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Incidental Encoding
--Manuscript Draft--

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Overview:

Long-term memory is a critical feature of human cognition, and it has been a prominent focus of research in experimental psychology. Many paradigms designed to tap long-term memory rely on asking participants to learn or study content, then testing memory about that content. This is a good approach if one wants to understand how memory supports educational achievement, for example, where explicit study is part of the process. But, in day-to-day life, people often form new memories — many of which last for a long time — incidentally. People do not remember what they read in a magazine, the moment a partner was met, or the plot of a favorite story because they *try to*. Somehow, a good deal of experience just gets encoded into memory as life goes by. To study this side of long-term memory, experimental psychologists use something called an "incidental encoding paradigm."

This video demonstrates the standard procedures for using the incidental encoding paradigm to investigate long-term memory when explicit study of a stimulus is not demanded.

Procedure:

1.   Stimulus and Apparatus.

    1.1.   Run the experiment on a computer.

    1.2.   Collect a set of pictures of real-world objects (**Figure 1**).

    1.3.   The experiment has two phases. The second is a surprise test phase. For the test phase of this version of the experiment, use a state discrimination in which observers are asked to discriminate a picture that they saw from a very similar picture. Therefore, each image needs a paired case in which the object in the picture is the same, but in a different state (**Figure 2**).

2.   Procedure.

    2.1.   The experiment has two phases. The first is the incidental encoding phase.

    2.2.   Expose the participant to a large set of images without their knowing that they will be tested later. This is the goal of the encoding phase, so for this reason, give the participant a cover task. In this case, use a letter judgment task.

        2.2.1. Ask the participant to name each object they see and to report whether the object's name has the letter "C" in it.

    2.3.   When the participant arrives for the experiment, explain the instructions for the

incidental encoding phase of the experiment and the cover task, as follows:

2.3.1. "The experiment you are about to participate in was designed to investigate human language, and in particular, how our brains relate visual inputs to the names of common nouns. On each trial of the experiment, you will be shown a common object for 2 seconds. Your task is to report whether that object has a letter 'C' in its name. For example, if you see a coffee machine, you would press the 'Y' key to indicate that 'coffee machine' does include the letter 'C'. But if you were to see a tennis ball, you would press the 'N' key. Please make your response as quickly as possible. After you make a response, the image will remain on the screen for a total duration of 2 seconds, and then the screen will be empty for 1 seconds, after which the next image will appear. You will be asked to judge a total of 100 images." (**Figure 3**).

2.4. Just as the instructions describe, have the participant complete 100 trials of the cover task, which expose them to the sample stimuli.

2.5. After the incidental exposure phase is complete, conduct the test phase immediately or after a break. For this experiment, use a 20 min break.

2.5.1. Let the participant know that they will now have a break before continuing on to additional experiments.

2.6. When the break is over, conduct the surprise memory test. Explain the instructions to the participant as follows:

2.6.1. "Thank you for your participation. I'd now like you to do a second task designed to investigate how well you remember the objects you saw earlier. On each trial, you will see two pictures of the same object. One will be the picture of that object that you saw when you were doing the letter judgment task. The other will be a picture of that object in a different state — it could be rotated, opened, closed, and so on. Your job is to identify the image you saw before. In each trial, one of the pictures will be on the right side of the screen and the other will be on the left. Press the right or left arrow key to indicate the image that you think is the one you saw before. If you are unsure, just guess."

2.7. As the instructions describe, each trial of the test phase includes an image from the encoding phase along with its paired state image. Present the images in a different random order from the encoding phase (**Figure 4**).

2.8. To analyze the results, compute the proportion of correct responses made by the participant during the test phase. With 100 images, participants should correctly identify between 65 and 95, on average. Note that 50 would be the expected outcome (on average) if one simply guessed and actually remembered nothing

about the images. So performances better than 50% indicate that images were encoded into long-term memory during the cover task.

