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RESEARCH ARTICLE

Human Mental Intentionality on the Aesthetics of Cooked Rice and *Escherichia coli* Growth

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Abstract—This study examines the "intentionality hypothesis"—i.e. subjects' ability to mentally influence microbial growth in samples of cooked rice. Over a 30-day period (under triple-blind conditions), subjects focused their positive and negative thoughts ('mental intentionality') toward three randomly formed groups of cooked rice samples (positive intentionality, negative intentionality, and a control group). After 30 days, pictures were taken of the nine rice samples (three groups, each group was conducted in triplicate), which were then judged for visual aesthetic value. Findings show aesthetic ratings of 'positive' rice samples to be significantly higher than those for 'negative' and 'control' ones ($p \leq 0.05$), with no significant difference between negative and control sample ratings ($p \geq 0.05$). A further test entailed a 7-day study measuring an *Escherichia coli* strain (a type of coliform that is closely associated with food safety, whose presence often indicates food poisoning and spoilage) in vitro under the same conditions of stimuli as the rice samples. Results show positive intention to be associated with lower *E. coli* division rate when compared with the "control" and "negative intention" groups, thereby further supporting the hypothesis, as well as suggesting an emerging inference, that intentionality might be associated with microbial growth and visual aesthetic ratings.

Introduction

This paper examines what is often referred to as the 'intentionality hypothesis', a view of physical reality in which the physical environment—be it macroscopic or microscopic—can be directly impacted by a researcher's mental intent ('mental intentionality') toward specific situational variables. Although considered rather outré by mainstream research psychologists, the intentionality hypothesis has been a focus of sustained study for more than 50 years. General findings suggest that an observer's mental intentionality does seem to possess the ability to subtly impact both living and non-living elements of the immediate physical environment (Radin & Nelson 2003).

The effects of intentionality toward non-living systems has been a topic of particular interest over the past few decades. For example, meta-analytic studies examining more than 500 relevant studies have convincingly concluded that human mental intentionality is capable of affecting the 'random' generation of digital bytes by computer microprocessors (Radin & Nelson 2003, Radin 2006).

In contrast, research examining the impact of mental intentionality upon living systems is considerably more limited. There do exist, however, a number of studies that examine this topic. For example, Radin, Taft, and Yount (2004) demonstrated the impact of mental intentionality upon human brain cell growth and healing. Similarly, Roney-Dougal and Solfvin (2002) demonstrated the effect of mental intentionality upon plant growth, while Verma and Pandey (2014) extended these findings to other areas of agricultural science.

Obviously, these types of findings need to be interpreted with a high degree of caution. Nonetheless, the overall pattern of results is quite intriguing, potentially suggesting a range of practical applications. As just one example, Radin, Taft, and Yount (2004) observed that mental intentionality can positively impact the growth and development of human brain cells, implying obvious therapeutic implications from intention for the rehabilitation of brain-damaged individuals.

While many studies demonstrate the effect of mental intentionality upon the immediate external environment, not all find similar patterns of results. For example, Lenington (1979) studied the growth patterns of plants irrigated with 'spiritually' treated water and those irrigated with tap water, but found no significant difference between the growth patterns of the two groups.

However, more recent studies tend to be more supportive of the intentionality hypothesis. For example, triple-blind studies reported by Emoto (2004) and Radin et al. (2008) reported that when water molecules were subjected to positive mental intentionality, their solid state (i.e. ice and snow) tended to be perceived as more aesthetic than molecules subjected to negative mental intentionality. Other recent studies have demonstrated the role of mental intentionality in the 'random' evolution of quantum wave functions (Radin 2006, Pitkanen, 2017).

Cited studies notwithstanding, the effects of mental intentionality upon living systems (particularly at the microscopic level) is clearly an area of study calling for further investigation. Of particular concern is the limited number of (successful) replication studies that have been conducted to date. This paucity of research is due to a number of factors, including practical difficulties in the replication of previously employed subject-selection and condition-assignment procedures, as well as the high cost and general impracticality often associated with reliability-oriented research.

For example, the replication of previous work demonstrating the effect of mental intentionality upon solid-state water molecules (i.e. snow and ice) requires researchers to judge which solid-state samples are sufficiently 'crystallized', in addition to obtaining access to a shielded research chamber and a room-sized freezer unit (Radin et al. 2006).

Random number experiments (RNE) have been considered repeatedly as a low-cost alternative in the study of mental intentionality (Radin & Nelson 2003, Radin 2006). In addition to low cost, these types of studies possess the decided virtue of minimizing, if not completely eliminating, issues regarding randomized subject selection and condition assignment. Despite being an economical model, RNE studies do not provide information regarding the interaction of mental intentionality and the behavior of microscopic living systems. However, they stimulated the idea of conducting this study at a low-cost level.

Intentionality and Micro-Organisms: Literature, Framework, and Concerns

This study aimed at testing the intentionality hypothesis on microbial growth and development. It was configured with a two-pronged approach. Firstly, the study was set up with triple-blind conditions, aimed at controlling biased sampling and the experimenter's subjective expectations—for and with both subjective and biological measures. In particular, the subjective measure was to test the "intentionality hypothesis" based on subjects' aesthetic perceptions of cooked rice samples, while the biological measure was based on bacterial samples aimed at testing the intentionality hypothesis further as well as helping to interpret the overall dataset. That said, the former examined cooked-rice cultures in terms of microbial growth and community, and the latter the microbial growth rate of a single species of bacteria (i.e. *Escherichia coli*) but in non-rice conditions. Secondly, the entire study served as a “cost-friendly” model, requiring simple and inexpensive equipment while enabling researchers to explore the principal interest in living system contexts, thereby strengthening the reproducibility of testing the “intentionality hypothesis.”

