Dublin, 2017) [www.tara.TCD.ie http://hdl.handle.net/2262/81899](http://hdl.handle.net/2262/81899)

Observations from the music academy

What follows is an account of the author's professional experience, based on work with two of her students. The subject of personal hormones, is a sensitive topic, and one, which some students might wish to keep private. It may therefore be extremely difficult for the teacher to identify problems which can occur due to ovarian cycle abnormality or the influence of contraceptive medications affecting the progress of learning. The author had the benefit of years of association with both women and had developed a good working relationship with each student.

Darcy is a 30 year old soprano who has been working as a professional singer for many years. She has come back into the music academy to improve her singing technique and learn vocal pedagogy with a view to developing her teaching skills. She has been taking contraceptive medications since she was 16 years old. Three years ago she came off the combined pill *Microlite* because she was experiencing bad migraines. Since then, she has been taking *Noriday* a progesterone only pill. Darcy's technical progress in her singing technique has been slower than expected given her experience. Over two years as her teacher, I felt sometimes she would daydream in lessons. Her brain seemed to me at a tangent to where I was attempting to direct her focus. She had a problem with holding physical tension, this tension impeding the freedom of her top notes and even though she was a hard worker she appeared to require more time than other students to securely memorise the amounts of repertoire assigned. I would describe Darcy as a lovely, quiet, if sometimes withdrawn girl, with what I would have described as a very even disposition. She has a beautiful voice although sometimes her nervousness and (her brain getting in the way) interfered with her fully expressing herself during performances.

Earlier this year, into my third year teaching this student something about Darcy changed. A more alert, vibrant, communicative, bouncy and happy Darcy began to appear during her singing lessons. I noticed a marked improvement in communication between us and in her visualisation abilities as we began to make more rapid progress vocally. The restrictions and difficulties we previously had encountered accessing the top register started to subside as she appeared to be better able to follow instructions to relax her body. Her personality, it seemed to me appeared to alter. Moments of frustration began to occur and were expressed in the moment. Laughter, became louder. Within a few weeks I hardly recognised the new Darcy

with the previous Darcy, as being one in the same person. It transpires Darcy had decided to come off her contraceptive pill. Her observances about herself and her singing are as follows;

For the last few years I was going further and further into what I can only describe as fog. I had no creative impulse I haven't written any music or painted in a long time. I feel like the pill has been blocking my feminine creativity if that makes any sense! I'm one month off the pill. I feel younger and more interested in life, in the ups and downs. I am better able to deal with stressful situations and I can think more clearly about possible solutions. I already feel more focused. I do feel more angry and raging now and then ... but I don't think that's a bad thing. During performances I am less likely to be controlled by the physical. I am able to slip away into the music and forget about everything that's happening around me. I can feel when I move people because I can feel moved by myself. This is something which is really coming to the fore since discontinuing the pill. When I think about future performances I have less physical anxiety. Previously I couldn't think about future performances without having a nervous reaction physically and mentally. I think this is to do with being able to compartmentalise things that aren't happening right now. I feel more real, closer to myself as I can see more clearly who I am, where I am in the world and how I relate to others. I have noticed a big difference in terms of attraction. I think it's to do with pheromones. I am now excited by the opposite sex in a way I'd forgotten. I think I am more attractive as well. I think this is important to performing in some way, maybe in relation to connecting with people.⁵⁴

In retrospect, as her teacher I feel that the real Darcy was hidden for as long as I have known her. That person is now gone and a happier, more ebullient Darcy has taken her place. It gives me pause to consider how much of the real personality may become masked or suppressed under hormonal contraceptive influence.