3.   Cover Task Variation.

    3.1.   The basic incidental encoding procedure has been used to ask many different kinds of questions about the nature of long-term memory. In order to do this, contrast the performances with different cover tasks. This allows a researcher to ask about the kinds of engagement that support better (or worse) incidental encoding into long-term memory.

    3.2.   One classic effect deals with levels of processing. To investigate the effects of levels of processing on memory encoding, test half the participants using the letter cover task described already ("Does the name of this object have a letter 'C' in it?"). This is an impersonal, and relatively superficial way, to evaluate an object.

    3.3.   Have the other half of the participants do a different cover task designed to engage personal and more detailed processing. Explain the following instructions to the participant:

        3.3.1.   "On each trial of the experiment, you will be shown a common object for 2 seconds. Your task is to report whether you have ever touched an object like the one shown. Think for a moment, and then press the 'Y' key if you can think of a time that you have touched such an object, or press the 'N' key if you cannot think of such a time. We are using this experiment to quantify how frequently people interact with basic objects. This is a process known as 'norming.' We will use the results of this experiment to analyze the results of future experiments that use these images as a stimulus set."

        3.3.2.   Note that the last part of the instructions is there to convince the participant of the "cover." It supplies a reason for asking them to complete a somewhat odd task, just like the suggestion that the experiment is designed to investigate language supplies a reason for the letter "C" task.

    3.4.   After the incidental encoding phase is complete, have these participants do a surprise retrieval test identical to the one described previously, completed by the other group of participants.

Representative Results:

An influential effect in the domain of long-term memory is that objects are more likely to be remembered when incidental processing is more elaborate, especially when it is personal. Memory performance in a surprise test is therefore usually worse among participants exposed to the letter "C" task and age-matched participants exposed to the more personal "have you ever touched it" task. **Figure 5** graphs this result, which suggests that encoding into memory is not a

random process, but instead, one that is influenced by the kinds of interactions a person is engaged in.

Applications:

Incidental encoding followed by surprise memory testing is the primary vehicle of current research into the mechanisms of long-term memory formation, attempts to improve memory, and attempts to understand memory disorders like Alzheimer's disease, in particular.

One recent study, for example, has demonstrated that caffeine improves incidental long-term memory. One might have thought coffee only improves learning by helping people to focus when they are trying to learn (**Figure 6**). Participants consumed either caffeinated or un-caffeinated coffee, not knowing which group they were in. They were exposed to images incidentally, much as just described, and then long-term memory was tested. The participants who drank the caffeinated coffee performed better.

Legend:

Figure 1: Sample stimuli for incidental encoding. Typical experiments utilize color photographs of everyday objects, like the five shown here. Many labs make such stimulus sets publicly available. These examples are from a group at MIT: http://cvcl.mit.edu/MM/uniqueObjects.html.

Figure 2: Examples of paired images in different states.

Figure 3: Procedure for incidental encoding. An object is shown in isolation for 2 sec, during which the participant needs to press a key to indicate whether the name for that object includes the letter "C." In the examples shown, a "Yes" response would be given for the first object (an "ABACUS"), but not for the second two ("TOMATO" and "BOOKS"). This is a cover task, to ensure that the participant is exposed to the stimuli incidentally, without knowing that memory will be tested later. Between images, the observer sees a blank 1 sec display. This experiment includes 100 distinct objects following this procedure.

Figure 4: Procedure for the surprise memory test. Each trial includes one of the images the participant saw during incidental exposure along with its state pair. The participant's task is to indicate which image they saw previously (the one on the right or left side of the screen).

Figure 5: Memory performance in a surprise state discrimination task as a function of incidental encoding cover task, either impersonal and superficial (Blue) or personal and more elaborate (Green). Elaborate and personal interactions are more likely to lead to strong long-term memory through incidental exposure.

