

Research Article

Substance Abuse and Poor Sleep Among Adolescents: A Mind Genomics Cartography

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Abstract

Ninety-nine young respondents evaluated different combinations of messages about the effects of substance abuse and sleep issues. The test stimuli were messages developed by generative AI (ChatGPT 3.5). The research followed the process established by the emerging science of Mind Genomics. The study investigated four elements (messages) each about four topics related to drug use: dangers and negative consequences, health alternatives to drug use, in depth consequences when one uses drugs, how poor sleep affects mood, energy levels, and ability to focus. The 16 elements were combined by experimental design, the specific combinations of elements (messages) differing for all respondents. The rating was "Describes Me." Analysis by ordinary least squares regression showed that no single message strongly applied to the entire panel of 99 respondents. Clustering to generate three mind-sets showed three distinct groups, easy-to-interpret response patterns. These are Leisure Enthusiasts who do not respond to the negative elements (n=44), Serious Behavioral Problems (n=31), and Emotion Issues with Impaired Judgment (n=24). AI summarized the mind-sets clearly at two levels, first in terms of strong messages and suggestions for new ideas, and then at a more global level. The paper shows the feasibility of creating databases of the mind at low cost, within a day, with powerful insights and direction for communication emerging from the process.

Keywords: Adolescent sleep issues, Adolescent substance abuse, Generative AI, Mind genomics

Introduction

The growing problem of drug use leading to sleep disorders among adolescents is becoming increasingly relevant to medicine specifically, but to society in general. According to current research, misuse of drugs made for children and adults may, in some cases, negatively affect sleep patterns, leading to a variety of health problems and cognitive deficits [1-3]. A conventional approach by practitioners provides targeted treatments and therapies to address both the drug misuse problem and the sleep disorders, considered as two different indications. Problems frequently occur when teenagers resist therapy or do not cooperate with prescribed measures, either or both making it difficult for healthcare professionals to effectively address the problem. The result is that adolescents suffering from drug use and sleep issues may express themselves in a number of ways, using language indicative of bewilderment, frustration, and pessimism. Emerging societal difficulties associated with drug use that cause sleep problems in teens include increasing rates of scholastic underachievement, social isolation, and mental health illnesses. In turn, parents of these adolescents may report feelings of shame, powerlessness, and concern for their child's well-being, exacerbating the issue [4-6].

Parents may go to considerable measures to address this issue—these include obtaining help from mental health specialists, attending

therapy sessions with their child, and adopting tougher regulations and monitoring to handle substance addiction and sleep problems. However, the complexities of drug use and sleep issues in teens coupled with other behavioral issues involved in maturation make long-term remedies hard to achieve [7,8]. When addressing the growing problem of drug use resulting in sleep disorders among teenagers, a key issue is how drug use affects the brain and interrupts young people's normal sleep habits. Adolescent sleep patterns may also be influenced by external variables such as drug usage, which can cause increased anxiety, restlessness, and interrupted sleep cycles, as well as the social determinant of drug use. Certain medicines such as stimulants and depressants have been reported to interfere with the synthesis of neurotransmitters which govern sleep, making it harder to fall and remain asleep. Other factors to consider which lead to teenage drug use are social and environmental situations. For example, peer pressure, stress, and a lack of parental monitoring may all contribute to young people commencing and continuing drug misuse habits [9].

Helping the Young Medical Professional to Understand the Adolescent Mind

Medical professionals play a vital role in understanding the minds of their adolescent patients, especially when it comes to identifying and addressing substance abuse issues. Experience can be a valuable

asset in this regard. Seasoned doctors may have encountered a wider range of cases and developed a deeper understanding of adolescent behavior and mental health. However, not all doctors have extensive experience with adolescent patients [10,11]. One standard way to learn about a patient's mind is to use questionnaires. At the time of this writing, fall of 2024, the practice of surveys is well-established in many domains, whether medical, commercial, and even recreational. The interested professional focuses on the topic and attempts to generate a set of questions about that topic, with these questions requiring simple answers. The common practice is to present these surveys, either or person, or more frequently on the internet. The survey-taker, known as the respondent, completes the questionnaire [12].

Questionnaires are powerful tools to gather information about adolescent patients, their experiences with substance abuse, as well as their sleep problems. By asking targeted questions about drug use, sleep patterns, and related behaviors, medical professionals can gain a better understanding of the factors contributing to these issues. Various questionnaires have been developed for use with teens, providing valuable data that can inform treatment plans and interventions aimed at addressing substance abuse and sleep disturbances in young people. One of the interesting sidebars of the "survey business" is the biases that the survey creator, viz., the "researcher" encounters. Biases range from non-response (refused to participate) to indifferent (assigned random responses), and all too often attempt to "outsmart" the researcher by guessing what are appropriate, socially acceptable answers, rather than real answers [13].

Creating a system that allows medical professionals to understand the minds of adolescents poses a significant challenge when the doctor lacks experience or the patient is non-communicative. Traditional methods of patient assessment may not always be effective with younger populations, who may struggle to express their thoughts and feelings verbally. In such cases, innovative approaches—such as using targeted questionnaires or assessments specifically designed for teens—could offer valuable insights into substance abuse and sleep-related issues. One metaphor for understanding the minds of adolescent patients is the concept of taking a patient's blood at the start of the patient-doctor interaction. Just as a blood test can provide valuable insights into a patient's physical health, a metaphorical "phlebotomy of the mind" could help medical professionals assess the mental and emotional well-being of their adolescent patients. By developing a systematic approach to understanding the minds of young people, doctors may be better equipped to address issues such as drug use and sleep problems [2,14,15].

The Mind Genomics Set up Process — AI Generated/ Human Edited Questions and Answers, Human Generated Classification and Rating Scale

An alternative approach to asking single, disconnected questions about a topic is to present people with combinations of ideas or messages, and instruct these respondents (viz., our survey-takers) to read the combination and to rate the entire combination. Furthermore, these combinations are comprised of single messages, simple phrases, seemingly thrown together in a haphazard manner, although later

we will show that this seemingly haphazard manner is far from the case. The combinations are structured according to an underlying experimental design [16]. The task is rather easy, although boring. The respondent sits in front of a computer screen. The respondent sees combinations of messages emerge. The respondent simply rates the combination. The average person simply goes through these combinations in almost an indifferent fashion, feeling like some how they are guessing. The reality is that there is an underlying structure, the ratings make sense, and the results show how people think.