Lucy's story had the potential to be far more serious. Lucy is completing the second year of her Masters in performance. Lucy has been on a combined pill since age 16 and I have been Lucy's teacher for about 7 years from the time she was twenty. The 'event' occurred roughly two years ago. Lucy at 25 years is someone who admits to suffering from bouts of anxiety. Lucy is highly intelligent, diligent, and fluent in languages, one of those students who, although they do not have a vast instrument, will have a career because they work twice as hard as everyone else. Initially in the early years there were a few setbacks. Recurring tonsillitis meant surgery to remove her tonsils. Impacted wisdom teeth, and dry socket during

⁵⁴ Direct quotes from Darcy on her experience after one month coming off a progesterone only pill or mini-pill *Noriday*. *Noriday* contains (Norethisterone, also known as *norethindrone*). She was on this pill for a period of 3 years, having previously been on a combined pill *Microlite* since age 16. *Microlite* contains the progestin (levonorgestrel) and (ethinylestradiol).

the procedure to remove them. It was observed that she suffered difficulties when equalising the air flow and she described a blockage along one side of the nasal passage. Surgery to pair-down overgrown turbinate's resolved the issue. Subsequently, we discovered Lucy had a natural facility for the high coloratura repertoire although she was prevented full freedom in her uppermost range. I felt there were more notes to be accessed, given her voice type. It was a perplexing situation as all other aspects of her vocal development were progressing as intended.

One lesson, Lucy mentioned in passing a change in her general practitioner (GP). The new GP was concerned that she had been on the same pill since she was sixteen *Ovranette*, and she had decided to alter Lucy's medication because of concerns regarding thrombosis and stroke. Over the next weeks I noticed a gradual but serious deterioration in Lucy's mental health. She became withdrawn overall, whilst on occasion aggressive, argumentative, and paranoid that I didn't believe in her. It appeared as if she was serious about making an application to change vocal teachers so unhappy had the situation become, and in a relatively short period of time about 6-8 weeks. She was unable to concentrate, had memory lapses, was convinced other students and teachers were talking about her behind her back. She turned into someone, I did not recognise. Due to the nature of our long term working relationship I felt I knew this girl reasonably well. Quietly, at the end of one very unproductive lesson, where I myself was taken aback by the vehemence of the rebuke I received when suggesting she try something, I gently asked if she might consider returning to her GP to discuss her hormonal balance as I thought she was not behaving quite like herself. The Lucy I had known for many years. Here are Lucy's observations about that time in her own words;

For a time it wasn't even anxiety. It was just nothing. I didn't particularly feel the extremes of any emotion. I was fairly even. But nor did I feel happy either. I was not me. I wasn't making conversation, I wasn't cracking jokes. I wasn't bright. I simply wasn't me. It was only when I began to feel the extremes of emotions did I realise there was something wrong. Even at that however, I assumed there was something innately wrong with me. I did not connect that it might have been hormonal. Something was not right but I kept telling myself to 'get over it' or 'get over yourself and move on'. I was riddled with paranoia and anxiety and would cry going to sleep. It was only when my teacher suggested that I look at my hormones, did it click and make sense. I realised my teacher was right. This wasn't normal for me. I came off the pill almost immediately. It was only a few weeks later, when I began to feel more like myself, did I realise how 'not myself' I was before. My teacher noticed I was much happier, talkative and responsive in lessons. Before I had not been able to do any work on repertoire or make

any progress. I felt a sort of ‘brain fog’ for those few months before and could not concentrate. To be feeling back to myself again was a huge relief.

It was a long time, however, before my voice recovered. We had noticed (during my time on the pill), my voice seemed to be somewhat limited, and I was finding things difficult, that ought to have been easy for my voice type. With the pill change I lost some of my high notes. When I came off the pill completely I did notice (within a couple of months) that it was all coming back, but it was a full year before I felt it settled. I did a competition a couple of months after coming off the pill and although it was all coming back, my voice was unreliable. Some days it would be great and other days I could barely use it without getting tired and losing my top. It was uncontrollable. I could feel it was not something I was doing wrong vocally, but something I just did not have control over, and would simply have to work and wait.

I believe coming off the pill was the best decision I ever made. My friends and my teacher commented that I seem more like myself, and happier than I had ever been when I was on the pill. Now, when I feel the various emotions, I feel them intensely. But it feels right. These things shouldn’t be numbed. I feel things more extremely, but this includes being happy. I also from time to time suffer with extremely painful periods, but they are not every month. I generally know my own body so well now and can feel things properly so I can tell if I will have a painful period and I do my best to prevent it with pain medication. I would much rather the odd painful period, and to feel all my emotions properly, than to be half-numbed to them and not be myself.

