Christopher Keim
PSYS 053
Professor Falls
6/27/15

Running head: Acute Laughter Increases BDNF in Adult Humans

Acute Laughter Increases Immediate Bloodstream BDNF Levels in Adult Humans[1]

Abstract[2]

Laughter is largely considered to favorably influence learning and memory, though there is little understanding as to why or how it does so at the neuronal level. We hypothesized that in the context of an episodic memory task, laughter would increase bloodstream brain-derived neurotrophic factor levels in adult humans. The study involved 50 adults, 25 female and 25 male (age: 25-35). Participants were trained in a serial episodic memory task and either exposed to a video of humans laughing (elicited laughter: 100%) or a control. Bloodstream BDNF levels were taken before training and post video manipulation. Participants in the laughter group showed significantly increased BDNF bloodstream levels. It was also shown that the duration of time spent laughing significantly influenced BDNF bloodstream levels. This study provides a potential physiological explanation for the favorable influence laughter has been shown to have on learning and memory and provides foundation for future research on laughter's effect on the nervous system.

[1] The title gives a clear idea of the variables that were being tested in the experiment and the results that were found. You will also note that there is a 'running head,' which is a shortened version of the title, stated explicitly on the title page and then headed on each page of the report.
[2] The abstract summarizes the entire report concisely and completely. It carries enough important information from each section that another psychologist could walk away understanding the experiment without reading the entire report.

Introduction

It's widely accepted that laughter is beneficial for both physical and mental health in humans. Laughter has also been widely associated with improved learning and memory in humans, though there is some nuance as to exactly why.[3] Behaviorally, laughter has been connected with better semantic memory (Schmidt, 1994; Carlson, 2011), episodic memory (Carlson, 2011; Chambers & Payne, 2014), and attention capture (Strick et al., 2010). Additionally it has been shown to favorably influence episodic memory consolidation (Chambers & Payne, 2014).[4] Work involving how laughing affects the nervous system at the neuronal level is sparse; there is little literature on how laughter affects hippocampal health specifically.[5] Physiologically laughter has been shown to increase heart rate and the delivery of endorphins (Cousins, 1979), presumably other blood born chemicals, and has been shown to directly regulate gene expression (Hayashi et al., 2006) though the regulation is not well understood.

The purpose of the current experiment is to investigate if laughing regulates bloodstream concentration of brain-derived neurotrophic factor, and consequently hippocampal neurogenesis.[6] BDNF is widely associated with hippocampal health, neurogenesis, and healthy memory in humans. Very specifically BDNF has been shown to facilitate hippocampal synapse plasticity (Lu et al., 2013) suggesting that it plays a vital role in human learning and memory. If laughing regulates BDNF bloodstream concentration it can be used as a cheap and ready treatment for memory decline. The results can also be used in learning theory and learning

---

[3] These introduction sentences provide a broad statement about where our current knowledge of the topic stands in the field.
[4] This summary of previous research paints a specific picture of work that has been on the topic and provides a solid grounding for the experiment to stand on.
[5] Importantly, this work has been limited in its scope - this experiment aims to address questions that the field up to now has left untouched.
[6] The purpose of the experiment is plainly stated and includes the variables being tested.

programs. If the hypothesis is supported, it opens the door for research into how laughter regulates expression of BDNF genetically or epigenetically.[7]

We hypothesize that paired with an episodic learning task, acute laughter should increase immediate BDNF bloodstream levels in adult humans.[8] Laughter will be measured as vocal output and rhythmic contractions of the diaphragm. BDNF will be measured as BDNF bloodstream concentration compared to baseline.[9] Experimental groups will be exposed to both auditory and visual stimuli of human laughter (i.e. a video of humans laughing) after training and prior to the episodic learning task. Their responses to the video will be recorded, including laughter intensity and pitch and body language, and coded. Chronic laughter in the context of an episodic learning experiment should increase overall hippocampal neurogenesis in adult humans compared to the control.

Methods[10]

Participants[11]

The participants in the study were 50 healthy adults (ages 25-35) obtained through an ad in the newspaper. 25 were female. All were informed of the nature of the experiment and gave full written consent. Participants were randomly assigned to be in the laughter and no laughter groups. All participants volunteered to be in the study.