The process presents people with ordinary "slices of life" created in a way that the respondent cannot "game the system." Rather, after a moment of surprise, most respondents sit down and do the task. The respondent ends up "grazing", looking at the vignette and then assign a rating. The system invokes what the late Nobel economist called System 1 thinking, where the responses are virtually automatic. The process works very well with motivated as well as unmotivated respondents. There is no requirement that the respondent think about the topic. Rather, it suffices that the respondent pays some attention to the material, and not just type the same answer again and again [17]. Mind Genomics requires four questions and four answers to each question. If that is done, the rest of the exercise is simple. But how does the researcher come up with these questions? The early history of Mind Genomics revealed a major block to the successful use of the approach. Many people, including professionals, ended up 'freezing' when instructed to provide four questions. It was simple enough to name the study, but the creation of questions posed problems—generally emotional ones. As an example, consider Figure 1: Panel A shows the screen as presented to the user. Figure 1, Panel B shows a completed screen. Often the requirement to create a set of four questions which "tells a story" becomes a daunting task, an obstacle to be overcome in the research process [18,19].

Recent enhancement of the Mind Genomics platform has incorporated AI in the form of LLM, large language models (here ChatGPT 3.5). The access to the AI is by means of Idea Coach, a small rectangle in which the user can type the request. Table 1 (top) shows the query as provided to the AI, and Table 1B shows the 15 questions generated from this first iteration. The query is simple, stressing simplicity and understandability. Once the user is satisfied with a question, it is a simple matter to select that question. The selection of a question results in the insertion of the question into the study. When the question has been selected, it is straightforward for the researcher to edit the question, polishing and formatting it so that the subsequent AI effort to "answer" this question will generate meaningful answers, rather than just questions which end up with yes/no answers. The same process is used to select four answers for each question. Idea Coach maintains the selected questions, allowing the user to iterate to find answers and then polish them before inserting the answers into the template [20,21].

In the use of the LLM, the questions and answers usually require some editing. The questions should be edited to encourage expansive answers, using words like "explain in detail". This embellishment is important because the AI will use the questions themselves to drive the creation of answers. The research requires answers which paint

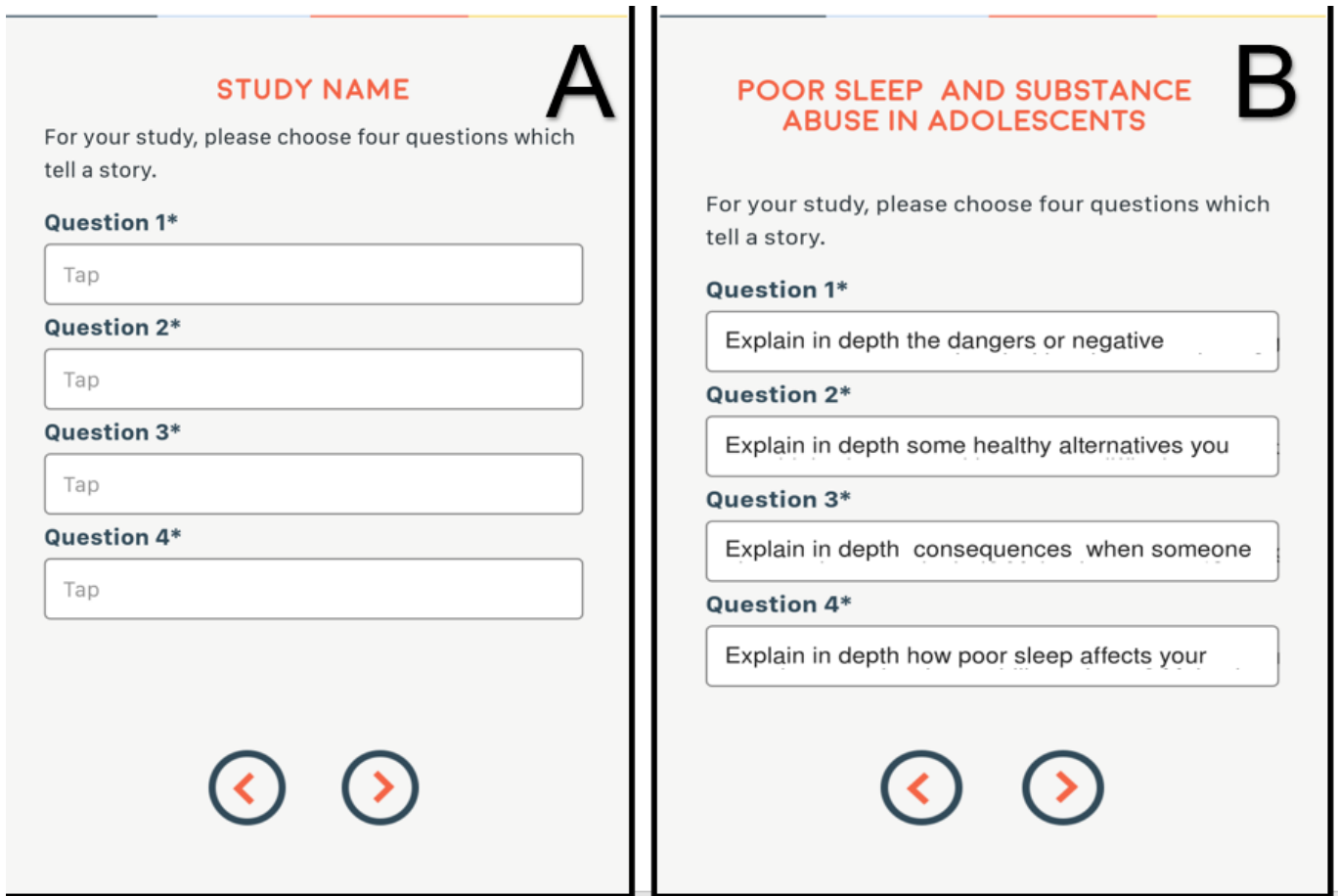


Figure 1: Panel A shows the screen as presented to the user. Panel B shows a completed screen.

Table 1: The instruction to AI to create the questions (top), and the 15 questions created in this iteration.