Regarding the effects of intentionality upon micro-organisms, the literature is scarce. However, a number of studies are available for reference. Despite the different species of micro-organisms involved, all the studies began with the protocol of using a single species of micro-organism as the target medium for testing the intentionality hypothesis. They also postulated that the effects of intentionality could be indicated by the density of micro-organisms (e.g., cell division rates) after being treated in different conditions. Thus, they act to provide a framework for this study. First of all, Barry (1968) reported that after ten subjects concentrated on 194 fungal cultures at a proximal distance, the growth of fungi was inhibited. Likewise, Tedder and Monty (1981) replicated the study but having the subjects concentrate on some fungal cultures at a distance of up to 15 miles. The results also showed the growth of the cultures being inhibited over sixteen of sixteen trials. Intentionality has also been found not purely in association with an inhibitive outcome. For example, Haraldsson and Thorsteinsson (1973) demonstrated that a group of health-related professionals managed to significantly increase the growth of yeast in 120 test tubes with their mental intent when compared with the controls ($p < 0.00014$) (i.e. no mental intent). Additionally, studies on mental intentionality have reported the likelihood that the behavior of microscopic systems could be inhibited or promoted. Nash (1982, 1984), for instance, showed that human intent seemed to be able to increase or decrease *E. coli*’s mutation rate to utilize lactose from “lactose negative” to “lactose positive.” Put simply, the bacteria were able to mutate in all desired directions. Based on these studies, a part of this experiment that focused on biological measures adopted the protocol of using a single species of micro-organism (i.e. *E. coli*) as the target element and its growth response under different conditions of mental intentionality.

Biological measures provide a more objective way of studying the intentionality hypothesis; however, it is yet to suffice for interpreting the subjective results. To this end, this study takes the further step of creating another piece in addition to the biological measure. In general terms, it attempts to study how far aesthetic perception could be associated with the effects of mental intentionality on microbial development. Moreover, it used highly economical types of samples as the culture medium for microbial development: cooked rice and *E. coli*. This study is of high significance, not only because it may provide valuable information about aesthetic perception and microbial growth, but also because it provides researchers with not only a low-cost approach but also a low-technology-to-acquire vehicle for studying the intentionality hypothesis.

Methods

Subjective Measure (Visual Aesthetic Study)

Subjects. The 62 subjects employed in this study were first-year students (aged 18 to 20) attending a liberal arts, four-year college located in mainland China. Students were members of a college-mandated course, and they received partial course credit in return for their participation in the study.

Materials and Stimuli Preparation. The (primary) materials used in this study include nine glass Petri dishes (100 mm × 15 mm), an electric rice cooker, an incubator, a digital camera, a slide projector, and rice. Prior to the cooking process, the rice and all dish materials were thoroughly cleansed with pure water. The Petri dishes were further prepared by autoclaving at 121 °C for 15 minutes. The rice was first cooked in the electric rice cooker at 100 °C and allowed to cool to room temperature. 60 grams of cooked rice was then placed in each Petri dish, which was immediately covered with a glass lid and sealed with parafilm. The Petri dishes were then stored for 30 days in the incubator, set at 27.5 °C.

Procedure. The nine closed and parafilm-sealed Petri dishes (each containing 60 grams of cooked rice) were randomly assigned to one of three experimental conditions: 'positive intentionality', 'negative intentionality', or 'non-intentionality' (i.e. the control condition). According to Schlitz et al. (2003), intentionality is defined as "*an attribute of a conscious and willful action* . . ." or *". . . a property of objective actions* . . ."

For 30 consecutive days at 10 a.m., the positive intentionality Petri dishes were removed from the incubator and placed on a work bench located in a research laboratory disinfected with 70% alcohol. The primary investigator spent three minutes verbally conveying positive intentionality (i.e. words and phrases of admiration, compliments, approval, etc.) toward these rice samples, captured an individual digital image of each sample, and returned the samples to the incubator. Of note, verbalization of the intentionality functioned as a mediation tool, or a technique employed to promote the investigator's consciousness, willfulness, and awareness while performing the action that would lead to more desirable or objective results. For the negative and non-intentionality samples, the procedure was identical, except the three minutes of verbally conveyed intentionality was either negative in nature (i.e. words and phrases of contempt, reprimand, disapproval, etc.), or the investigator simply remained silent with no intentionality given to the control rice samples.

Following the 30-day incubation period, the rice samples were removed from the Petri dishes. Two digital images of each rice sample (presented against an off-white backdrop; see Appendix 1), one on each side (top and bottom), were created and copied onto projector slides.

Subjects' aesthetic ratings of the 18 projector slide images of cooked rice served as the dependent variable for this study. To minimize error variance (e.g., experimenter/subject biases), the primary investigator had no direct contact with the research assistant who actually collected the aesthetic ratings. Similarly, neither the research assistant nor the subjects were informed of the 'intentionality' component of the study. All subjects were tested in a single session, and were instructed to make their judgments independently from those of the other subjects. A total of 62 subjects participated in the aesthetic rating study.

