Rubric for the 250-word Assignment and Peer Review: The peer review rubric is based on a set of questions the students are asked to address when they review their peer's 500-word essay. Students are graded on whether and how well they covered these questions in their review. The 250-word rubric is based on criteria the students are given to transition their 500-word essay into the 250-word essay. These are graded together for a total of 100 points.

Peer review of the 500-word writing assignment (20pts): How well did the review address the following questions?

Content and writing - Description of hormone (8pts)

- Did the author address the following questions in the description of their hormone: Where is the hormone produced (what tissues)? What are target tissues? What is the physiological function and the biological relevance?
- Did the writing reflect an understanding of the hormone?
- Did the author describe the significance of studying their hormone? Is the writing compelling (Are you convinced that this hormone is important to study)?
- Is the writing repetitive?
- Is the writing informative (Did you learn about this hormone from performing this review)?

Length (2pts)

- Remember the assignment was for no more than 500 words. Is the paper too long or too short?
- In transitioning to the 250-word assignment, should the scope of the subject be expanded or narrowed?

Grammar, writing style, and format (6pts)

- Is the writing clear and concise? Does the author convey ideas in a way that is easily understood? Is there adequate detail without extraneous information?
- Are there spelling/grammar mistakes?
- Do ideas progress logically? Are transitions used effectively?
- Is the word choice appropriate? Is sentence structure correct? Are tenses and cases correct? Do they agree with one another?
- Is the essay easy to read? Does it flow well?
- Is the paper formatted correctly (e.g. correct margins, font, etc…)

References - formatting and use in writing (4pts)

- Is the correct number and type of references (at least 2 primary articles and 1 review article) used?
- Are the references used effectively in the essay?
- Are references in the correct format?

250-Word Assignment (80pts)

Content and writing - Description of hormone (40pts)

- The title is descriptive
- Appropriate biology is covered such as: where the hormone is produced, description of its target tissues, and how the hormone exerts its actions (mechanism of action)
- The authors describe the hormone's physiological function and biological relevance focusing on one particular aspect of physiology/behavior
- The writing reflects an understanding of the focused aspect of this hormone
- The writing describes the significance of studying this aspect of the hormone
- The writing is focused and not repetitive
- The writing is informative and goes beyond what is covered in lecture

Length, grammar, writing style, and format (15pts)

- The length is appropriate (250 words) and effective
- The writing is clear and concise. The author conveys ideas in a way that is easily understood, and there is adequate detail without extraneous information
- There are no spelling/grammar mistakes
- Ideas progress logically, and use of transitions is effective
- Word choice is appropriate, and the correct sentence structure is used throughout. Tenses and cases are correct and agree with one another
- The essay easy to read, and flows well
- The essay is formatted correctly (margins, font, etc…)

References - formatting and use in writing (25pts)

- The correct number and type of references is used (at least 3 primary articles and 1 review article)
- References are used in the writing correctly and effectively. Use of references in the writing reflects adequate research on the focused aspect of the hormone
- References are formatted correctly in-text and for the bibliography

Rubric for the Poster: The poster rubric is based on a set of criteria the students are given to advance their project from the 250-word essay to a more detailed and focused study. Students are graded on the effectiveness of their poster and their presentation of the poster. Students also evaluate their peers' posters. These evaluations are included in their poster grade.

Title (2pts)
- Short, descriptive title

Abstract (6pts)
- Concise description of the study (no more than 250 words)

Introduction (15pts)
- Contains a brief background (bullet points are acceptable) of the hormone biology/functions
- Describes clearly the specific aspect under study using appropriate background information
- Describes why this current study is needed

Hypothesis (10pts)
- Novel, relevant, and feasibly tested
- Is clearly stated on poster

Experimental design (12pts)
- The experiment "conducted" and the methods "used" to complete the experiment are clearly described in enough detail to evaluate whether what is proposed is feasible and whether it would successfully test the hypothesis
- Illustrations of experimental design (if used) are effective

Results (15pts)
- Results of the study are clear and logical
- There are 2-3 graphs with the following
  - Short, descriptive title
  - Detailed legends
  - Clearly labelled axes
  - Error bars
  - Statistics are used to analyze results

Conclusion and interpretations (10pts)
- A short summary (bullet points are acceptable) describing how the results fit into context with what is known in the literature, and how the "current" results advance our understanding of the field