My voice is now able to reach notes it wasn’t before. What I feel is its actual range. Even now I am discovering different things that I can do with my voice, and although this is more to do due to consistent training and general maturing, I feel I wouldn’t be making the progress I am if I was still on the pill.⁵⁵

Lucy’s pill *Ovranette* has the progestin *Levonorgestrel* which is a second-generation and the most widely prescribed contraceptive progestin worldwide. It has high progestational and androgenic effects. This may have had influence in reducing the F0 and limiting the top range

⁵⁵ Lucy was on the pill from 16. She went on the pill because of bad period pain. She commenced on *Yasminelle* a light pill. This made no difference to the period pain. The stronger version *Yasmin* (also for 3 months) this also made no difference to the period pain. When she was older aged 17 she began the pill *Ovranette*. This helped with period pain but caused weight gain. She was on *Ovranette* till 22 years old. She came off for about 7 months, she suffered mid-cycle ovulation pain, also began to suffer painful periods again and experienced ruptured cysts on the uterine wall. So she resumed taking *Ovranette* till at 25 she began experiencing bad headaches and migraines. The new GP was concerned. She switched the pill to *Cilest*. She believes she was on this pill for about 3 months although she finds it difficult to remember any detail from that time. *Yasmin* contains (ethinylestradiol) and (drospirenone). *Ovranette* contains (ethinylestradiol) and (levonorgestrel). *Cilest* contains (ethinylestradiol) and (norgestimate).

of Lucy's voice. Levonorgestrel also negatively affects serum lipoproteins. The change to *norgestimate* had almost immediate and severely depressive effects on Lucy.

Lã et al. (2007) and (2009) suggest that *Yasmin* which has *Drospirenone* as the active progestin component and has anti-androgenic and anti-mineralocorticoid properties might 'dampen' unwanted hormonal fluctuations affecting the professional singing voice.⁵⁶

However, more research needs to be undertaken to determine what other dampening effects may occur in the body due to hormonal contraceptive medications, especially any unforeseen effects with regard to brain function and emotional processing. Typically birth control pills contain oestrogen (ethinyl estradiol) and one of 8 different types of progestin component. Norethindrone,⁵⁷ Norethindrone acetate,⁵⁸ Ethynodiol diacetate,⁵⁹ Levonorgestrel,⁶⁰

⁵⁶ Filipa M. B. Lã et al., 'The Effects of A Third Generation Combined Oral Contraceptive Pill on the Classical Singing Voice', *Journal of Voice* 21 (2007), 754; Filipa M. B. Lã et al., 'Oral contraceptive pill containing drospirenone and the professional voice: An electrolaryngographic analysis', *Journal of Logopedics Phoniatrics Vocology* 34 (2009), 11-19.

⁵⁷ **Norethindrone** is a first-generation progestin available in monophasic, biphasic and triphasic formulations. It has low progestational and slight estrogenic activity. It tends to be less androgenic than the second-generation progestins (levonorgestrel and norgestrel), but more androgenic than newer progestins, like desogestrel. In low doses (any pill containing less than 50 mcg of ethinyl estradiol), this progestin improves lipid profiles by raising HDL and lowering LDL cholesterol.

⁵⁸ **Norethindrone acetate** is a progestin of low progestational activity and slight estrogenic effects. It is a first-generation progestin. It tends to be less androgenic than the second-generation progestins, but more androgenic than newer progestins, like desogestrel. The brand *Etrostep* was designed to more closely mimic a woman's natural menstrual cycle by providing increasing levels of estrogen with a constant progestin dose. It is the only triphasic brand with this progestin. This brand may be helpful for women who experience minor estrogen-related side effects such as nausea, migraines, or fluid retention with other pill combinations.

