Module 12: Bachelor's Thesis

Nicer Design, Better Learning?

The Impact of Anthropomorphic Design Features on Emotions and Learning

Zoë Elster (S3006670)

Department of Psychology, University of Twente

Supervisor: Loes Hogenkamp

Second Reader: Dr. Alieke van Dijk

Date: 24.06.2025

Abstract

This study examines how emotional responses, memory retention, and perceived task difficulty are affected by facial anthropomorphic design elements in static learning materials. The study investigates whether anthropomorphic features, like eyes and mouths, can improve students' emotional engagement and cognitive functioning in context with the growing interest in emotional design in education. A total of 64 university students were randomly assigned to one of three experimental conditions: text-only, non-anthropomorphic images, and anthropomorphic images. A multiple-choice test was used to measure memory retention, and the Positive and Negative Affect Schedule (PANAS) was used to evaluate emotional responses. Participants also indicated their perceived difficulty of the task. The findings showed that there was no significant difference in emotional responses of the different experimental groups. Furthermore, it was found that, while task difficulty was a significant predictor of memory retention, the presence of anthropomorphic design features did not significantly impact retention scores. These findings suggest that the design of the study did not allow for a significant effect of anthropomorphism to be assessed. The study contributes to the ongoing debate on emotional design, emphasising the need for further research into the effects of anthropomorphism in an educational setting.

Introduction

Learning has been a driving force of human evolution, shaping how people develop and adapt over centuries. While the quality of the content of instructional materials is crucial, so is the way in which learning materials are designed (Mayer, 2020; Sequeira, 2012). Instructional design refers to the deliberate structuring and planning of teaching and learning materials to aid learners in achieving their learning goals (İşman, 2011). This consists of selecting content, methods, and assessments for learning, but also taking into account how learners engage with the material. In the past, instructional design was largely focused on discovering how to make information stay in long-term memory (Hultberg et al., 2018). Today, however, with the growing variety of learning materials, especially in digital formats, there is increasing interest in how learners emotionally engage with materials, as emotions have been shown to influence motivation, attention, and ultimately the effectiveness of learning (Özgür & Altun, 2021). More specifically, there is more attention to design aspects, such as colour, animation, and human-like visuals and how this affects learning outcomes and affective responses in learners.

This current growing interest in affective influences is rooted in expanding research on affective neuroscience, which has shown links between cognitive and affective regions in the brain (Plass & Hovey, 2021). Specifically, studies have shown that cognitive regions of the brain are involved in emotional processing, and vice versa (Pessoa, 2008, as cited in Plass & Hovey, 2021). This indicates that while cognitive processes like problem-solving or decision-making may cause emotional reactions, emotional experiences can also influence how we pay attention to, interpret, and remember information (Plass & Hovey, 2021). This demonstrates that emotions are not just a byproduct of learning, but that they actively shape how the learner processes information and achieves their learning goals. Due to this interaction, emotions may promote or hinder learning outcomes in an academic setting.

Negative emotions like boredom or anxiety may inhibit attention and impair cognitive flexibility; on the other hand, positive emotions like enjoyment or interest are typically associated with deeper engagement and more successful learning strategies (Pekrun, 2006).

So far, research has revolved around two main narratives concerning how emotions influence learning. They both have empirical support, however additional research is needed to determine when and in which context one may be more applicable than the other. Firstly, the suppression hypothesis suggests that emotions, particularly those unrelated to a learning task, occupy cognitive resources in working memory, which are already limited by nature, thereby hindering learning by leaving fewer resources available for processing task-relevant information (Plass & Kalyuga, 2019; Knörzer et al., 2016). In contrast, the facilitation hypothesis suggests that emotions can broaden the scope of cognitive processes, enhance motivation, and serve as retrieval cues for the content of the learning material, thus supporting learning and memory (Plass & Kalyuga, 2019; Knörzer et al., 2016).

One way to target emotional engagement in learning materials is through emotional design. Emotional design is the creation of learning materials with the aim of impacting the emotions of the learners, to influence learning performance (Schneider et al., 2016). It is thought that if learning elements are visually appealing, they will enhance cognitive processes and lead to more effective learning. Often times enhancing important visual components with visually appealing elements like expressive faces, vivid colours, or rounded shapes are used in educational emotional design (Um et al., 2012; Mayer & Estrella, 2014). Such design elements can focus attention, encourage motivation, and support generative cognitive processes like the selection, organisation, and integration of materials (Moreno & Mayer, 2007). However, it is not wise to blindly add emotionally stimulating visuals to learning materials, without first thinking about the rationale behind adding them. Emotional design might not be helpful if the emotional features are perceived as irrelevant or distracting

(Heidig et al., 2015). This can especially be the case when learners do not see the emotional elements as related to the task, or when such elements are overly complex or poorly integrated with instructional content. In contrast, emotional design may help when it successfully evokes emotions that increase intrinsic motivation, task engagement, and perceived task value, while also promoting deeper cognitive processing (Um et al., 2012; Heidig et al., 2015). Thus, studies show that learners who are exposed to successfully implemented emotionally designed materials not only express greater motivation and a lower sense of difficulty, but they also do better on comprehension and retention tests (Um et al., 2012; Mayer & Estrella, 2014).