<p>Instructions Presented to the AI (LLM) in Idea Coach</p> <p>Explain how to talk to adolescents about substance abuse and poor sleeping. I want to learn what to say to them to understand their thoughts about substance abuse and poor sleeping. Make the questions no longer than 15 words. Make the language understandable to any 12-year-old.</p> <p>15 Questions Returned to the User by the AI, in the Precise Language Used By AI</p> <p>(The questions selected can be edited/polished by the researcher after selection.)</p> <ol style="list-style-type: none"> 1. Do you know what substance abuse means? 2. Have you ever heard of any harmful effects of drugs or alcohol? 3. How common do you think substance abuse is among teenagers your age? 4. Do you think poor sleep can affect your daily life and well-being? 5. What are some reasons you might have trouble sleeping at night? 6. Have you ever noticed any changes in your mood or behavior when you don't get enough sleep? 7. Can you think of any ways that substance abuse could impact your sleep patterns? 8. What are some ways that poor sleep can affect your school performance? 9. Have you ever heard of any strategies to improve sleep quality? 10. Are you aware of any dangers or negative consequences associated with substance abuse? 11. How do you think substances like drugs or alcohol might affect your brain and body? 12. What are some healthy alternatives you can think of to cope with stress or difficult emotions? 13. Have you ever had any concerns or worries about substance abuse or poor sleep? 14. Can you share any personal experiences or stories related to these topics? 15. Do you feel comfortable talking to someone, like a trusted adult, if you have questions or concerns about substance abuse or poor sleep?
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a word picture. The only way to get those answers painting a word picture is to instruct the AI to “explain” or “embellish,” or “describe how”. These are words which generate meaningful phrases painting the word picture.

The next step creates the self-profiling classification questionnaire

which enables the researcher to gain more information about the respondent. Two questions are automatically asked—age and gender. The researcher can ask up to eight additional self-profiling questions, each with a possible eight answers. Table 2 shows the self-profiling classification created specifically for this study by the researcher.

Table 2: The self-profiling questions and answers, completed at the start of the evaluation, before any vignettes are rated.

<p>The Self-Profiling Questions</p> <p>Preliminary question: How do you feel when you talk about your problem to someone?</p> <p>1 = Relieved 2 = Embarrassed 3 = Hopeful 4 = Angry 5 = Sad</p> <p>Preliminary question: Tell me how easy it is for you to talk to your best friend about your problems</p> <p>1 = Very easy 2 = Easy 3 = I just share some of them 4 = I don't like to share 5 = Hard 6 = Very Hard</p> <p>Preliminary question: Tell me how easy it is for you to talk to your doctor about your problems</p> <p>1 = Very Easy 2 = Easy 3 = I just share some of them 4 = I don't like to share with my doctor 5 = Hard 6 = Very hard</p> <p>Preliminary question: Tell me how easy it is for you to talk to your girlfriend/boyfriend about your problems</p> <p>1 = Very Easy 2 = Easy 3 = I just share some of them 4 = I don't like to share with my doctor 5 = Hard 6 = Very hard</p> <p>Preliminary question: Tell me how easy it is for you to talk to your teacher about your problems</p> <p>1 = Very Easy 2 = Easy 3 = I just share some of them 4 = I don't like to share with my doctor 5 = Hard 6 = Very hard</p>
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Table 3: The "raw" material, comprising questions and answers.

	Question A: Explain in depth the dangers or negative consequences associated with substance abuse? Make the answer 12 word or less. Make the answer simple so the 12-year-old can understand it.
A1	Mental health problems worsen.
A2	It can lead to risky behaviors and unsafe situations.
A3	Impaired judgment: making bad decisions with serious consequences.
A4	Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways.
	Question B: Explain in depth some healthy alternatives you can think of to cope with stress or difficult emotions? Make the answer 12 word or less. Make the answer simple so the 12-year-old can understand it.
B1	Try this: Try yoga or meditation.
B2	Try this: Do exercises or play sports.
B3	Try this: Spend time in nature.
B4	Try this: Engage in enjoyable activities or hobbies.
	Question C: Explain in depth consequences when someone abuses drugs or alcohol? Make the answer 12 words or less. Make the answer simple so the 12-year-old can understand it.
C1	Negative results: Mental health problems like depression and anxiety.
C2	Negative results: Decline in school or work performance.
C3	Negative results: Addiction and dependency
C4	Negative results: Employment problems
	Question D: Explain in depth how poor sleep affects your mood, energy levels, or ability to focus? Make the answer 12 word or less. Make the answer simple so the 12-year-old can understand it.
D1	Consequences: Lack of sleep reduces your ability to think clearly.
D2	Consequences: Insufficient sleep can make it difficult to remember things.
D3	Consequences: Not sleeping well makes it harder to concentrate and pay attention.
D4	Consequences: Poor sleep makes you feel grumpy and irritable.

Creating Vignettes by Combining “Elements” (Answers)

Table 3 shows the four questions generated by the combination of the human researchers and AI. Under each question are the four answers. Each edited/polished question generated 15 answers. The researcher selected four answers, inserting the answers into the study after polishing them. As a consequence, the questions and answers in Table 4 are usually better than what would be generated even by an experienced professional. The user can run many iterations for questions and for answers, as well as polishing them to make them more precise.

If this study was run as a typical study, then each of the 16 elements (A1-D4) would be presented as a single question, and the respondent (survey-taker) would evaluate each element independently. Of course, the researcher would randomize the order of the elements to reduce order bias. The biggest problem of these one-at-a-time evaluations is that they have no context—or at least the context may change depending upon the element.

The Experimental Design Underlying the Construction of the Vignettes

A better way might be to create combinations of these elements, doing so in a structured manner, so that the combinations, the vignettes, tell a story, albeit a story which has few connectives. Figure 2 shows an example of what the respondent might see.

Figure 2 looks disconnected but the respondent evaluating the vignette ends up with a sense of what is being communicated. After evaluating the first two or so vignettes, most respondents stop fidgeting and simply look at the vignette, and rate it on the scale shown

Table 4: Five-point rating scale.

What is your opinion based on what you just read in the vignette
1=Doesn't describe me and not typical
2=Doesn't describe me but typical
3=I don't know
4=Describes me but not typical
5=Describes me and typical

in Table 4. It is important to note that Figure 1 does not attempt to present a polished paragraph to the respondent, one which reads well, with all the connectives. Although one might be tempted to “pretty up” the vignette, the reality is that the respondent has an easier time “grazing through” the sparse structure presented by the vignette. Less effort is required to identify the information in the vignette, and consequently the respondent can quickly evaluate each vignette. The happy consequence is that the respondent can go through the 24 vignettes quite quickly without incurring much fatigue.

The vignette is rated by the respondent on a simple 5-point scale shown in Table 4. The scale has two sides. The left side, the first part read, has the respondent decide whether the description in the vignette describes or does not describe them. The right-hand side has the respondent decide whether the description is typical or not typical. The rating question captures two aspects of the vignette, fit to the person, and typicality of the statements. These are not explained to the respondents. Most respondents end up having an intuitive sense of what the rating scale means. Their answers suggest that this intuitive sense of its meaning operates in the interview, as we will see below.