Each of the 18 slide images of cooked rice was presented randomly for 10 seconds. During each presentation period, subjects used a Likert scale (ranging from 0 to 4, with 0 = 'Not Aesthetic', and 4 = 'Very Aesthetic') to rate that image's aesthetic appeal. Following this rating process, subjects were thanked for their participation, completely debriefed, and escorted out of the research lab.

Objective Measure (Biological Study as the Follow-Up Protocol)

In this follow-up experiment, *Escherichia coli* (*E. coli*) was cultured in nutrient broth (dissolving 5 g peptone and 3 g meat extract in 1 L dd H_2O, pH 7, autoclaved at 125 °C for 20 minutes prior use) under different intentions: (i) positive intention (subject to 3 minutes of positive intention daily—praising words); (ii) negative intention (subject to 3 minutes of negative intention daily—mean and hateful words); and (iii) no intention (control group) for 7 days. Approximately 20,000 *E. coli* cells were inoculated into sterilized flasks, each containing 20 ml of sterilized nutrient broth, at day 0 of the experiment. A blank was included in this experiment in which the culture flasks contained only nutrient broth with no *E. coli*. The amount of *E. coli* in each culture flask was counted daily using a hemacytometer for a period of 7 days. All cultures were kept at 27.5 °C throughout the experiment. Due to the following constraining circumstances, this experiment had a duration of only 7 days (rather than 30 days as with the rice samples):

1) *E. coli* were grown in batch culture (i.e. there was no continuous input of nutrients and no removal of wastes and toxins secreted by *E. coli* cells).

2) A typical close batch culture tends to reach maximum cell density in one week and the cells begin to die off soon after due to lack of nutrients and to the buildup of toxic substances.

Statistical Analysis

One-way analysis of variance (ANOVA) was used to test the null hypothesis that intention did not cause significant changes for the aesthetic score. Two-way ANOVA was used to test the null hypotheses that (i) intention did not cause significant changes in *E. coli* growth at each time interval measured within the 7-day incubation period; and (ii) *E. coli* cell density did not change over time within the same treatment group. A significant difference was detected with $p \leq 0.05$. Statistics were performed using the statistical software SigmaPlot 12.5 (Systat, USA) with graphs plotted with GraphPad Prism 7 (GraphPad Software, USA).

Further Remarks about Six Concerns

To introduce the protocols for both measurements more clearly, there is a need to specify six specific concerns:

1) Rice samples in this study got only subjective aesthetic perception ratings. Using them for tracing microbial growth within the experimental period not only would have contaminated them irreversibly, but also would have projected other intentions onto the rice samples, hence affecting the perception results.

2) Biological measures of the rice samples at the end of the experimental period were considered. If done, that would rather have examined the microbial communities in the rice samples. However, this study postulates as others have (e.g., Barry 1968, Haraldsson & Thorsteinsson 1973, Nash 1984) that the rate of microbial growth in terms of cell division was the target of mental intentionality. That said, the identification and characterization of different microbial species in the rice samples are worthy of further investigation since the aesthetics of the cooked rice samples could be associated with different species of microorganisms present.

3) Studying a single species of bacterium in vitro allows the data to be collected and reported with some credibility. In particular, we aimed to prevent the experimenter from creating the "file-drawer" issue in which only positive or desirable effect sizes in the context of bacterial variety—if cooked rice samples were used—were reported. To avoid overestimates or underestimates of effect sizes of microbial cell division, a mono-species of cell cultures was thus employed in vitro (rather than in the rice cultures) as the key element of the followup protocol.

Figure 1. Figures 1a, 1b, and 1c show the growth of microorganisms in positive, negative, and control rice in selected samples, respectively, after 30 days of incubation at 27.5 °C.

4) *E. coli* was chosen as the test species in this study as its presence in food and drinks increases the risks of food poisoning (and death in serious cases). To ensure public safety, the presence of *E. coli* in food and drinking water is closely monitored by the USFDA and the EPA (U.S. Food and Drug Administration 1998, U.S. Environmental Protection Agency 2009) and many other governmental bodies around the world.

5) Whether evidence could be drawn from one to another, namely biological to subjective or vice versa, was a big concern. This issue has been addressed by adopting a "two-way interpretation"—i.e. by interpreting the subjective and biological measures both together and separately. This two-way system allows interpretation of data not purely for the sake of making any inferences from one to another but, as mentioned, also providing a gateway for testing the intentionality hypothesis further.

6) All experiments using these or similar procedures, either biological or not, have been reported in this paper.

Results

Subjective Measure Findings

Microbial growth was observed in all nine rice samples after 30 days of incubation, with/without positive and negative intention (see Figure 1).

The Brown-Forsythe test of variance homogeneity shows that the current dataset contains statistically significant non-equivalent error variances among the three experimental conditions ($p < 0.05$). Because of this, the non-parametric Kruskal-Wallis one-way analysis of variance of sample medians was used to interpret the data, as compared with the more traditional, parametric-bound, one-way analysis of variance of sample means (see Appendix 2).