---

[7] These sentences explain how the experiment is useful and worthwhile.
[8] The hypothesis is clearly and concisely stated and includes the independent and dependent variables.
[9] The independent variable and the dependent variable are operationalized – meaning that they are translated into physical things that a psychologist can measure consistently.
[10] This section is clearly labeled and is broken up into a 'Participants,' 'Materials,' and 'Procedure' section. The entire section is written in past tense and includes enough information to allow another psychologist repeat the experiment step-for-step.
[11] How the participants were obtained, pertinent background information (like sex), informed consent, how experimental groups were assigned, and how the participants were compensated (or not compensated) is included.

Materials[12]

The memory test was an episodic serial memory task. 50 simple pictures . . . [sentences omitted] . . .

Participants were trained and tested in a room equipped with video and microphone . . . Laughter was induced in the experimental group by having the participants watch 3 minutes of a video including both auditory and visual stimuli of humans laughing. The video can be found here: . . . [omitted] . . . The control group watched 3 minutes of a video of humans pronouncing non-sense words.[13] Laughter was defined as vocal output and rhythmic contractions of the diaphragm and was analyzed based on the participant's loudness and pitch and body language for its authenticity.[14] The total duration of time that the participant spent laughing was also recorded on a stop watch in real time and on video.

Blood was immediately frozen until analysis. BDNF concentration was measured by . . . [company brand] . . . Assay System (Company Name, City, State, Country) according to the manufacturer's instruction.[15]

Procedure[16]

Blood was taken prior to any interaction with the experiment design for the baseline BDNF blood concentration measure. All participants came into the lab and received training in the episodic memory task . . . [sentences omitted] . . .

---

[12] This subsection contains the exact tools that were used to complete the experiment.
[13] Both the experimental group and the control group's treatment are explained.
[14] The exact, operationalized definition of the dependent variable is clearly stated.
[15] Experimental tools that were bought or created by someone else are always cited with information about the company that made them. The way that the experimenter used the tool is explicitly stated.
[16] This subsection provides a step for step rundown of how the experiment was performed, from the moment the participant walked into the lab to how the data was analyzed.

Results[17]

Laughter significantly increased bloodstream levels of BDNF compared to the control group (Fig 1).[18] Average baseline bloodstream BDNF levels between all participants were 15 ng/mL (SD: 0.085).[19] The mean BDNF level in the control group at post video was 15.1 ng/mL (SD: 0.09) while the mean BDNF level in the laughter group was 15.7 ng/mL (SD: 0.13).

The laughter group averaged a better score on the episodic memory test than the control group, though the difference was not statistically significant (Fig 2). Average episodic memory test score at post video for the control group was 14.5/20 (SD: 2.5), while the laughter group averaged 16.1/20 (SD: 2.5) . . . [sentences/graphs omitted] . . .

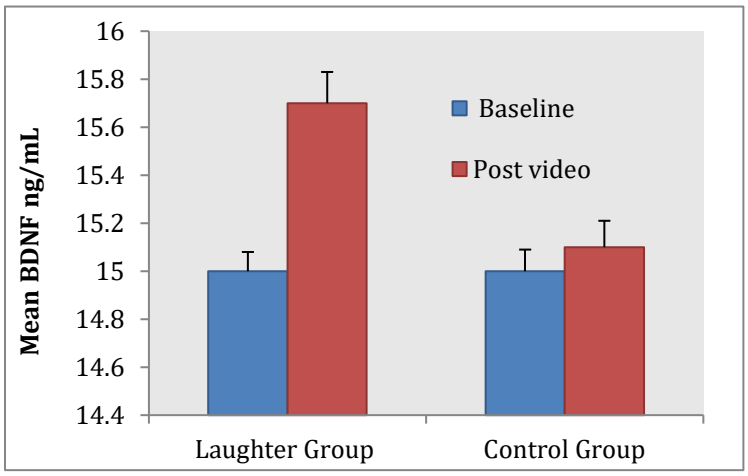

Fig. 1. Mean BDNF (ng/mL) bloodstream levels in the laughter group and the control at baseline and post video.