Experimental Design to Create Vignettes Which Represent “Slices of Life”

The Mind Genomics effort allows exploratory research rather than requiring confirmatory research. As such, the studies need not be based on theory, with the goal of confirming or disconfirming a hypothesis. Rather, the Mind Genomics studies end up encouraging exploration, intuition, and iteration. It is easy to react to combinations of messages, vignettes. We do it all day long, as we react at an almost automatic level to the world around us. Rather than asking ourselves “what is important about this vignette” or this particular situation, a task requiring thought, we simply react to what is around us. In colloquial terms we “go with the flow”.

By presenting respondents with combinations of messages, i.e., mixture of messages such as the answers (elements) shown in Table 3, we put the respondent into a more natural situation, one which resembles daily experience. All the respondent has to do is react.

<p>We are talking about the problem of substance abuse and sleep deprivation. Imagine experiencing and thinking about this group of ideas. Tell us your opinion. </p>

Consider the ENTIRE VIGNETTE as ONE IDEA

What is your opinion?

Mental health problems worsen.

Try this :Do exercises or play sports.

Negative results: Addiction and dependency

Consequences: Poor sleep makes you feel grumpy and irritable.

Figure 2: Example of what the respondent might see.

The structure of the vignette allows the researcher to present slices of life to the respondent, have the respondent rate the combinations of these slices of life, and when done, properly enables the researcher to numerically estimate the driving power of each of the 16 elements, even when the respondent themselves cannot do so. The experimental design will enable us to determine the degree to which each of the 16 elements fits the respondent. The key to success here is to present the “right” combinations of elements, the “right” slices of life.

The experimental design for Mind Genomics comprises one basic specified set of combinations, which is permitted into several hundred variations. Each variation differs in the specific combinations, but the mathematical structure is maintained, and the design is tested to ensure that it runs in the statistical analysis.

1. The design requires four questions (aka categories, silos), each question associated with four answers (aka messages, elements).
2. The underlying experimental design creates 24 combinations or vignettes.
3. Each vignette has a minimum of two elements and a maximum of four elements.
4. Each element appears equally often, meaning that it appears five times in the set of 24 questions and is absent 19 times.
5. The experimental design lays out the structure of each of the 24 vignettes. Some vignettes will have only two elements. Some vignettes will have three elements. Most vignettes will have four elements.
6. The absence of elements in a vignette means that the combinations of these vignettes are incomplete. That incompleteness is deliberate. It allows the researcher to estimate the contribution of each of the 16 elements to the rating because there are situations where the element is missing. This is important for regression analysis, specifically dummy variable regression analysis,
7. Up to now, we have created a set of 24 combinations for one respondent with the property that each question can contribute at most one element (answer) to a vignette, sometimes contributing no answer to the vignette, but never contributing two answers to the vignette. This is important for statistics and also ensures that the vignette will not present mutually contradictory messages.
8. The 16 elements are statistically independent of each other.
9. The final benefit or the final piece of information is that all of these vignettes, these combinations form one experimental design.
10. The final task is to permute the design. We keep the basic structure of the design, but we change the specific combinations by changing the element numbers. For instance, A1 may become A3, A2 may become A1, A3 may become A2, and A4 may remain as A4. This permutation must be checked to make sure that the elements remain statistically independent of each

other. The result is several hundred permuted designs.

11. Every respondent is presented with a different set of 24 combinations, although the mathematical structure remains the same. The practical benefit is that the researcher need not know anything coming into the study. The researcher need not know the correct combinations because the system itself will take care of it.
12. To sum up, the underlying experimental design ensures that the researcher can understand how people respond to ideas, by forcing them to respond to combinations, the vignettes, the aforementioned “slices of life.” Through statistics, specifically OLS (ordinary least squares) regression used by Mind Genomics, the driving power of each element emerges immediately in a way that cannot be “gamed.”

Fielding the Study with a Panel Provider (Or with One’s Own Patients)

Once those bookkeeping steps are done, the user contacts the panel provider—in this case Lucid Inc., a panel aggregator with access to tens of millions of people around the world. The actual panelists are the appropriate group, adolescents, who have agreed to participate in these studies. They receive rewards. To the authors, these respondents, these survey-takers, are totally anonymized. We have no idea who they are, no idea the reward that they get. Typically, to run 99 people as respondents requires approximately an hour or two from the time the email invitation is mailed out until the respondents complete the 3–4-minute survey. There is a tremendous benefit of having a panel of paid, motivated people. Otherwise, it might take weeks and months to get the same number of respondents.

The panel provider is contacted, and the request is made for a specific age group, market, etc. The age range requested was 15 to 21 years old. No two respondents evaluated the same set of combinations. The result is that the study allowed us to explore a wide variety of combinations. As noted above, a key benefit is that there is no need to know the topic at the start of the project.

Transforming the Data and Creating Models Relating Elements to the Newly Transformed Binary Variable

Each rating generated a rating on the 5-point scale. A rating of 1, 2 or 3 was converted to 0. A rating of 4 or 5 was converted to 100. A vanishingly small random number was added to each newly created binary variable, the aforementioned 0 or 100. The reason for that is purely prophylactic. With the vanishingly small random number ($<10^{-2}$), one does not influence the analysis through ordinary least squares regression, but one guarantees that every one of the respondents will have variability in their newly created binary variables. The analysis is straightforward, whether we do it at the level of a group such as the total panel of 99 respondents, by groups defined by who the respondent claims to be based on the self-profiling classification, or even by individuals.

Recall that the dependent variable, the newly created binary variable, takes on 0 or 100, and each of the 16 elements has the value 0

when absent from the vignette, and 1 when present in the vignette. We create a simple equation of the form listed below:

Dependent variable = $k_1A1 + k_2A2 + k_3A3 \dots k_{16}D4$. The magnitudes of the coefficients, $k_1 - k_{16}$, tells us the degree to which the appearance of the element in a vignette drive the respondent to say, "that is me."

Recall that our respondents were just sitting there being exposed to a variety of messages embedded or combined in these vignettes. They had no idea what was going on. It was a "blooming, buzzing confusion" to them, in the words of Harvard psychologist William James. But throughout the effort, the respondents just simply sat there, grazed, as we said, through the vignettes, and assigned a number. Most of the adolescents, had we asked them, would have said they were guessing and would shrug their shoulders.