⁵⁹ **Ethinodiol diacetate** is a first-generation progestin of medium progestational activity. It has minor estrogenic effects and little androgenic activity. Ethynodiol diacetate is a derivative of norethindrone, so it is easily converted to norethindrone within the body. Birth control pills containing *ethynodiol diacetate* tend to be associated with increased early or mid-cycle breakthrough bleeding and spotting as compared to other combination pills. However, higher estrogen dosages can counteract the likelihood of breakthrough bleeding, so pill brands that contain higher levels of estrogen can alleviate this side effect.

⁶⁰ **Levonorgestrel** is a second-generation progestin and is the most widely prescribed contraceptive progestin worldwide. It has high progestational and androgenic effects. Levonorgestrel negatively affects serum lipoproteins. Several low-dose estrogen brands containing this progestin are available. Levonorgestrel birth control has also been FDA approved for emergency contraception (such as Plan B One-Step and Next Choice). The FDA has stated that all combination pills with this progestin are safe and effective for emergency contraception under the Yuzpe method. The American FDA has also approved three extended cycle pill brands that use this progestin—Seasonale, Seasonique, and Lybrel.

Norgestrel,⁶¹ Desogestrel,⁶² Norgestimate,⁶³ and Drospirenone.⁶⁴ As previously outlined the amounts or dose of oestrogen (ethinyl estradiol) will impact the action of the progestin component of the pill (depending on which progestin) the actions that particular progestin has on the target steroid receptors and neurotransmitters and its effects). Therefore, when determining if a student may be having vocal or other difficulties as a result of contraceptive medication, it would be prudent to verify the androgenicity of the progestin component of the particular pill and have the student discuss their vocal and/or emotional concerns with their GP.⁶⁵

Summary

Professional singing is a stressful career. Hormonal balance in the body is essential for health and well-being. Fluctuation, dysfunction and hormonal medication which impacts the female menstrual cycle may affect how different individuals process stressful situations. Changes in brain chemistry cause changes in cognition, emotion processing, personality, and observable behaviours. Synthetic steroids which affect brain chemistry are implicated in altered learning and behaviour. Both combined and progestin only HC's are implicated in increased risk of depression, however more research needs to be undertaken in this area. For example, Graham

⁶¹ **Norgestrel** is (a second-generation progestin) is a mixture of both an inactive and active isomer—dextro-norgestrel (inactive) and levonorgestrel (biologically active). Norgestrel has high progestational and strong anti-oestrogen effects while also being high in androgenic activity.

⁶² **Desogestrel** is a third-generation progestin with high progestational selectivity, minimizing androgenic effects and estrogenic activity. It shows a lower negative impact on metabolism, weight gain, acne, and other side effects typical of older progestins. It shows positive effects on lipoproteins as seen by a slight rise of HDL cholesterol. Clinical trials show a possibly higher risk of non-fatal venous thrombosis with desogestrel pills versus those with levonorgestrel. *Mircette* (a low-dose estrogen/desogestrel pill) provides a shorter placebo interval, which may be helpful for women who have migraines, dysmenorrhea, or other negative issues during that week. A low estrogen/varying desogestrel triphasic pill, *Cyclessa*, is also available.

⁶³ **Norgestimate**, a third-generation progestin, has high progestational activity while showing slight estrogenic effects and tends to be less androgenic. It also has minimal effect on serum lipoproteins as well as on carbohydrate metabolism. The low androgenic effects of norgestimate have resulted in successful treatment of acne. In fact, birth control pills that contain norgestimate are the only ones FDA approved to help reduce acne. Ortho Tri-Cyclen Lo is a brand that provides norgestimate and a mid-level dose of estrogen. So this pill may be helpful in lowering side effects such as nausea and vomiting while not causing an increased incidence of spotting (typically associated with low-estrogen pills).

⁶⁴ **Drospirenone** is the only progestin derived from 17 α -spiro lactoneis. It helps suppress the secretion of the hormones that regulate the body's water and electrolytes. It also has low androgenic activity. Drospirenone and estrogen seem to lessen symptoms associated with mild PMS (increased appetite, negative mood, and water retention). Drospirenone may cause higher potassium levels, so women with kidney, liver, or adrenal disease should not use it. The brands YAZ and Beyaz have 24 days of active pills and four days of placebo pills. This combination may cause fewer hormone fluctuations than typical pill packs. YAZ has also been FDA- approved in the USA to help treat premenstrual dysphoric disorder as well as treat moderate acne in females aged 14 years and up.