[17] This section presents the raw results of the experiment in a clear manner, saving any interpretation, outside of data manipulation, for the discussion section.
[18] Data collected is shown graphically/visually and is referenced in the text. The x and y axes are labeled correctly and the graph is scaled appropriately. The graph contains a subtitle that explains the data in sufficient detail.
[19] All data manipulation is stated explicitly.

The laughter group also averaged a significantly higher heart rate than the control group at post video and pre episodic memory test.

Discussion[20]

Laughter in the context of an episodic learning task significantly increased immediate BDNF bloodstream levels in adult humans compared to a control.[21] The increase was accompanied by slightly better scores on the post manipulation episodic memory test and significantly higher heart rates at measurement. The duration of the laughter significantly influenced BDNF bloodstream levels within the laughing group, while the intensity of the laughter did not show any significant effect.[22]

BDNF is thought to facilitate hippocampal synapse neuroplasticity (Lu et al., 2013) and increased bloodstream BDNF may be a potential explanation for the favorable influence laughter has been shown to have on semantic (Schmidt, 1994; Carlson, 2011) and episodic (Carlson, 2011; Chambers & Payne, 2014) memory.[23] Very importantly laughter increases heart rate and consequently the delivery speed of any chemicals that are blood born. There may be other chemicals that favorably influence hippocampal health that are directly moderated by laughter or are delivered faster by laughter's influence on heart rate.[24]

This study is limited in that a small age group was used and that laughter was only tested for its effects immediately after being done. BDNF is widely associated with hippocampal neurogenesis, and it follows that chronic laughter in the context of a memory task should lead to

---

[20] Now it is time to interpret the results of the experiment. This section incorporates the findings into the broader sense of the research that has been done up until now.
[21] The evidence of the experiment supported the hypothesis.
[22] The results are briefly restated in the context of the hypothesis.
[23] The explanation of the results references our current understanding in the field.
[24] An alternative potential explanation for the results is given – it could be that laughter increased other brain-born chemicals.

increased hippocampal neurogenesis. The current study provides a necessary stepping-stone for research involving chronic laughter's effect on hippocampal neurogenesis and health. It is also not possible to determine within this experiment if the effects observed were caused by the subject's own laughter or by their having observed another person laughing. Research involving non-human stimuli to evoke laughter may be able to dissociate these variables.[25]

It has been shown that laughter directly influences gene expression (Hayashi et al., 2006) and research directed towards if and how laughter moderates the expression of BDNF and BDNF related genes would have wide reaching clinical and scientific implications.[26]

[25] The limitations of this experiment are put forward clearly.
[26] In closing, possible paths for further research are suggested.

References[27]

Carlson, K. A. (2011). The impact of humor on memory: Is the humor effect about humor?. *Humor: International Journal Of Humor Research*,*24*(1), 21-41. doi:10.1515/HUMR.2011.002

Chambers, A. M., & Payne, J. D. (2014). Laugh yourself to sleep: Memory consolidation for humorous information. *Experimental Brain Research, 232*(5), 1415-1427. doi:http://dx.doi.org/10.1007/s00221-013-3779-7

Cousins, N. (1979). Anatomy of an illness, New York: W.W.Norton

Hayashi, T., Urayama, O., Kawai, K., Hayashi, K., lwanaga, S., Ohta, M.Murakami, K. (2006). Laughter regulates gene expression in patients with type 2 diabetes. *Psychotherapy and Psychosomatics, 75*(1), 62-65. doi:http://dx.doi.org/10.1159/000089228

Lu B, Nagappan G, Guan X, Nathan PJ, Wren P. BDNF-based synaptic repair as a disease-modifying strategy for neurodegenerative diseases. *Nat Rev Neurosci*. 2013 Jun;14(6):401-16.PubMed.

Schmidt, S. R. (1994). Effects of humor on sentence memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(4), 953-967. doi:http://dx.doi.org/10.1037/0278-7393.20.4.953

Strick, M., Holland, R. W., van Baaren, R., & van Knippenberg, A. (2010). Humor in the eye tracker: Attention capture and distraction from context cues. *The Journal of General Psychology, 137*(1), 37-48.

[27] This list of references is formatted in APA style and includes all of the sources cited in the report.