Future research (5pts)
- At least 1 suggestion for future studies is provided

References (10pts)
- The correct number and type of references is used (at least 4 primary articles and 1 review article)
- References are used in the poster correctly and effectively. Use of references in the writing reflects adequate research on the focused aspect of the hormone
- References are formatted correctly

Organization, writing style, presentation style, and format (10pts)
- The author's name, institution, and course appears below the title
- The poster is arranged in columns
- Posters can be read from a distance (Font size and type is appropriate)
- Poster design is effective (enhances material and does not detract from information)
- The writing is clear, concise, and easily understood without extraneous information
- There are no spelling/grammar mistakes
- Word choice is appropriate
- Oral presentation was well organized and clear

Evaluations (5pts)
- Evaluation sheets are completed and the reviews are thoughtful and constructive

Sample of student writing assignment and poster. Below are 2 samples which include the 500-word essay, the 250-word essay and the poster.

Sample 1: 500-word essay

Kisspeptin: The Unveiling of the New Love Hormone?

Kisspeptins are a class of peptide hormones that are encoded by the KISS1 gene. The KISS1 gene codes directly for a prohormone that is 154 amino acids in length (3). The prohormone form of kisspeptin can be chopped into many different lengths including kisspeptin-54, kisspeptin-14, kisspeptin-13, and kisspeptin-10, which can at as active hormones in the body. The expression of this KISS1 gene is found in the hypothalamus, liver, gonads, pancreas, and the placenta. Kisspeptin also has its own receptor, KISS1R, that is expressed in these same areas plus the pituitary gland. Now that we have a background of what kisspeptin is we can investigate why it is important and how it works.

First, we will explore the receptor for kisspeptin, KISS1R. KISS1R is a G-protein coupled receptor (GPCR). When kisspeptin binds KISS1R, the alpha-q subunit of the receptor gets activated and in turn activates phospholipase C (PLC) that catalyzes the conversion of PIP_2 into DAG and IP_3. DAG activates protein kinase C (PKC) which in turn phosphorylates multiple proteins and leads to transcription and translation of cell division and growth proteins. IP_3 releases intracellular Ca^{++} stores that can lead to multiple biochemical changes within the cell and organism. But what kind of cells have receptors and are modulated by kisspeptin?

One of the most important roles kisspeptin has is in stimulating gonadotropin releasing hormone (GnRH). That means that neurons that secrete kisspeptin have strong connections to the GnRH-producing cells of the arcuate nucleus in the hypothalamus. That also means that these GnRH-producing cells of the hypothalamus have KISS1R's and are able to be affected by kisspeptin release. When kisspeptin neurons fire and release kisspeptin, the kisspeptin binds KISS1R's on GnRH-producing neurons, stimulating the $G_{\alpha q}$ complex which helps to depolarize and fire the GnRH cells. These cells release GnRH down to the pars distalis (anterior pituitary) and stimulate release of luteinizing hormone (LH) and follicle stimulating hormone (LSH). Furthermore, LH and FSH move down to the gonads and stimulate production of testosterone and estradiol, respectively. So in total, kisspeptin plays a role in regulating not only the production of GnRH, but also in the production of testosterone and estradiol. Furthermore, some studies have shown that if you use kisspeptin antagonists in the arcuate nucleus of the hypothalamus, you can block the pulsatile release of GnRH that is required for the release of LH and FSH (1,2).

What I have briefly detailed here is just the smallest touch of what kisspeptin does in the body. There is still much to learn about this unique peptide hormone and how it affects behavior and normal function.

References

1. **Li XF, Kinsey-Jones JS, Cheng Y, et al.** Kisspeptin signalling in the hypothalamic arcuate nucleus regulates GnRH pulse generator frequency in the rat. *PLoS One* 4:e8334, 2009.
2. **Roseweir AK, Kauffman AS, Smith JT, et al.** Discovery of potent kisspeptin antagonists delineate physiological mechanisms of gonadotropin regulation. *Journal of Neuroscience* 29:3920-3929, 2009.
3. **Tng EL.** Kisspeptin signaling and its roles in humans. *Singapore Medical Journal* 56(12):649-656, 2015.

Sample 1: 250-word essay

Don't You Wanna Kiss-a-Peptin?

Kisspeptin is a peptide hormone that is encoded by the KISS1 gene (5). It is highly expressed in neurons of the hypothalamus, specifically, the arcuate and anteroventral periventricular nuclei It is also produced in the reproductive system, the liver, pancreas, and white adipose tissue (1). Kisspeptin has its own GPCR, KISS1R/GPR54, that is expressed in the same areas as the protein (4). Kisspeptin plays an important role as a regulator of pubertal initiation.