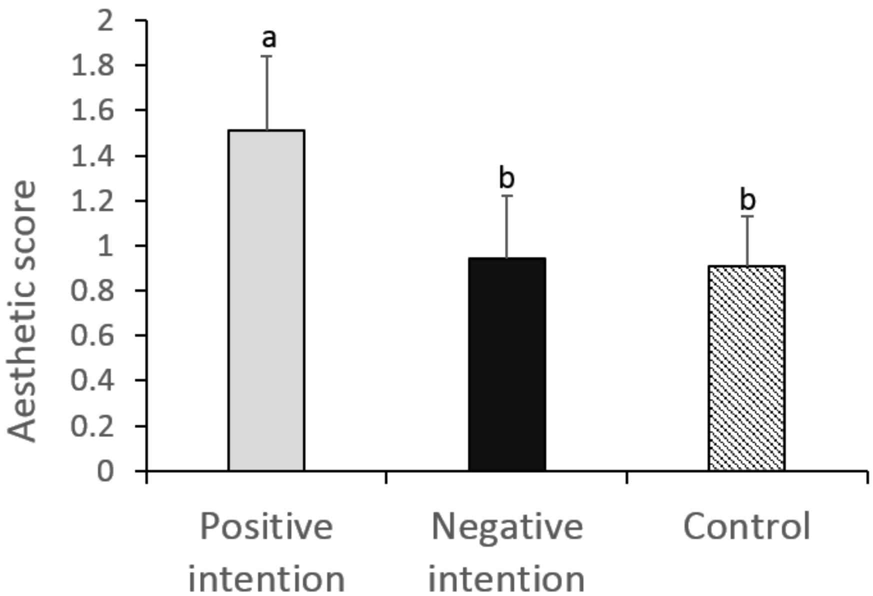

Figure 2. Average scores of aesthetics perceived for all images of rice. Different treatment groups marked with the same letter are not significantly different from one another (*p* ≥ 0.05); treatment groups marked with different letters are significantly different from one another (*p* ≤ 0.05). Data are expressed as mean ± S.E.M.

The initial analysis of variance shows a statistically significant overall test statistic; H(2) = 32.12, $p \leq 0.05$, indicating one or more significant differences between average aesthetic ratings for the three different groups (i.e. positive, negative, and non-intentionality) of cooked rice cultures. A Student-Newman-Keuls post hoc multiple comparison test specifies that the average aesthetic rating for the positive intentionality rice cultures is significantly higher than those obtained for the negative and non-intentionality cultures (Figure 2). No significant difference was found for the aesthetic ratings between the negative and non-intentionality rice cultures.

Biological Measure Findings

Two-way parametric ANOVA was performed to investigate if different intentions caused significant differences in *E. coli* growth in batch culture (Figure 3 and Appendix 3). After incubation for 24 h at 25 °C, *E. coli* cell

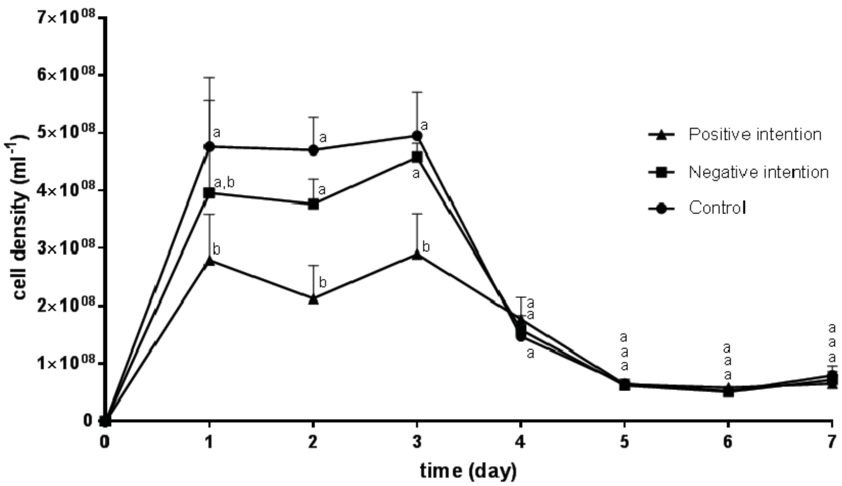

Figure 3. Growth of E. coli in batched culture under different intentions for 7 days. Within each time interval, different treatment groups marked with the same letter are not significantly different from one another (*p* ≥ 0.05); treatment groups within the same time interval marked with different letters are significantly different from one another (*p* ≤ 0.05). Data are expressed as mean ± S.E.M.

density (cell/ml) was significantly higher in the "control" group than that of the "positive intention" group ($p \leq 0.05$). At day 2 and 3 of the incubation period, significantly higher cell density was observed in both the "control" and "negative intention" groups when compared with the "positive intention" group ($p \leq 0.05$). Cell density among all three groups ("control," "negative," and "positive" intention groups) declined significantly at day 4 of the study, mainly resulting from the build-up of toxins and the run-out of nutrients in the culture medium. No cell was observed in the blank group throughout the experimental period.