Figure 6: A student studying while drinking a cup of coffee to improve their focus – but unknown to the student, the effects of coffee also improve incidental long-term memory.
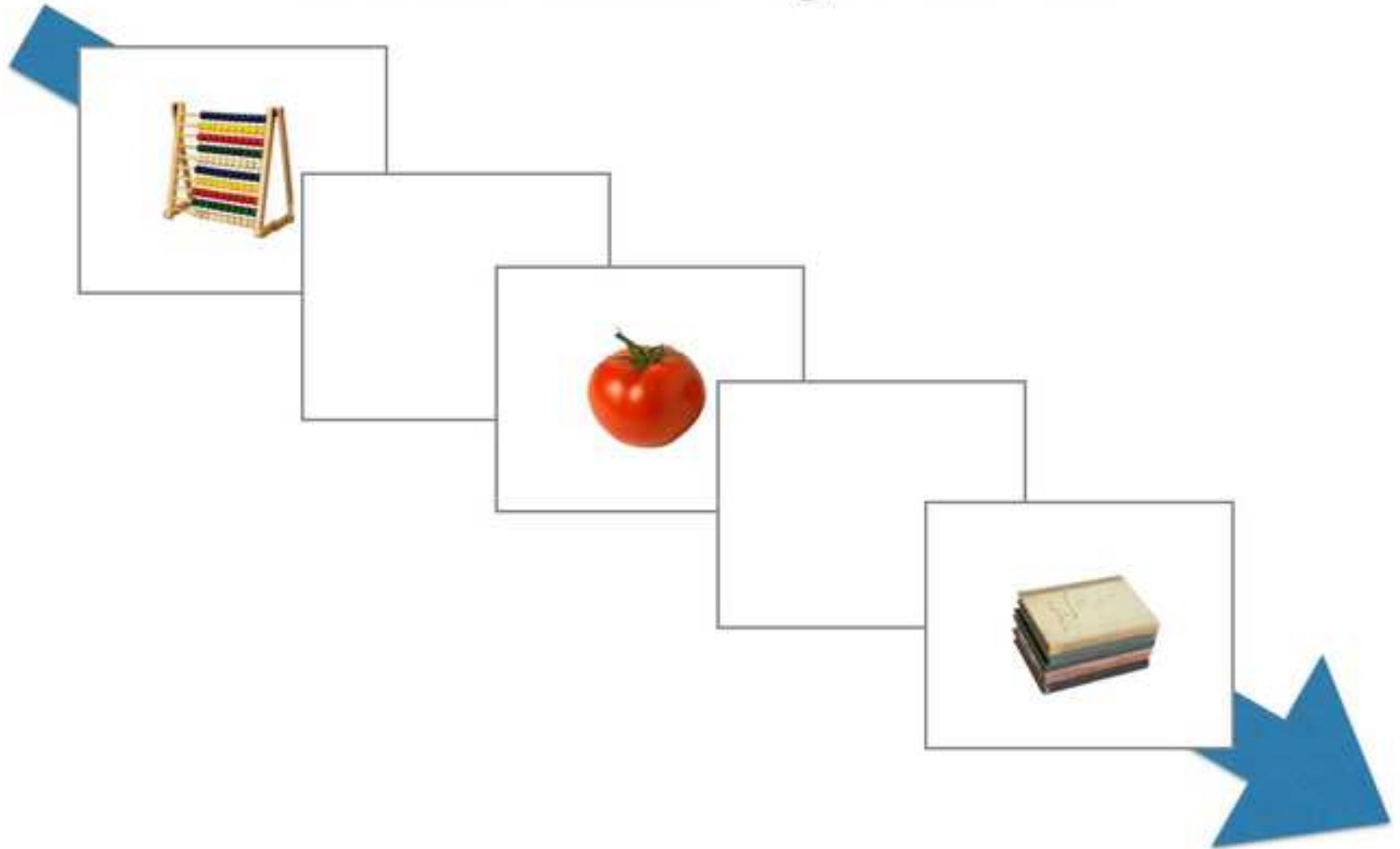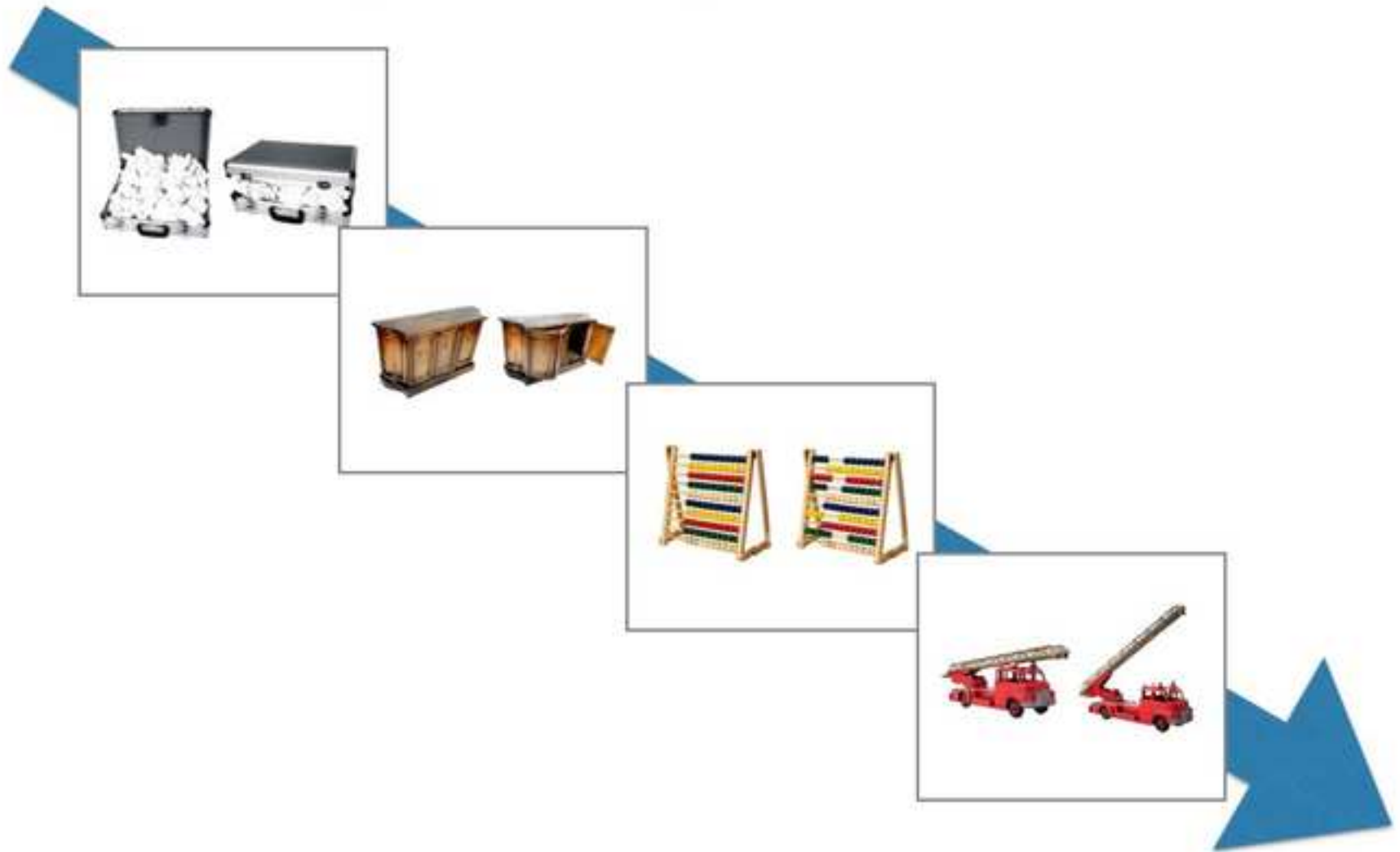
Sample Stimuli for Incidental Encoding