Puberty involves the biological process of sexual development that leads to increased sex steroid release, and ability to reproduce. Studies suggest that leptin is involved in kisspeptin secretion. During puberty, leptin is overexpressed in adipose cells, causing a large increase in kisspeptin secretion. People with a leptin deficiency do not reach puberty and remain in a pre-pubescent state for life. Furthermore, estrogens also play a crucial role in the initiation of puberty. When an organism is unable to initiate puberty, estrogens act on a subset of estrogen receptors in the AVPe to inhibit the kisspeptin secretion (3). However, when the organism receives signals to initiate puberty, estrogens activate a different subset of estrogen receptors that stimulate kisspeptin release. Kisspeptin appears to be an essential regulator for certain hormones such as GnRH (5). Kisspeptin neurons stimulate GnRH-producing neurons in the hypothalamus. These GnRH neurons stimulate release of LH and FSH from the gonadotropes of the pituitary gland, which activate release of estradiol and testosterone in the gonads. The release of these sex steroids initiates physiological processes involved with puberty.

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1. **Cortes M, Carrera B, Rioseco H, Pablo del Rio J, Vigil P.** The Role of Kisspeptin in the Onset of Puberty and in the Ovulatory Mechanism: A Mini-review. Journal of Pediatric and Adolescent Gynecology 28, (5): 286–291, 2015.
2. **Goodman R, Lehman M, Smith J, Coolen L, V. R. de Oliveira C, Jafarzadehshirazi M, Iqbal APJ, Caraty A, Ciofi P, Clarke I.** Kisspeptin Neurons in the Arcuate Nucleus of the Ewe Express Both Dynorphin A and Neurokinin B. Endocrinology 2007; 148 (12): 5752-5760.
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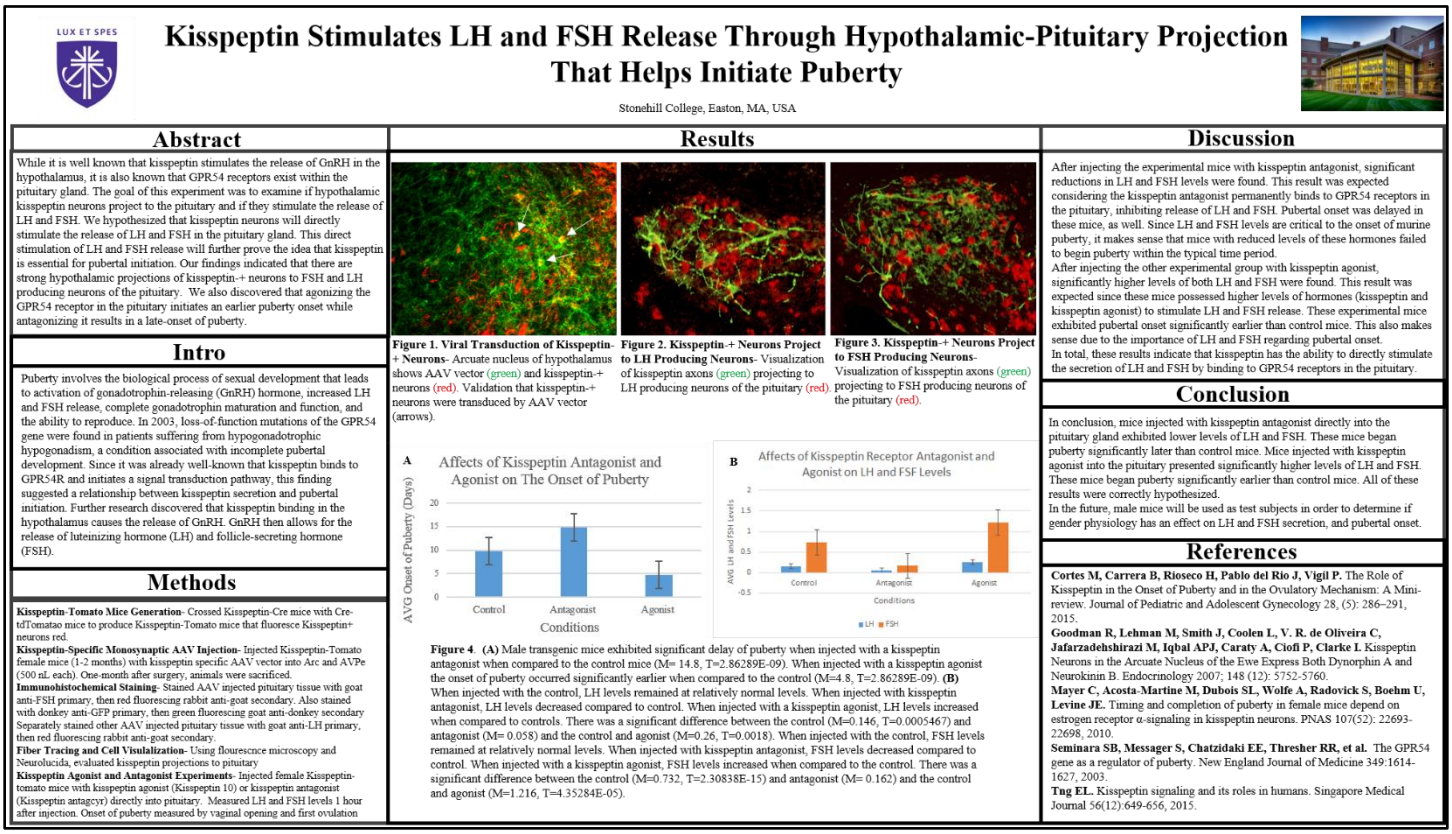
5. **Tng EL.** Kisspeptin signaling and its roles in humans. Singapore Medical Journal 56(12):649-656, 2015.