Table 5 shows the coefficients. The coefficients show the degree to which the element is perceived as saying "this is me." We can consider the coefficients as conditional percentages. Thus, a coefficient of 10 means that 10% of the answers would be "that describes me", were the element to be put into the vignette. From many of these studies, it would appear that a coefficient around 20 would be considered statistically significant. The rationale for this number is that the coefficients estimated with an additive constant show that a coefficient around 10 is statistically significant based upon a simple T test of coefficients. A model without an additive constant would show that same value of 10 to be 20. Thus, we create a simple operational rule that we should look for high coefficients of 21 or higher in models

estimated without an additive constant, viz., models that are said to go through the origin.

With the following in mind, Table 5 suggests that no elements can be said to read our operational criterion of 21 or higher.

Mind-Sets: Moving to 'Deducing how a Person Thinks' by the Pattern of the Coefficients

Individuals vary in their preferences, coping mechanisms, and interactions with medical professionals. We are also aware that individuals may or may not be capable of identifying what they consider to be essential. With the aid of Mind Genomics, researchers are able to comprehend emergent groups of individuals whose decision-making processes adhere to distinct sets of criteria. Mind Genomics enables the researcher to identify different mind-sets. Mind-sets are defined as people thinking the same way about a topic. The important contribution of Mind Genomics is its ability to create these mind-sets at the level of the granular, at the level of the problem and its specificities. By having a bottom-up approach, one can create mind-sets for any specific problem, such as the one we are dealing with right now. One does not need mental gymnastics to translate macro mind-sets to specific topics, an issue often calling for creative re-thinking, with the mind-set data reworked and analyzed to produce an answer for a specific granular problem.

To create the mind-sets, one uses k-means clustering, a well-recognized statistical approach [22]. In our specific case of 16 elements,

Table 5: Coefficients for the total panel for each of the 16 elements. Coefficients of 21 or higher denote very strong performing elements. The elements are presented in descending order of magnitude for each question

	Group (Binary Ratings)	Total
	Base Size	99
	Question A: Explain in depth the dangers or negative consequences associated with substance abuse?	
A2	It can lead to risky behaviors and unsafe situations.	13
A3	Impaired judgment: making bad decisions with serious consequences.	13
A1	Mental health problems worsen.	12
A4	Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways.	12
	Question B: Explain in depth some healthy alternatives you can think of to cope with stress or difficult emotions?	
B2	Try this: Do exercises or play sports.	16
B1	Try this: Try yoga or meditation.	15
B4	Try this: Engage in enjoyable activities or hobbies.	14
B3	Try this: Spend time in nature.	13
	Question C: Explain in depth consequences when someone abuses drugs or alcohol?	
C3	Negative results: Addiction and dependency	17
C1	Negative results: Mental health problems like depression and anxiety.	15
C4	Negative results: Employment problems	14
C2	Negative results: Decline in school or work performance.	11
	Question D: Explain in depth how poor sleep affects your mood, energy levels, or ability to focus?	
D3	Consequences: Not sleeping well makes it harder to concentrate and pay attention.	11
D2	Consequences: Insufficient sleep can make it difficult to remember things.	10
D4	Consequences: Poor sleep makes you feel grumpy and irritable.	10
D1	Consequences: Lack of sleep reduces your ability to think clearly.	9

each respondent has 16 coefficients. We compute the distance between all pairs of the 99 respondents—a simple statistic. That statistic is called D, for distance, and is defined as $(1 - \text{Pearson correlation})$. The Pearson correlation quantifies the strength of the linear relation between two sets of data. A Pearson correlation of +1 means a perfect linear relation, whereas a Pearson correlation of -1 means a perfect inverse relation. Respondents with high values of D, near 2 are always in the same mind-set or cluster. Respondents with low values of D near 0 are generally in different mind-sets or clusters.

Once the respondents are assigned to either two clusters or mind-sets or separately three clusters or mind-sets, it is simple to create new groups for OLS regression, which we saw above for the Total Panel in Table 6. This time we run five regressions, first for the two mind-sets, and then for the three mind-sets.

Table 6 shows us the coefficients for the two mind-sets and then for the three mind-sets. The sum of the number of respondents is always 99. Each respondent fits into only one of the three mind-sets. There are empty cells in Table 6, corresponding to the elements whose coefficients are 5 or lower. Finally, Table 6 is sorted by the mind-sets, with all elements failing to score strongly in at least of the mind-sets put at the bottom of the Table. The mind-sets for the three-cluster segmentation by k-means make intuitive sense. The mind-sets are coherent, even though the entire analysis was done strictly

by mathematical principles without any appeal whatsoever to the meaning of the elements. The mind-sets emerge quite clearly.

Table 7 shows the distribution of the selected answers for the three mind-sets, and for total panel. The distribution of the self-profiling answers by mind-set is unclear, in contrast to the clarity emerging from strong performing elements for each mind-set. There are some differences among the mind-sets, but the patterns are hard to discern, even though one might have expected to see more pronounced differences among the segments. It is this interpretability of mind-sets based upon very strong performing elements which enables Mind Genomics to create easy-to-understand “new knowledge.”

Putting AI to the Task of Adding Insights to the Mind-Sets

The last part of our analytics from the study itself is the interpretation of the findings through artificial intelligence. The automated re-analysis looks at the results from each mind-set, considering only those elements in the mind-set which generated a coefficient of 21 or higher. Through generative AI (ChatGPT 3.5) the AI answers a fixed set of questions as shown in Table 8. The results for each mind-set and to answer a variety of prompts. AI looks only at the strong performing elements, previously defined as elements which have coefficients of 21 or higher. Therefore, if a mind-set does not have any elements of 21 or higher, it does not appear in this AI analysis.

Table 6: How the elements performed when the 99 respondents were separately divided into two mind-sets, and then into three mind-sets respectively. Strong performing coefficients of 21 or higher are shaded. The table is sorted by the coefficients for the three mind-sets to highlight the differences among the mind-sets.