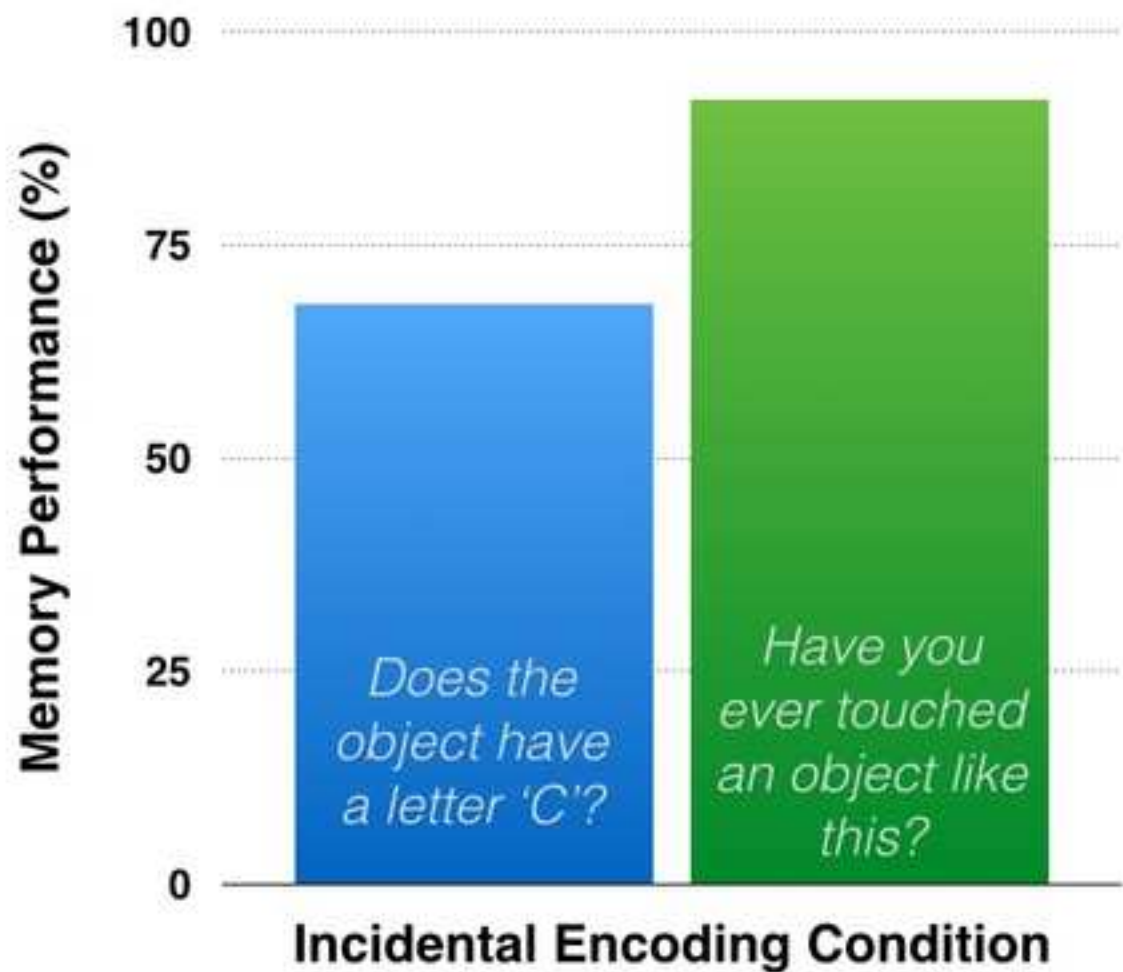State Pair Examples for Surprise Memory Test