Sample 1: Poster



Kisspeptin Stimulates LH and FSH Release Through Hypothalamic-Pituitary Projection That Helps Initiate Puberty

Stonehill College, Easton, MA, USA

Abstract

While it is well known that kisspeptin stimulates the release of GnRH in the hypothalamus, it is also known that GPR54 receptors exist within the pituitary gland. The goal of this experiment was to examine if hypothalamic kisspeptin neurons project to the pituitary and if they stimulate the release of LH and FSH. We hypothesized that kisspeptin neurons will directly stimulate the release of LH and FSH in the pituitary gland. This direct stimulation of LH and FSH release will further prove the idea that kisspeptin is essential for pubertal initiation. Our findings indicated that there are strong hypothalamic projections of kisspeptin-+ neurons to FSH and LH producing neurons of the pituitary. We also discovered that agonizing the GPR54 receptor in the pituitary initiates an earlier puberty onset while antagonizing it results in a late-onset of puberty.

Intro

Puberty involves the biological process of sexual development that leads to activation of gonadotrophin-releasing (GnRH) hormone, increased LH and FSH release, complete gonadotrophin maturation and function, and the ability to reproduce. In 2003, loss-of-function mutations of the GPR54 gene were found in patients suffering from hypogonadotrophic hypogonadism, a condition associated with incomplete pubertal development. Since it was already well-known that kisspeptin binds to GPR54R and initiates a signal transduction pathway, this finding suggested a relationship between kisspeptin secretion and pubertal initiation. Further research discovered that kisspeptin binding in the hypothalamus causes the release of GnRH. GnRH then allows for the release of luteinizing hormone (LH) and follicle-secreting hormone (FSH).

Methods

Kisspeptin-Tomato Mice Generation- Crossed Kisspeptin-Cre mice with Cre-tdTomatao mice to produce Kisspeptin-Tomato mice that fluoresce Kisspeptin+ neurons red.
Kisspeptin-Specific Monosynaptic AAV Injection- Injected Kisspeptin-Tomato female mice (1-2 months) with kisspeptin specific AAV vector into Arc and AVPe (500 nL each). One-month after surgery, animals were sacrificed.
Immunohistochemical Staining- Stained AAV injected pituitary tissue with goat anti-FSH primary, then red fluorescing rabbit anti-goat secondary. Also stained with donkey anti-GFP primary, then green fluorescing goat anti-donkey secondary Separately stained other AAV injected pituitary tissue with goat anti-LH primary, then red fluorescing rabbit anti-goat secondary.
Fiber Tracing and Cell Visualization- Using flourescnce microscopy and Neurolucida, evaluated kisspeptin projections to pituitary
Kisspeptin Agonist and Antagonist Experiments- Injected female Kisspeptin-tomato mice with kisspeptin agonist (Kisspeptin 10) or kisspeptin antagonist (Kisspeptin antagcyr) directly into pituitary. Measured LH and FSH levels 1 hour after injection. Onset of puberty measured by vaginal opening and first ovulation

Results

Figure 1. Viral Transduction of Kisspeptin-+ Neurons- Arcuate nucleus of hypothalamus shows AAV vector (green) and kisspeptin-+ neurons (red). Validation that kisspeptin-+ neurons were transduced by AAV vector (arrows).