		MS 1 of 2	MS 2 of 2	MS 1 of 3	MS 2 of 3	MS 3 of 3
	Base (number of respondents in this group)	49	50	44	31	24
	MS 1 of 3 – Leisure Enthusiasts					
B4	Try this: Engage in enjoyable activities or hobbies.	21	9	21	18	
	MS 2 of 3 – Serious behavioral problems					
A1	Mental health problems worsen.		24		29	18
A3	Impaired judgment: making bad decisions with serious consequences.		27		28	22
A4	Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways.		25		26	25
A2	It can lead to risky behaviors and unsafe situations.	7	20	6	22	19
B2	Try this: Do exercises or play sports.	19	11	19	21	
	MS 3 of 3 – Emotional issues, impaired judgment					
C3	Negative results: Addiction and dependency.	15	18	14	12	25
A4	Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways.		25		26	25
C1	Negative results: Mental health problems like depression and anxiety.	12	18	11	13	24
D2	Consequences: Insufficient sleep can make it difficult to remember things.	14	6	14		22
A3	Impaired judgment: making bad decisions with serious consequences.		27		28	22
	Not strong for any mind-set					
C2	Negative results: Decline in school or work performance.	6	16	6	13	20
C4	Negative results: Employment problems.	13	15	13	11	19
D3	Consequences: Not sleeping well makes it harder to concentrate and pay attention.	16	6	16		18
D4	Consequences: Poor sleep makes you feel grumpy and irritable.	13	7	14		17
D1	Consequence: Lack of sleep reduces your ability to think clearly.	16	4	18		17
B1	Try this: Try yoga or meditation.	19	11	18	15	8
B3	Try this: Spend time in nature.	16	9	15	12	8

Table 7: The distribution of answers by mind-set and total for the self-profiling classification.

		MS1	MS2	MS3	Total
		Leisure enthusiast	Serious behavioral problems	Emotional issues, impaired judgment	
Total		44	31	24	100
Gender					
1	Male	66	39	58	56
2	Female	34	61	42	44
Question #1: How do you feel when you talk to someone about your problem?					
1	Relieved	71	61	50	63
2	Embarrassed	5	10	17	9
3	Hopeful	23	26	17	22
Question #2: Tell me how easy it is for you to talk to your best friend about your problems					
1	Very easy	48	36	25	38
2	Easy	27	39	42	34
3	I just share some of them	23	23	25	23
Question #3: Tell me how easy it is for you to talk to your doctor about your problems					
1	Very easy	30	16	29	25
2	Easy	43	58	29	44
3	I just share some of them	16	19	29	20
Question #4: Tell me how easy it is for you to talk to your girlfriend/boyfriend about your problems					
1	Very easy	27	16	46	28
2	Easy	34	42	21	33
3	I just share some of them	21	26	17	21
Question #5: Tell me how easy it is or you to talk to your teacher about your problems					
1	Very easy	7	10	17	10
2	Easy	23	29	21	24
3	I just share some of them	21	13	29	20
4	I don't like to share with my teacher	25	26	21	24
5	Hard	16	19	8	15

Table 8: AI summarization and deeper analysis of the strong performing elements for each of the three mind-sets.

<p>Mind-Set 1 of 3 — Leisure Enthusiasts</p> <p>A. Describe this segment:</p> <p>Engage in enjoyable activities or hobbies. This segment of the total sample of the research study consists of individuals who actively participate in enjoyable activities or hobbies. These individuals may engage in various recreational pursuits, such as sports, crafts, music, traveling, or any other activity that brings them joy and fulfillment. They prioritize finding happiness and satisfaction through their hobbies and make an effort to regularly engage in them. This segment may comprise individuals who value work-life balance and find solace and relaxation in their leisure activities.</p> <p>B. Describe the attractiveness of this segment as a target audience:</p> <p>Engaging in enjoyable activities or hobbies is a desirable attribute for a target audience because it suggests that individuals in this segment prioritize their personal interests and are willing to dedicate time and effort to activities that bring them joy. This segment is likely to be motivated, proactive, and enthusiastic about pursuing their hobbies, making them receptive to products or services that enhance their experiences in these activities.</p> <p>As a target audience, these individuals may be more open to trying out new products or services related to their hobbies, making them potentially lucrative for businesses operating in this niche. Moreover, their engagement in enjoyable activities suggests that they value personal satisfaction and well-being, making them more likely to invest in products or services that contribute to their overall happiness and fulfillment.</p> <p>Additionally, this segment's passion for their hobbies may create a strong sense of community and shared interests, making it easier for businesses to target and reach these individuals through specialized marketing strategies. By understanding their specific needs and preferences, businesses can tailor their products or services to cater to this target audience's unique interests and enhance their overall experience.</p> <p>Overall, individuals who engage in enjoyable activities or hobbies present an appealing target audience due to their motivation, enthusiasm, and willingness to invest in products or services that enhance their experiences in their chosen activities.</p> <p>C. List and briefly describe attractive new or innovative products, services, experiences, or policies for this segment:</p> <p>Based on the research study, one of the attributes of the total sample is their interest in engaging in enjoyable activities or hobbies. This suggests that this segment values leisure and recreational pursuits and seeks opportunities to indulge in them.</p>

Attractive new or innovative products, services, experiences, or policies for this segment could include:

1. Activity-based subscription services: Offering monthly or annual subscriptions that provide access to a variety of enjoyable activities or hobbies such as cooking classes, fitness programs, art workshops, or outdoor adventures. This would allow individuals to explore different interests without the need for long-term commitments.
2. Collaborative online platforms: Creating digital platforms that connect individuals with similar interests and facilitate the organization of group activities or hobby clubs. These platforms would enable users to find like-minded enthusiasts, exchange tips, and plan events or outings together.
3. Experiential travel packages: Designing travel packages that focus on providing unique experiences and opportunities for engagement in enjoyable activities or hobbies. This could include curated itineraries based on specific interests like culinary tourism, adventure sports, or cultural immersion.
4. Flexible work policies: Advocating for policies that promote a work-life balance and allow individuals to dedicate time to their preferred hobbies or activities. This could involve implementing remote or flexible work options or providing ample leave for personal pursuits.
5. Local community initiatives: Supporting initiatives that promote the development of local community centers or hubs dedicated to offering diverse leisure activities and hobby classes. These spaces would provide a platform for individuals to learn, socialize, and engage in enjoyable activities within their own neighborhood.

Overall, the focus for this segment should be on providing accessible and diverse opportunities for individuals to pursue their hobbies or engage in enjoyable activities, whether through innovative products, services, experiences, or policies.

A. Which messages will interest this segment?

1. "Discover new hobbies and activities that will add excitement to your life!"
2. "Join us for a fun-filled evening of engaging activities and hobbies!"
3. "Rediscover the joy of participating in your favorite activities and hobbies."
4. "Unlock the secrets to finding true happiness through engaging in enjoyable activities and hobbies."
5. "Are you ready to embark on a journey of fun and fulfillment through exploring new hobbies and activities?"

Mind-Set 2 of 3 — Serious Behavioral Problems

A. Describe this segment:

Mental health problems worsen. It can lead to risky behaviors and unsafe situations. Impaired judgment: making bad decisions with serious consequences. Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways. Try this: Do exercises or play sports.