Incidental Encoding Procedure

Surprise Memory Test Procedure

Surprise Memory Test Performance

PI: Jonathan Flombaum
Psychology Education **Title:** Incidental Encoding

Overview:

Long-term memory is a critical feature of human cognition, and it has been a prominent focus of research in experimental psychology. Many paradigms designed to tap long-term memory rely on asking participants to learn or study content, then testing memory about that content. This is a good approach if one wants to understand how memory supports educational achievement, for example, where explicit study is part of the process. But, in day-to-day life, people often form new memories — many of which last for a long time — incidentally. People do not remember what they read in a magazine, the moment a partner was met, or the plot of a favorite story because they *try to*. Somehow, a good deal of experience just gets encoded into memory as life goes by. To study this side of long-term memory, experimental psychologists use something called an "incidental-encoding paradigm."

The paradigm is especially useful for investigating the kinds of experiences that tend to produce strong long-term memories. Researchers think about experiences in terms of the kind of engagement they demand — personal, purely intellectual, deep, or shallow, for example. The incidental-encoding paradigm can be used to contrast long-term memory formation during different kinds of engagement by varying the cover task used to expose an individual to stimuli. A cover task is a task that a participant is asked to complete without, not knowing that memory for the stimuli in the task is tested later.

This video demonstrates the standard procedures for using the incidental encoding paradigm and two different cover tasks to investigate long-term memory when explicit study of a stimulus is not demanded.

Procedure:

1. Stimulus and Apparatus..

    1.1. Run the experiment on a computer.

    1.2. Collect a set of pictures of real-world, everyday objects (**Figure 1**).

    1.3. The experiment has two phases. The second is a surprise test phase. For the test phase of this version of the experiment, use a state discrimination in which observers are asked to discriminate a picture that they saw from a very similar picture. This experiment will require a set of images of everyday objects, and fFor Therefore, each such image, create needs a paired case in which the object in the picture is the same, but in a different state (**Figure 2**).

2. Procedure.

2.1.	The experiment has two phases. The first is the incidental encoding phase.

2.2.	Expose the participant to a large set of images without their knowing that they will be tested later. This is the goal of the encoding phase, so for this reason, give the participant a cover task. In this case, use a letter judgment task.

2.2.1.	Ask the participant to name each object they see and to report whether the object's name has the letter "C" in it.

2.3.	When the participant arrives for the experiment, explain the instructions for the incidental encoding phase of the experiment and the cover task, as follows:

2.3.1.	"The experiment you are about to participate in was designed to investigate human language, and in particular, how our brains relate visual inputs to the names of common nouns. On each trial of the experiment, you will be shown a common object for 2 seconds. Your task is to report whether that object has a letter 'C' in its name. For example, if you see a coffee machine, you would press the 'Y' key to indicate that 'coffee machine' does include the letter 'C'. But if you were to see a tennis ball, you would press the 'N' key. Please make your response as quickly as possible. After you make a response, the image will remain on the screen for a total duration of 2 seconds, and then the screen will be empty for 1 second, after which the next image will appear. You will be asked to judge a total of 100 images." (**Figure 3**).

2.4.	Cover Task Variation. The basic incidental encoding procedure has been used to ask many different kinds of questions about the nature of long-term memory. In order to do this, ~~researchers~~ contrast the performances with different cover tasks. This allows a researcher to ask about the kinds of engagement that support better (or worse) incidental encoding into long-term memory.

2.5.	One classic effect deals with levels of processing. To investigate the effects of levels of processing on memory encoding, test half the participants using the letter cover task described already ("Does the name of this object have a letter 'C' in it?"). This is an impersonal, and relatively superficial way, to evaluate an object.

2.6.	Have the other half of the participants do a different cover task designed to engage personal and more detailed processing. Explain the following instructions to the participant:

2.6.1. "On each trial of the experiment, you will be shown a common object for 2 seconds. Your task is to report whether you have ever touched an object like the one shown. Think for a moment, and then press the 'Y' key if you can think of a time that you have touched such an object, or press the 'N' key if you cannot think of such a time. We are using this experiment to quantify how frequently people interact with basic objects. This is a process known as 'norming.' We will use the results of this experiment to analyze the results of future experiments that use these images as a stimulus set."

2.6.2. Note that the last part of the instructions is there to convince the participant of the "cover." It supplies a reason for asking them to complete a somewhat odd task, just like the suggestion that the experiment is designed to investigate language supplies a reason for the letter "C" task.