Figure 2. Kisspeptin-+ Neurons Project to LH Producing Neurons- Visualization of kisspeptin axons (green) projecting to LH producing neurons of the pituitary (red).

Figure 3. Kisspeptin-+ Neurons Project to FSH Producing Neurons- Visualization of kisspeptin axons (green) projecting to FSH producing neurons of the pituitary (red).

Figure 4. **(A)** Male transgenic mice exhibited significant delay of puberty when injected with a kisspeptin antagonist when compared to the control mice (M= 14.8, T=2.86289E-09). When injected with a kisspeptin agonist the onset of puberty occurred significantly earlier when compared to the control (M=4.8, T=2.86289E-09). **(B)** When injected with the control, LH levels remained at relatively normal levels. When injected with kisspeptin antagonist, LH levels decreased compared to control. When injected with a kisspeptin agonist, LH levels increased when compared to controls. There was a significant difference between the control (M=0.146, T=0.0005467) and antagonist (M= 0.058) and the control and agonist (M=0.26, T=0.0018). When injected with the control, FSH levels remained at relatively normal levels. When injected with kisspeptin antagonist, FSH levels decreased compared to control. When injected with a kisspeptin agonist, FSH levels increased when compared to the control. There was a significant difference between the control (M=0.732, T=2.30838E-15) and antagonist (M= 0.162) and the control and agonist (M=1.216, T=4.35284E-05).

Discussion

After injecting the experimental mice with kisspeptin antagonist, significant reductions in LH and FSH levels were found. This result was expected considering the kisspeptin antagonist permanently binds to GPR54 receptors in the pituitary, inhibiting release of LH and FSH. Pubertal onset was delayed in these mice, as well. Since LH and FSH levels are critical to the onset of murine puberty, it makes sense that mice with reduced levels of these hormones failed to begin puberty within the typical time period.
After injecting the other experimental group with kisspeptin agonist, significantly higher levels of both LH and FSH were found. This result was expected since these mice possessed higher levels of hormones (kisspeptin and kisspeptin agonist) to stimulate LH and FSH release. These experimental mice exhibited pubertal onset significantly earlier than control mice. This also makes sense due to the importance of LH and FSH regarding pubertal onset.
In total, these results indicate that kisspeptin has the ability to directly stimulate the secretion of LH and FSH by binding to GPR54 receptors in the pituitary.

Conclusion

In conclusion, mice injected with kisspeptin antagonist directly into the pituitary gland exhibited lower levels of LH and FSH. These mice began puberty significantly later than control mice. Mice injected with kisspeptin agonist into the pituitary presented significantly higher levels of LH and FSH. These mice began puberty significantly earlier than control mice. All of these results were correctly hypothesized.
In the future, male mice will be used as test subjects in order to determine if gender physiology has an effect on LH and FSH secretion, and pubertal onset.

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Goodman R, Lehman M, Smith J, Coolen L, V. R. de Oliveira C, Jafarzadehshirazi M, Iqbal APJ, Caraty A, Ciofi P, Clarke I. Kisspeptin Neurons in the Arcuate Nucleus of the Ewe Express Both Dynorphin A and Neurokinin B. Endocrinology 2007; 148 (12): 5752-5760.
Mayer C, Acosta-Martine M, Dubois SL, Wolfe A, Radovick S, Boehm U, Levine JE. Timing and completion of puberty in female mice depend on estrogen receptor α-signaling in kisspeptin neurons. PNAS 107(52): 22693-22698, 2010.
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Sample 2: 500-word essay

Melatonin's Effects on Seasonal Affective Disorder (SAD)

Melatonin, more formally N-acetyl-5-methoxytryptamine, is a hormone that is primarily secreted by the pineal gland and has a key role in regulating the timing of endogenous circadian rhythms; its levels peaking at night and then inhibited due to daylight (1). It's important to understand this hormone due to the many clinical aspects it carries. For instance, it has been determined that melatonin has a significant effect on mood spectrum disorders such as bipolar disorder (BD), major depressive disorder (MDD), and seasonal affective disorder (SAD), all of which have been observed to occur because of a dysregulation of the diffuse melatonin secretion as well as dysregulation of the circadian rhythm (1). Out of all of the melatonin-affected disorders, only a lens will be placed on seasonal affective disorder (SAD) for the time being for the sake of specificity.