Discussion

Searching the Internet, one can find sites touting accounts of an interesting nature with regard to the use of rice claimed to be intentionally treated. While this interest in testing the intention hypothesis is thought to be anecdotal or not abiding by rules of science, our study tapped into this interest and found that there seems to be a plausible relationship between microbial growth patterns and intentions, i.e. human intentions may inherently affect microbial growth and populations. In this study, the aesthetic ratings for the 'positive' rice group is higher than for the 'negative' and control ones. Seeing the differences, we continued with a follow-up study, which shows that the positive intentionality lowered the growth rate of *E. coli* in that group compared with those of the negative and control groups. That said, it provides some hints on the rice sample study that the higher aesthetic rating of the 'positive' rice cultures might be associated with cell divisions (i.e. microbial changes) of harmful microbes inhibited by positive mental intentionality. However, since this inferential interpretation is based on the assumed premise that cell division modality was the target of mental intentionality, we have yet to examine the diversity of micro-organisms that would also affect the appearance (also known as the aesthetic score) of the 30-day cultured rice samples. As mentioned, this aspect of concern shall be the objective of future research.

More importantly, though, the subjective and biological findings could (or should) also be interpreted separately (i.e. not using the biological measure to make inferences to the subjective one). When interpreted in this way, both approaches separately support the intentional hypothesis in terms of perceived or actual differences. In other words, positive mental intentionality was associated with a higher perceived level of aesthetic ratings in the rice samples and a lower density of *E. coli* in vitro.

If the subjective and biological measures show emerging evidence to demonstrate mind–matter interactions—beyond chance, as indicated in the current study—then the discussions mentioned below are worthy of being explored.

First, it remains too soon to confirm that there has been any interaction between mind and matter simply based on this study. However, it contributes to the extant evidenced-based literature (Radin et al. 2008, Radin, Michel, & Delorme 2016, Pitkanen 2017) arguing that fewer data are found to deny the hypothesis under concern. In its wake, more research testing the hypothesis is warranted.

Second, the authors unexpectedly learned that the subjective and biological measure scores of the control groups, although not significantly different from the 'negative' groups, were the lowest. To recap, the two control groups were the ones treated without any intention, meaning that they were "ignored" at all times. It thus stimulated our thinking about whether being ignored is more detrimental than receiving contemptuous, reprimanding, and disapproval treatments. This result may relate to current studies in psychoimmunology, pointing out that the effects of intentionality on health are not merely from thinking positively or negatively but also from being ignored (which has the worst outcome).

Third, the influences of mental intentionality on cell growth, divisions, or microbial changes have been topics drawing some attention for research purposes. This study on rice and non-rice conditions seems to warrant more study—particularly for therapeutic concerns on two fronts:

1. *The mind–matter role of intentionality in terms of health*: Microbial changes or growth of micro-organisms are conditions of micro-living systems affecting health. In light of both subjective and biological findings as evidence, this study tends to support other mind–matter studies which involved micro-organisms such as fungi (Barry 1968, Haraldsson & Thorsteinsson 1973, Tedder & Monty 1981) and bacteria (Nash 1982, 1984), etc., thereby suggesting that therapeutic intention for controlling the growth of micro-organisms for health purposes deserves further attention.

2. *Impacts of intentionality*: Intentionality appears to be gaining its evidence-based stance regarding its possible impact on microbial modalities (at least from this study and others mentioned). As such, any research regarding human diseases due to micro-organisms might need to take intentionality into account since it might bring to light certain risk factors for subjects. Whether it should be taken into account also for therapeutic purposes needs further investigation.

Conclusion

This study presents findings that support the "intentionality hypothesis." In addition, it has demonstrated a low-cost and low-technology-to-acquire approach. It proves the point that testing the mental intention hypothesis in living systems contexts could be as inexpensive as the RNE model, and hopefully will thereby encourage more researchers to replicate the approach or to keep testing their interest in finding an approach that is replicable and reproducible.

Acknowledgments

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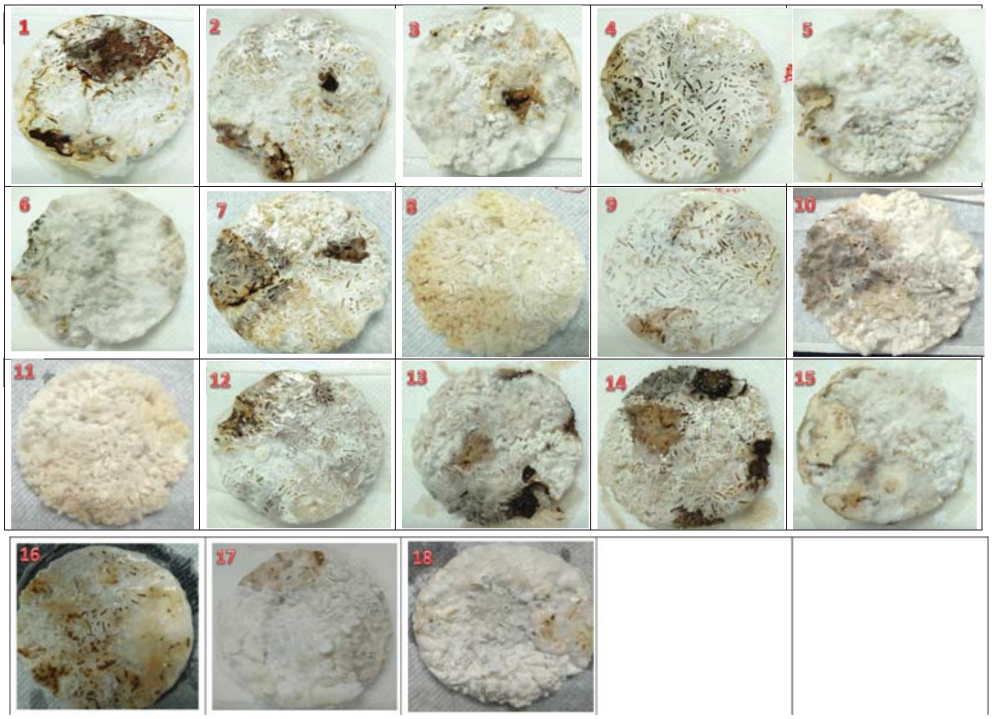
APPENDIX 1