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2.3. When the participant arrives for the experiment, explain the instructions for the incidental encoding phase of the experiment and the cover task, as follows:

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2.4.2.7. Just as the instructions describe, have the participant complete 100 trials of thewith one of the cover tasks, which expose them to the sample stimuli. A participant will do only does one of the cover tasks.

2.5.2.8. After the incidental exposure phase is complete, conduct the test phase immediately or after a break. For this experiment, use a 20 min break.

2.5.1.2.8.1. Let the participant know that they will now have a break before continuing on to additional experiments.

2.6.2.9. When the break is over, conduct the surprise memory test. Explain the instructions to the participant as follows:

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2.7.2.10. As the instructions describe, each trial of the test phase includes an image from the encoding phase along with its paired state image. Present the images in a different random order from the encoding phase (**Figure 4**).

2.8. To analyze the results, compute the proportion of correct responses made by the participant during the test phase. With 100 images, participants should correctly identify between 65 and 95, on average. Note that 50 would be the expected outcome (on average) if one simply guessed and actually remembered nothing about the images. So performances better than 50% indicate that images were encoded into long-term memory during the cover task.

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3.4.2.11. After the incidental encoding phase is complete, have these participants do a surprise retrieval test identical to the one described previously, completed by the other group of participants.

Representative Results:

An influential effect in the domain of long-term memory is that objects are more likely to be remembered when incidental processing is more elaborate, especially when it is personal. Memory performance in a surprise test is therefore usually worse among participants exposed to the letter "C" task and age-matched participants exposed to the more personal "have you ever touched it" task. **Figure 5** graphs this result, which suggests that encoding into memory is not a random process, but instead, one that is influenced by the kinds of interactions a person is engaged in.

Figure Legends:

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object includes the letter "C." In the examples shown, a "Yes" response would be given for the first object (an "ABACUS"), but not for the second two ("TOMATO" and "BOOKS"). This is a cover task, to ensure that the participant is exposed to the stimuli incidentally, without knowing that memory will be tested later. Between images, the observer sees a blank 1 sec display. This experiment includes 100 distinct objects following this procedure.

Figure 4: Procedure for the surprise memory test. Each trial includes one of the images the participant saw during incidental exposure along with its state pair. The participant's task is to indicate which image they saw previously (the one on the right or left side of the screen).

Figure 5: Memory performance in a surprise state discrimination task as a function of incidental encoding cover task, either impersonal and superficial (Blue) or personal and more elaborate (Green). Elaborate and personal interactions are more likely to lead to strong long-term memory through incidental exposure.

~~**Figure 6:** A student studying while drinking a cup of coffee to improve their focus – but unknown to the student, the effects of coffee also improve incidental long-term memory.~~

> **Comment [JS7]:** Should be excluded from the manuscript

Applications:

Incidental encoding followed by surprise memory testing is the primary vehicle of current research into the mechanisms of long-term memory formation, attempts to improve memory, and attempts to understand memory disorders like Alzheimer's disease, in particular. It is well established that intentional encoding in Alzheimer's disease is extremely impaired. For example, ~~That is, i~~if patients try to remember stimuli, because they know they will be tested later, then they remember very little compared with controls. This can be shown by exposing patients to images just as they would be in the incidental encoding task, but instructing them to try to remember each image because they will be tested later. In contrast, Alzheimer's patients have better memory for images encoded incidentally in tasks that involve emotional or personal processing of the stimulus. This suggests that some kinds of incidental processing leads to stronger memories than even intentional encoding, and it suggests that activation of emotion areas in the brain may foster memory encoding.

> **Comment [JS8]:** Can you give more information?
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~~One recent study, for example, has demonstrated that caffeine improves incidental long-term memory. One might have thought coffee only improves learning by helping people to focus when they are trying to learn (**Figure 6**). Participants consumed either caffeinated or un-caffeinated coffee, not knowing which group they were in. They were exposed to images incidentally, much as just described, and then long-term memory was tested. The participants who drank the caffeinated coffee performed better.~~