SAD, also know as winter depression, affects up to 10% of individuals who live at temperate latitudes and is characterized by depressive periods that occur during times of limited light exposure, which usually occurs during the fall and winter seasons (1, 2). Key symptoms will develop alongside depression that help characterize the disorder, which include lethargy, sadness, fatigue, and a craving for carbohydrates (1). Melatonin levels, along with the timings of

secretions, are commonly used markers to identify SAD in patients, as those are both significantly different compared those with more normal levels (6). These levels and timings can either be measured via the patient's plasma or saliva. Those with SAD are largely impacted by phase delays or shifts, that essentially pushes back and changes when melatonin is secreted, its duration, as well as its offset (4, 6).

The phase shift hypothesis (PSH) states that SAD's most effective antidepressant treatment is through bright light exposure in the morning. However, there is not enough evidence to support light exposure provides treatment in the evenings (5). Therapeutic use of light therapy and antidepressant medication has been rationalized as a proper treatment for mood disorders that include seasonal affective disorder (1, 2, 5). In a study performed by Alfred Lewy observed that patients with SAD who had been administered low doses of melatonin in the afternoon reported having significantly less depressive symptoms compared to those receiving a placebo (4).

In a similar study, Sami Leppämäki, et al., specifically studied melatonin's role on sleep, waking up, and the overall well-being of those who were afflicted with weather-associated depressive symptoms. Patients in the study had received either melatonin or a placebo before they went bed for three weeks, having their salivary melatonin levels tested early the next morning along in comparison to changes in their baseline levels. They found that patients who had received melatonin had significant improvement in their quality of sleep, as well as vitality. However, they did not see such improvement towards the more "atypical symptoms" which included their overall well-being (3).

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1. De Berardis D, Orsolini L, Serroni N, Girinelli G, Iasevoli F, Tomasetti C, . . . Di Giannantonio M. The role of melatonin in mood disorders. ChronoPhysiology and Therapy, Volume 5 65-65, 2015.
2. Howland RH. An overview of seasonal affective disorder and its treatment options. Phys Sportsmed 37:104–115, 2009.
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Sample 2: 250-word essay

Melatonin: Biological Mechanisms and its Effects on Mood Disorders

Melatonin is a hormone primarily secreted by the pineal gland that regulates the timing of endogenous circadian rhythms (2). Its levels peak at night and are inhibited due to daylight, influencing a normal sleep-wake schedule for diurnal mammals (6). Melatonin targets many tissues in the body, including the hippocampus, liver, and blood vessels. The receptors found on these target tissues are G protein-coupled receptors (GPCRs), named MT1 and MT2 (1). It was found that the overall formation of homodimers or MT1/MT2 heterodimers are relatively equal, containing functional binding sites and inducing conformational changes. The G proteins activated by melatonin binding are primarily pertussis toxin-sensitive G proteins, which inhibit the forskolin-stimulated cAMP-PKA pathway (7). Inhibition of cAMP, PKA and CREB is critical during the sleep phase of circadian rhythms.

Understanding the biology of melatonin is important due to the clinical aspects it carries, such as its effect on mood spectrum disorders including bipolar disorder, major depressive disorder, and seasonal affective disorder (SAD) (2). These been observed to occur due to dysregulation of melatonin secretion affecting their circadian rhythms. Melatonin, alongside light therapy and antidepressants have been an effective treatment for these disorders (3). Alfred Lewy, et al., observed that patients with SAD who had been administered low doses of melatonin in the afternoon reported significantly less depressive symptoms compared to a placebo (5). More research is needed to understand the interactions between melatonin and antidepressants in the treatment of sleep disturbances due to mood disorders (4).

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Sample 2: Poster

Melatonin Agonist as Treatment for Insomnia

Endocrinology - Stonehill College, 320 Washington St, North Easton MA 02357

Abstract

Insomnia is a condition that affects all age groups and around 30-50% of the general population. It is caused by decreased melatonin levels and MT_1/MT_2 receptor binding. One affected region is the suprachiasmatic nucleus (SCN), which plays a part in the body's circadian rhythm. Our study determined that using a melatonin agonist with a higher affinity for MT_1/MT_2 receptors, such as ramelteon, significantly decreased cAMP levels in the SCN, as well as increased total time asleep in insomniac mice. Potent melatonin agonists may be preferable over melatonin itself for the treatment of insomnia.