SLIDES OF RICE SAMPLES AFTER REMOVAL FROM PETRI DISHES, USED FOR JUDGING OF AESTHETIC RATINGS BY SUBJECTS



Positive intention: Image numbers:	7, 8, 10, 11, 16, 18
Negative intention: Image numbers:	1, 4, 5, 6, 12, 15
Control "no" intention: Image numbers:	2, 3, 9, 13, 14, 17

Note: Each photo was projected onto the screen by a teaching assistant (who was not informed of the nature of the experiment), and each student had 10 seconds to score the image on a 5-point Likert scale (0 to 4). When rating, the judges independently and blindly assessed the images' overall aesthetic appeal, where 0 meant "not aesthetic" to 4 "very aesthetic."

APPENDIX 2

ONE-WAY ANOVA—RICE AESTHETICS SCORE

Result from Sigma Plot

One-Way Analysis of Variance October 09, 2017, 15:03:55
Data source: Data 1 in Rice experiment
Normality Test (Shapiro-Wilk): Passed ($P = 0.514$)
Equal Variance Test (Brown-Forsythe): Failed ($P < 0.050$)
Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One-Way Analysis of Variance on Ranks October 09, 2017, 15:03:55
Data source: Data 1 in Rice experiment

Group	**N**	**Missing**	**Median**	**25%**	**75%**
Negativity	62	0	0.917	0.500	1.375
Control	62	0	0.917	0.500	1.333
Positivity	62	0	1.500	1.000	2.000

H = 32.118 with 2 degrees of freedom. ($P = <0.001$)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference ($P = <0.001$)

To isolate the group or groups that differ from the others, a multiple comparison procedure is used.

All Pairwise Multiple Comparison Procedures (Student-Newman-Keuls Method):

Comparison	**Diff of Ranks**	**q**	***P***	***P* < 0.050**
Positivity vs Control	3034.000	7.157	<0.001	Yes
Positivity vs Negativity	2817.500	9.956	<0.001	Yes
Negativity vs Control	216.500	0.765	0.589	No

Note: The multiple comparisons on ranks do not include an adjustment for ties.

APPENDIX 3

TWO-WAY ANOVA—E. COLI GROWTH RATE

Two-Way Analysis of Variance August 24, 2018, 11:16:07
Data source: Intentions on *E. coli* growth rate (7-day study)
Balanced Design Dependent Variable: log10(cell density)
Normality Test (Shapiro-Wilk) Passed ($P = 0.081$)
Equal Variance Test: Passed ($P = 0.585$)

Source of Variation	**DF**	**SS**	**MS**	**F**	***P***
day	7	533.294	76.185	4135.640	<0.001
treatment	2	0.133	0.0663	3.602	0.035
day x treatment	14	0.318	0.0227	1.232	0.285
Residual	48	0.884	0.0184		
Total	71	534.629	7.530		

The difference in the mean values among the different levels of day is greater than would be expected by chance after allowing for effects of differences in treatment. There is a statistically significant difference (P = <0.001). To isolate which group(s) differ from the others, a multiple comparison procedure is used.

The difference in the mean values among the different levels of treatment is greater than would be expected by chance after allowing for effects of differences in day. There is a statistically significant difference ($P = 0.035$). To isolate which group(s) differ from the others, a multiple comparison procedure is used.

The effect of different levels of day does not depend on what level of treatment is present. There is not a statistically significant interaction between day and treatment. ($P = 0.285$)

Power of performed test with alpha = 0.0500: for day: 1.000
Power of performed test with alpha = 0.0500: for treatment: 0.485
Power of performed test with alpha = 0.0500: for day x treatment: 0.129

Least square means for day:

Group	**Mean**
d0	0.000
d1	8.523
d2	8.511
d3	8.594
d4	8.194
d5	7.796
d6	7.721
d7	7.841

Std Err of LS Mean = 0.0452

Least square means for treatment:

Group	**Mean**
Control	7.196
neg	7.154
pos	7.092

Std Err of LS Mean = 0.0277

Least square means for day x treatment:

Group	**Mean**
d0 × control	0.000
d0 × neg	0.000
d0 × pos	0.000
d1 × control	8.666
d1 × neg	8.492
d1 × pos	8.411
d2 × control	8.666
d2 × neg	8.570
d2 × pos	8.298
d3 × control	8.683
d3 × neg	8.660
d3 × pos	8.438
d4 x control	8.166

d4 × neg	8.189
d4 × pos	8.227
d5 × control	7.807
d5 × neg	7.790
d5 × pos	7.791
d6 × control	7.705
d6 × neg	7.697
d6 × pos	7.760
d7 × control	7.876
d7 × neg	7.838
d7 × pos	7.808

Std Err of LS Mean = 0.0784

All Pairwise Multiple Comparison Procedures (Duncan's Method):