⁶⁵ Katherine A. Szabo and Eric A. Schaff, 'Oral contraceptives: Does the formulation matter?', *The Journal of Family Practice* 62 (2013), E1-E12.

and Milad, (2013) determined oestrogen is essential in order for the brain to process and extinguish fear.⁶⁶ This is important if techniques such as exposure therapy are employed to combat performance issues such as music performance anxiety. Women who are experiencing low oestrogenic phases or those whose oestrogen is suppressed by HC's may not benefit from such therapies (to the same degree) as performers who have sufficient levels of oestrogen. Singers who suffer with hormonal issues or adverse reactions to HC's may experience alterations in vocal and emotional behaviour. It is essential that singers and their teachers be aware of cues that point to either problems due to the ovarian cycle or adverse reactions to HC's. There are benefits and risks associated with all types of medications. Women are acutely aware of the benefits of HC's. Widespread access to contraception has facilitated beneficial social change for women since they were introduced over 50 years ago. However, research has begun to investigate other unforeseen consequences directly attributable to HC use. Clearly, the use of HC's may have other implications in the body beyond preventing reproduction. HC's are chemically different from endogenous hormones but act in the body by suppressing the production of the natural hormone. Synthetic hormones may affect the CNS differently, it is not yet fully understood what implications, if any, occur in the brain due to chemical substitution. Long term medicating with HC's which has unintended or previously unforeseen influence on the female CNS and which results in changes in behaviour however subtle, requires further research.

Conclusions

There is considerable complexity regarding dosage and content of different brands of contraceptive medications. General practitioners (GP's) are concerned with solving medical issues that are presented to them by the patient. Safeguarding the professional voice may not be the first priority amongst GP's considering the treatment of patients. The reasons for prescribing contraceptive medications, whether in order to prevent pregnancy, or increasingly not, as patient profiles are getting younger; for painful periods, acne or other hormonally treatable imbalances in the body, or as a means to improve vocal stability, requires review. The increasingly broad spectrum of use of these medications, commencing oftentimes at a very young age and continuing over prolonged periods (often multiple decades) make it imperative that individuals prioritise disclosures relating to all extenuating factors, this

⁶⁶ Bronwyn M. Graham and Mohammed R. Milad, 'Blockade of Estrogen by Hormonal Contraceptives Impairs Fear Extinction in Female Rats and Women', *Journal of Biological Psychiatry* 73 (2013), 371.

includes occupation in addition to full medical history. Prioritising occupation may assist GPs to consider unwanted voice effects when prescribing hormonal medications to singers. With regard to changes in mood, all medications should be closely monitored with regard to depressive effects. More research is required to determine the impact of HC's on female cognition and vocal instrument, as, if either is significantly disrupted, both have been found to have the potential to interfere with the acquisition of singing technique.

This paper aims to create awareness of how these pills work and how they might affect the singer and professional voice. It is suggested that familiarity with these issues may prove beneficial amongst those teaching singing. Certainly, in today's music academy vocal teachers may not initially have the advantage of many years working with a particular singer and it may be extremely difficult to recognise changes in behaviour or limiting voice effects over short term interactions. This paper discusses two separate cases involving singers with adverse reactions to HC's. The author's observations, combined with testimonies from the singers demonstrate that HC's may significantly mask or dampen the personality, upsetting social interaction, inhibiting communication and learning. Sopranos in particular may experience problems reaching the full extension of their vocal range. Altered perceptions or dulled sensory stimuli when under the influence of contraceptives may 'blunt' the sensory feedback singers receive from their own emotional connection to the music and further, may alter their perceptions of the sensory feedback they receive from the audience responses to their singing during performances. Inhibiting the natural response of the singing artist or dulling of the senses of any kind in the art of singing, is something which is best avoided. If difficulties of this nature are observed in the music academy, systems ought to be in place to offer the appropriate assistance and support to both singing teachers and their students.

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