This segment is characterized by individuals who experience worsening mental health problems. These problems can lead to engaging in risky behaviors and finding themselves in unsafe situations. They also display impaired judgment, making bad decisions that have serious consequences. Additionally, individuals in this segment may exhibit a loss of self-control, becoming unpredictable and behaving in harmful or dangerous ways. One potential solution for this segment is to engage in exercises or play sports, which may help improve their mental well-being.

B. Describe the attractiveness of this segment as a target audience:

The segment described in the total sample of the research study is characterized by individuals experiencing mental health problems that worsen over time. These individuals may engage in risky behaviors and find themselves in unsafe situations. They also suffer from impaired judgment, making bad decisions with serious consequences, and may exhibit a loss of self-control, behaving in harmful or dangerous ways.

From a target audience perspective, this segment may be of interest to organizations or professionals offering mental health services, therapy, or counseling. With their mental health problems worsening, these individuals are likely seeking help and support to manage their conditions. Therefore, they may be more receptive to interventions or initiatives focused on improving mental well-being.

The mention of recommending exercises or playing sports within the description suggests that physical activity might be beneficial for this segment. It may be seen as an attractive option for interventions that aim to address mental health issues. Organizations promoting exercise and sports-related programs could target this segment to encourage physical fitness and psychological well-being.

Overall, this segment is attractive for target audience consideration as they are facing mental health challenges and are potentially more open to receiving support and engaging in activities that can positively impact their well-being.

C. List and briefly describe attractive new or innovative products, services, experiences, or policies for this segment:

Teletherapy Platforms:

1. In order to address the worsening mental health problems, a new and innovative product could be a teletherapy platform. This platform would allow individuals to access mental health professionals remotely, providing them with the support and therapy they need from the comfort of their own homes. This would not only make mental healthcare more accessible, but also reduce the stigma associated with seeking help.

Wearable Devices for Monitoring:

2. To address the issue of risky behaviors and unsafe situations, a product could be developed that uses wearable devices to monitor and track an individual's behavior. These devices could alert the user or their loved ones when they engage in behaviors that put them at risk, such as excessive alcohol consumption or leaving familiar environments. This would help prevent potential harm and provide a sense of security.

Decision-Making Tools:

3. To address impaired judgment and bad decision-making, innovative tools could be developed to assist individuals in making better choices. These tools could use artificial intelligence algorithms to analyze various factors and provide recommendations or guidance for decision-making. This could help individuals think more critically and make informed decisions with fewer serious consequences.

Mental Health Wellness Apps:

4. To combat the loss of self-control and unpredictable behavior, mental health wellness apps could be introduced. These apps could provide individuals with resources and strategies for managing their emotions and impulses. They could offer tools such as mindfulness exercises, breathing techniques, and mood tracking to help individuals regain control over their behavior and promote healthier ways of coping.

Active Lifestyle Communities:

1. Encouraging exercise and sports among this segment could have positive effects on their mental health. Innovative services could focus on creating active lifestyle communities where individuals can participate in group activities, such as exercise classes, team sports, or outdoor adventures. These communities would provide opportunities for social interaction, physical activity, and a sense of belonging, all of which contribute to overall mental well-being.

A. Which messages will interest this segment?

The messages that are likely to interest this segment are:

1. "Mental health problems worsen." This message acknowledges the problem and suggests that the segment is likely to be interested in finding solutions or seeking help for their mental health issues.
2. "It can lead to risky behaviors and unsafe situations." This message highlights the negative consequences of mental health problems, indicating that the segment may be interested in learning about how to avoid or mitigate such behaviors.
3. "Impaired judgment: making bad decisions with serious consequences." This message emphasizes the impact of impaired judgment on decision-making, implying that the segment may be interested in learning how to improve their cognitive processes or seeking advice on decision-making strategies.
4. "Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways." This message acknowledges the loss of self-control associated with mental health problems, indicating that the segment may be interested in learning techniques to regain control or seeking support in managing their behaviors.
5. "Do exercises or play sports." This message suggests engaging in physical activities as a potential solution for mental health problems. It implies that the segment may be interested in finding ways to improve their mental well-being through exercise or sports participation.

Mind-Set 3 of 3 — Emotional Issues, Impaired Judgment

A. Describe this segment:

Impaired judgment: making bad decisions with serious consequences. Loss of self-control: becoming unpredictable and behaving in harmful or dangerous ways. Negative results: Mental health problems like depression and anxiety. Negative results: Addiction and dependency; Consequences: Insufficient sleep can make it difficult to remember things.

This segment can be described as individuals who exhibit impaired judgment, loss of self-control, and experience negative results such as mental health problems like depression and anxiety. They are also prone to addiction and dependency. Additionally, this segment is likely to face consequences like difficulty in remembering things due to insufficient sleep.

B. Describe the attractiveness of this segment as a target audience:

Based on the provided description, the target audience segment of this research study may not be considered attractive from a marketing standpoint. The attributes mentioned, such as impaired judgment, loss of self-control, mental health problems, addiction and dependency, and difficulty in remembering things due to insufficient sleep, indicate a group that may not be receptive or ideal for marketing efforts.

The negative consequences associated with this segment's characteristics suggest potential challenges in effectively communicating with them or influencing their behavior for marketing purposes. Their impaired judgment and unpredictable behavior could make it hard to engage with them in a consistent and predictable manner. Additionally, their mental health issues and addiction may further impede their ability to respond favorably to marketing messages or initiatives.

Overall, this target audience may not be a priority for marketing efforts, and alternative segments with more desirable characteristics should be considered for achieving marketing objectives.

C. List and briefly describe attractive new or innovative products, services, experiences, or policies for this segment:

1. Cognitive Behavioral Therapy App: An innovative mobile application that offers cognitive-behavioral therapy techniques to improve judgment and decision-making. This app provides interactive modules and exercises to help individuals develop better decision-making skills and avoid impulsive behaviors.
2. Emotional Regulation Program: A comprehensive program that combines therapy sessions with virtual reality experiences to help individuals regain control over their emotions. This program uses cutting-edge technology to create realistic scenarios where users can practice self-control and develop healthier coping mechanisms.
3. Mental Health Support Platform: An online platform that offers personalized mental health support for individuals struggling with depression and anxiety. This service provides 24/7 access to licensed therapists through text, audio, or video chat, ensuring immediate assistance during challenging times and promoting a proactive approach to mental health well-being.
4. Addiction Recovery App: A mobile app specifically designed to support individuals in overcoming addiction and dependency. This app offers a range of features, including personalized recovery plans, access to support groups, reminders for medication and therapy sessions, and educational resources to help users break free from their dependencies.
5. Sleep Optimization Program: A holistic program that combines sleep tracking devices with personalized sleep coaching to promote better sleep habits. This service includes insights into the user's sleep patterns, education on the importance of sufficient sleep for cognitive function, and techniques to improve sleep quality and duration.