Comparisons for factor: **day**

Comparison	**Diff of Means**	**p**	**q**	***P***	***P* < 0.050**
d3 vs. d0	8.594	8	189.950	<0.001	Yes
d3 vs. d6	0.873	7	19.297	<0.001	Yes
d3 vs. d5	0.798	6	17.631	<0.001	Yes
d3 vs. d7	0.753	5	16.641	<0.001	Yes
d3 vs. d4	0.400	4	8.842	<0.001	Yes
d3 vs. d2	0.0824	3	1.820	0.231	No
d3 vs. d1	0.0706	2	1.560	0.276	Do Not Test
d1 vs. d0	8.523	7	188.390	<0.001	Yes
d1 vs. d6	0.802	6	17.737	<0.001	Yes
d1 vs. d5	0.727	5	16.072	<0.001	Yes
d1 vs. d7	0.682	4	15.081	<0.001	Yes
d1 vs. d4	0.329	3	7.283	<0.001	Yes
d1 vs. d2	0.0118	2	0.261	0.855	Do Not Test
d2 vs. d0	8.511	6	188.129	<0.001	Yes
d2 vs. d6	0.791	5	17.477	<0.001	Yes
d2 vs. d5	0.715	4	15.811	<0.001	Yes
d2 vs. d7	0.671	3	14.821	<0.001	Yes
d2 vs. d4	0.318	2	7.022	<0.001	Yes
d4 vs. d0	8.194	5	181.107	<0.001	Yes
d4 vs. d6	0.473	4	10.455	<0.001	Yes
d4 vs. d5	0.398	3	8.789	<0.001	Yes
d4 vs. d7	0.353	2	7.799	<0.001	Yes
d7 vs. d0	7.841	4	173.308	<0.001	Yes
d7 vs. d6	0.120	3	2.656	0.081	No
d7 vs. d5	0.0448	2	0.990	0.487	Do Not Test
d5 vs. d0	7.796	3	172.318	<0.001	Yes
d5 vs. d6	0.0754	2	1.666	0.245	Do Not Test
d6 vs. d0	7.721	2	170.653	<0.001	Yes

Comparisons for factor: **treatment**

Comparison	**Diff of Means**	**p**	**q**	***P***	***P* < 0.050**
control vs. pos	0.104	3	3.770	0.014	Yes
control vs. neg	0.0418	2	1.507	0.292	No
neg vs. pos	0.0627	2	2.263	0.116	No

Comparisons for factor: **treatment within d0**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
control vs. pos	0.000	3	0.000	1.000	No
control vs. neg	0.000	2	0.000	1.000	Do Not Test
neg vs. pos	0.000	2	0.000	1.000	Do Not Test

Comparisons for factor: **treatment within d1**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
control vs. pos	0.255	3	3.252	0.033	Yes
control vs. neg	0.174	2	2.227	0.122	No
neg vs. pos	0.0804	2	1.026	0.472	No

Comparisons for factor: **treatment within d2**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
control vs. pos	0.368	3	4.690	0.002	Yes
control vs. neg	0.0957	2	1.221	0.392	No
neg vs. pos	0.272	2	3.469	0.018	Yes

Comparisons for factor: **treatment within d3**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
control vs. pos	0.245	3	3.130	0.040	Yes
control vs. neg	0.0231	2	0.294	0.836	No
neg vs. pos	0.222	2	2.835	0.050	Yes

Comparisons for factor: **treatment within d4**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
pos vs. control	0.0612	3	0.781	0.608	No
pos vs. neg	0.0382	2	0.487	0.732	Do Not Test
neg vs. control	0.0230	2	0.294	0.836	Do Not Test

Comparisons for factor: **treatment within d5**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
control vs. neg	0.0175	3	0.223	0.884	No
control vs. pos	0.0161	2	0.205	0.885	Do Not Test
pos vs. neg	0.00139	2	0.0177	0.990	Do Not Test

Comparisons for factor: **treatment within d6**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
pos vs. neg	0.0629	3	0.803	0.597	No
pos vs. control	0.0550	2	0.702	0.622	Do Not Test
control vs. neg	0.00796	2	0.102	0.943	Do Not Test

Comparisons for factor: **treatment within d7**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
control vs. pos	0.0681	3	0.870	0.567	No
control vs. neg	0.0384	2	0.490	0.731	Do Not Test
neg vs. pos	0.0298	2	0.380	0.789	Do Not Test

Comparisons for factor: **day within control**

Comparison	Diff of Means	p	q	*P*	*P* < 0.05
d3 vs. d0	8.683	8	110.809	<0.001	Yes
d3 vs. d6	0.978	7	12.483	<0.001	Yes