Introduction

- Melatonin is released by the pineal gland to induce sleep during the sleep/wake cycle.[1]
- Melatonin binds a G protein, which inhibits the cAMP pathway, decreasing levels of cAMP, PKA and CREB as in Figure 1.[2]
- The suprachiasmatic nucleus (SCN) of the hypothalamus expresses the MT_1/MT_2 receptors and has an effect on circadian rhythms.[3]
- Insomnia is a common disorder affecting all ages, which is treated with physiological level melatonin supplements.[4]
- Ramelteon (agonist) has a very high affinity for MT_1/MT_2 receptors compared to melatonin.[5]
- Ramelteon has been shown to be a treatment for insomnia.[6]
- Mice strain DBA/2J expresses insomnia-like sleep disorder by experiencing more time awake.[7]

Figure 1. Melatonin signaling cascade

Hypothesis

The agonist will significantly decrease levels of cAMP in the SCN and increase hours of sleep compared to melatonin and control.

Methods

- 24 adult male DBA/2J strain mice were separated into 3 groups of 8: Control, Melatonin, and Agonist.
- EEG/EMG data recording electrodes were placed in the head of each mouse and data was recorded for average hours of sleep in a 24 hour day over days 1-7.
- 100 pg of vehicle control, melatonin or agonist were injected into the SCN one hour before established bedtime over days 8-14. Average hours of sleep per 24 hour day was recorded via electrodes.
- Mice were euthanized, SCN extracted, and cells lysed. A Bradford assay determined total protein content for each sample. Western blot was performed with an anti-cAMP antibody and analyzed with ImageJ.
- Behavioral data were statistically analyzed by 2-way ANOVA and Post hoc Tukey's test, and cAMP levels were analyzed by 1-way ANOVA and Post hoc Tukey's test.

Results

Figure 2. Agonist and melatonin increases average hours of sleep

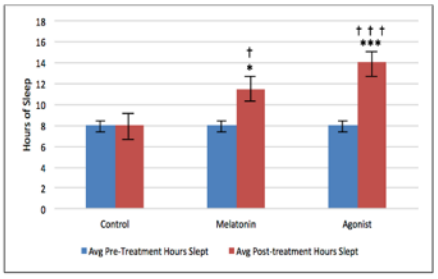

Fig 2. Average hours of sleep per night over 7 nights pre-treatment (blue), and post-treatment (red). Treatment with melatonin and the agonist induced significantly more hours of sleep in comparison to the control. The agonist also significantly increased hours of sleep compared to melatonin.

* p<0.05, *** p<0.001, different from control post-treatment. †p<0.05, † † †p<0.001, different from pre-treatment in same group.

Figure 3. Agonist and melatonin decreases SCN cAMP level

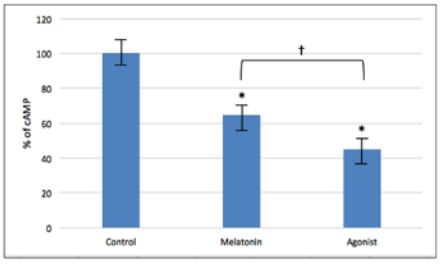

Fig 3. Treatment with melatonin and agonist significantly decreased levels of cAMP in mice SCN after 7 days of treatment. The agonist decreased cAMP more significantly than melatonin alone.

* p<0.05, different from control post-treatment.
†p<0.05, different from one another.

Discussion

- Post-treatment cAMP levels in the SCN of insomniac mice were significantly decreased when given 100 pg of agonist compared to melatonin or vehicle control.
- The agonist significantly increased the number of hours slept in insomniac mice compared to those who received melatonin or a vehicle control as expected.
- The agonist was more effective than melatonin.
- Using a melatonin agonist that has a higher affinity for MT_1/MT_2 receptors may be preferable over current melatonin treatment for the management of insomnia.

Future Directions

- All mice survived treatment, but study of long-term side effects is necessary for successful use of the drug for insomnia treatment.
- Use an siRNA knockdown of cAMP and measure hours of sleep to determine if the decrease in cAMP is what regulates sleep.
- Examine whether anti-depressants have interactions with melatonin agonists.

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