Overall, these innovative products, services, experiences, and policies aim to address the negative consequences identified in the research study's sample. By leveraging technology, personalized support, and evidence-based approaches, these offerings provide valuable tools for individuals to improve their judgment, self-control, mental health, and overall well-being.

D. Which messages will interest this segment?

The segment that is interested in the mentioned attributes may be individuals who are concerned about the negative effects of impaired judgment, loss of self-control, mental health problems, addiction, dependency, and the consequences of insufficient sleep. Based on these attributes, the following messages may interest this segment:

1. "Learn how to make better decisions and avoid serious consequences."
2. "Take control of your behavior and live a safer, healthier life."
3. "Discover effective ways to manage and overcome depression and anxiety."
4. "Break free from addiction and regain control of your life."
5. "Improve your memory and cognitive abilities with quality sleep."
6. "Discover the link between sleep deprivation and negative outcomes and find solutions for a better night's sleep."

These messages target the specific concerns of impaired judgment, loss of self-control, mental health problems, addiction, dependency, and the consequences of insufficient sleep, offering potential solutions and information to address these issues.

Table 8 shows the analysis. The prompts shown in Table 8 give a sense of some of the deeper information and insights that might emerge from the data. We might characterize the material in Table 8 as preliminary material for additional insights. Or, to take a phrase from the late Professor of Computer Science at Harvard University, Anthony Gervin Oettinger, the material in Table 6 could be considered TACT, Technical Aids to Creative Thought [23].

Instructing AI to Provide a Simple Overview

Final analysis is based on the need to simplify the results. We can take all of the information provided by AI detailed analysis in Table 8 and summarize it through one simple query as shown in Table 9. The artificial intelligence does a very good job of taking the material that it itself has generated and summarizing it. The bottom of Table 9 shows the summarization in terms of what the mind-sets are, in what aspects they differ, and what innovations can AI suggest. The important thing here is that we can have artificial intelligence summarize and summarize more. Here is a situation where less is more.

Table 9: AI summarization of the results previously presented in Table 8.

Please list the major mind-sets of substance abuse and poor sleep among adolescents from the point of view of the adolescents and explain each mind-set using three sentences. Many of the mind-sets are similar. But many are very different from each other. Find the most different mind-sets. List them, explain why they are different from each other. Give innovations for each of these very dissimilar mind-sets so I know what to do. Tell me the innovation, what the innovation actually does, and why is it important.

Major Mind-sets of Substance Abuse and Poor Sleep Among Adolescents

“Recreational indulgence”: Some adolescents see substance abuse and poor sleep as a way to have fun and enjoy themselves without considering the potential negative consequences. They may view experimentation with drugs or staying up late as a normal part of teenage life.

“Coping mechanism”: Others use substance abuse and poor sleep as a way to cope with stress, anxiety, or other emotional issues. They may turn to drugs or stay awake at night as a way to escape from their problems and find temporary relief.

“Social pressure”: Some adolescents feel pressured by their peers to engage in substance abuse or stay up late, as they believe it is necessary to fit in and be accepted within their social circle. They may not want to be left out or feel ostracized by their friends.

“Self-destructive behavior”: A subset of adolescents may engage in substance abuse and poor sleep as a form of self-sabotage or self-harm. They may have low self-esteem or unresolved psychological issues that lead them to engage in behaviors that are harmful to their well-being.

“Healthy habits”: On the other hand, there are adolescents who prioritize their physical and mental health by avoiding substance abuse and practicing good sleep hygiene. They understand the importance of taking care of their bodies and minds in order to function optimally and prevent potential health problems.

Innovations for Different Mind-sets

For those in the “Recreational indulgence” mind-set, an innovation could be implementing educational programs in schools that highlight the dangers and consequences of substance abuse and poor sleep. This innovation would increase awareness among adolescents and help them make more informed decisions about their behaviors.

Adolescents in the “Coping mechanism” mind-set could benefit from access to mental health resources and support systems that teach healthier coping mechanisms for stress and emotional issues. This innovation would provide them with alternative strategies to manage their emotions and reduce their reliance on harmful behaviors.

To address the “Social pressure” mind-set, creating supportive environments where adolescents feel accepted and valued regardless of their choices could be an effective innovation. This would help alleviate the pressure to conform to negative influences and empower adolescents to make decisions that align with their values and well-being.

For those engaging in “Self-destructive behavior,” interventions focusing on building self-esteem, promoting self-love, and addressing underlying psychological issues could be transformative. This innovation would help adolescents develop healthier ways of coping with their emotions and break free from destructive patterns.

To reinforce the “Healthy habits” mind-set, promoting positive lifestyle choices through education, community programs, and role modeling could be pivotal. This innovation would encourage adolescents to prioritize their health and well-being, leading to a higher quality of life and decreased risk of substance abuse and sleep problems.

Discussion and Conclusions

Mind Genomics studies offer a unique approach to understanding human behavior and decision-making, unlike traditional questionnaires. By presenting respondents with descriptions and scenarios, researchers can tap into their instinctual responses and emotions, providing a more accurate representation of their feelings about a topic or product. This method often involves experiments where participants are presented with varying descriptions or messages, making it difficult for them to guess the “right” answer. This allows researchers to capture genuine gut-level reactions, revealing hidden insights that may not be apparent through traditional questioning methods.

Mind Genomics studies offer a practical and efficient way to gather data, as they focus on individuals’ reactions to descriptions or messages, allowing researchers to quickly compile large databases of knowledge. Dividing people into groups based on their responses to different messages and descriptions allows for a deeper understanding of how individuals process information and make decisions. By identifying patterns in how different groups respond, researchers can tailor messaging and communication strategies to better reach and engage specific audiences.

The study presented here is an example of the effort put in versus the output emerging. The time to create the questionnaires can be measured in hours, certainly less than half a day. The time to set up the study itself and launch was another hour or two. The time to obtain the fully analyzed data was an hour or two, with the fully analyzed data emerging in the form of a user-friendly Excel file. Finally, the time to summarize the data a second time through AI was less than an hour. Altogether, the project could have been completed within 24 hours. The time to write the paper is, of course, longer, at least for the

current iteration of Mind Genomics, but that time will “collapse” in future iterations.

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