d3 vs. d5	0.876	6	11.178	<0.001	Yes
d3 vs. d7	0.807	5	10.296	<0.001	Yes
d3 vs. d4	0.518	4	6.605	<0.001	Yes
d3 vs. d2	0.0174	3	0.222	0.884	No
d3 vs. d1	0.0169	2	0.216	0.880	Do Not Test
d1 vs. d0	8.666	7	110.593	<0.001	Yes
d1 vs. d6	0.961	6	12.267	<0.001	Yes
d1 vs. d5	0.859	5	10.963	<0.001	Yes
d1 vs. d7	0.790	4	10.081	<0.001	Yes
d1 vs. d4	0.501	3	6.389	<0.001	Yes
d1 vs. d2	0.000503	2	0.00641	0.996	Do Not Test
d2 vs. d0	8.666	6	110.587	<0.001	Yes
d2 vs. d6	0.961	5	12.261	<0.001	Yes
d2 vs. d5	0.859	4	10.956	<0.001	Yes
d2 vs. d7	0.789	3	10.074	<0.001	Yes
d2 vs. d4	0.500	2	6.383	<0.001	Yes
d4 vs. d0	8.166	5	104.204	<0.001	Yes
d4 vs. d6	0.461	4	5.878	<0.001	Yes
d4 vs. d5	0.358	3	4.573	0.003	Yes
d4 vs. d7	0.289	2	3.691	0.012	Yes
d7 vs. d0	7.876	4	100.513	<0.001	Yes
d7 vs. d6	0.171	3	2.186	0.151	No
d7 vs. d5	0.0691	2	0.882	0.536	Do Not Test
d5 vs. d0	7.807	3	99.631	<0.001	Yes
d5 vs. d6	0.102	2	1.304	0.361	Do Not Test
d6 vs. d0	7.705	2	98.326	<0.001	Yes

Comparisons for factor: **day within negative**

Comparison	**Diff of Means**	**p**	**q**	***P***	***P* < 0.05**
d3 vs. d0	8.660	8	110.514	<0.001	Yes
d3 vs. d6	0.963	7	12.290	<0.001	Yes
d3 vs. d5	0.870	6	11.107	<0.001	Yes
d3 vs. d7	0.822	5	10.491	<0.001	Yes
d3 vs. d4	0.471	4	6.016	<0.001	Yes
d3 vs. d1	0.168	3	2.148	0.158	No
d3 vs. d2	0.0900	2	1.149	0.421	Do Not Test
d2 vs. d0	8.570	7	109.365	<0.001	Yes
d2 vs. d6	0.873	6	11.141	<0.001	Yes
d2 vs. d5	0.780	5	9.958	<0.001	Yes
d2 vs. d7	0.732	4	9.342	<0.001	Yes
d2 vs. d4	0.381	3	4.867	0.002	Yes
d2 vs. d1	0.0783	2	0.999	0.483	Do Not Test
d1 vs. d0	8.492	6	108.366	<0.001	Yes
d1 vs. d6	0.795	5	10.142	<0.001	Yes
d1 vs. d5	0.702	4	8.959	<0.001	Yes
d1 vs. d7	0.654	3	8.343	<0.001	Yes
d1 vs. d4	0.303	2	3.868	0.009	Yes
d4 vs. d0	8.189	5	104.498	<0.001	Yes
d4 vs. d6	0.492	4	6.273	<0.001	Yes
d4 vs. d5	0.399	3	5.090	0.001	Yes
d4 vs. d7	0.351	2	4.475	0.003	Yes
d7 vs. d0	7.838	4	100.023	<0.001	Yes

d7 vs. d6	0.141	3	1.798	0.237	No
d7 vs. d5	0.0482	2	0.615	0.666	Do Not Test
d5 vs. d0	7.790	3	99.408	<0.001	Yes
d5 vs. d6	0.0927	2	1.183	0.407	Do Not Test
d6 vs. d0	7.697	2	98.225	<0.001	Yes

Comparisons for factor: **day within positive**

Comparison	**Diff of Means**	**p**	**q**	***P***	***P* < 0.05**
d3 vs. d0	8.438	8	107.679	<0.001	Yes
d3 vs. d6	0.678	7	8.651	<0.001	Yes
d3 vs. d5	0.647	6	8.254	<0.001	Yes
d3 vs. d7	0.630	5	8.036	<0.001	Yes
d3 vs. d4	0.211	4	2.694	0.087	No
d3 vs. d2	0.140	3	1.782	0.241	Do Not Test
d3 vs. d1	0.0265	2	0.338	0.812	Do Not Test
d1 vs. d0	8.411	7	107.341	<0.001	Yes
d1 vs. d6	0.651	6	8.313	<0.001	Yes
d1 vs. d5	0.620	5	7.916	<0.001	Yes
d1 vs. d7	0.603	4	7.698	<0.001	Yes
d1 vs. d4	0.185	3	2.356	0.122	Do Not Test
d1 vs. d2	0.113	2	1.444	0.312	Do Not Test
d2 vs. d0	8.298	6	105.897	<0.001	Yes
d2 vs. d6	0.538	5	6.869	<0.001	Yes
d2 vs. d5	0.507	4	6.472	<0.001	Yes
d2 vs. d7	0.490	3	6.254	<0.001	Yes
d2 vs. d4	0.0715	2	0.912	0.522	Do Not Test
d4 vs. d0	8.227	5	104.985	<0.001	Yes
d4 vs. d6	0.467	4	5.957	<0.001	Yes
d4 vs. d5	0.436	3	5.559	<0.001	Yes
d4 vs. d7	0.419	2	5.342	<0.001	Yes
d7 vs. d0	7.808	4	99.643	<0.001	Yes
d7 vs. d6	0.0482	3	0.615	0.686	No
d7 vs. d5	0.0171	2	0.218	0.878	Do Not Test
d5 vs. d0	7.791	3	99.425	<0.001	Yes
d5 vs. d6	0.0312	2	0.398	0.780	Do Not Test
d6 vs. d0	7.760	2	99.028	<0.001	Yes

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.