To facilitate emotions in learning, a form of emotional design called facial anthropomorphism can be used. Anthropomorphism refers to attributing human characteristics to inanimate objects (Mutlu-Bayraktar, 2024). In the case of facial anthropomorphism, this can be in the form of adding eyes or a mouth to a graphical element (Kaifeng & Pengbo, 2024). This is done as it is assumed that such facial expressions may communicate emotions to the viewer (Atkinson et al., 2004). A meta-analysis by Kaifeng and Pengbo (2024) showed that facial anthropomorphism yielded significant improvements in transfer, retention and comprehension of learning materials across a number of 33 independent studies. Additionally, the study by Mayer and Estrella (2014) found that, in comparison with the control group, the group with emotional design features with human-like faces improved participants' retention of learning material. Nevertheless, there is still theoretical uncertainty about how emotions affect learning in spite of these encouraging results.

Despite increasing interest in emotional design and its impact on learning, the specific effects of facial anthropomorphism in static visual learning materials remain insufficiently understood. It is useful to consider implementing static visuals, as they remain a key principle of instructional content due to their low production cost, accessibility, and ease of distribution, particularly in classrooms, textbooks, and settings with limited internet access. If simple anthropomorphic enhancements are able to increase the emotional appeal and cognitive effectiveness of static materials, this would offer a low-cost, scalable way to improve learning outcomes without requiring complex animations or interactive technologies (Schneider et al., 2016). The majority of previous research has focused on emotional design in multimedia or interactive formats, often overlooking simpler forms of media like static visuals. However, studying these simpler formats and adding anthropomorphic features may help establish a stronger foundational understanding of emotional design, which is essential for effectively advancing its application, potentially also across more complex media environments. (Lee et al., 2018). Nevertheless, it is unknown how exactly anthropomorphic features affect the retention of information and the perceived difficulty of an academic learning task in static materials. Some research indicates that these emotional design features may improve engagement and recall, which are key in a learning context (Kaifeng & Pengbo, 2024; Mayer & Estrella, 2014); however, further research is required to confirm findings and promote the generalisability of them.

Notably, three meta-analyses have found only modest benefits of animation over static visuals in most learning contexts (Höffler & Leutner, 2007; Berney & Bétrancourt, 2016; Castro-Alonso et al., 2019). As a result, Clark and Mayer (2016) recommend using static illustrations by default unless there is a strong instructional rationale for animation. For explanatory content, they suggest using a series of static frames rather than a continuous animation. Ploetzner et al. (2021) similarly concluded that animations are only clearly beneficial when learners need to understand the specifics of motion or change over time. In contrast, static visuals are often more effective for teaching spatial arrangements, as they allow uninterrupted focus on the overall configuration (Ploetzner et al., 2021). However, these studies did not investigate emotional design in their studies, also leaving scientific unclarity on its effects in this area.

Therefore, the aim of the current study is to investigate how facial anthropomorphic design elements in static learning materials influence learners' emotions, memory retention and perceived task difficulty. Thus, the study seeks to provide a better understanding of emotional design in educational settings and promote evidence-based decision-making in educational development by concentrating on this particular design element. Additionally, the study aims for an exploratory approach in investigating the facilitation and suppression hypotheses to better understand the specifics of when either one of them may apply.

From a theoretical and practical perspective, it is important to gain more insight into the unclarity in the field of emotional design and anthropomorphism in education. In practice, educational materials often use design features, particularly in digital learning environments, striving for more engagement with the material. However, due to the absence of clarity in the field and depending on how users interpret and interact with the design, certain design decisions run the risk of potentially overloading cognitive resources. Theoretically, this also adds to the ongoing discussion on the suppression and facilitation hypotheses by shedding light on the ways in which emotional features and cognitive processing interact in a static-material context.

Theoretical Framework

Emotion and Learning

Cognitive Load Theory. An important theory to understand the workings of the brain during learning is Cognitive Load Theory (CLT) by John Sweller, which outlines the limits of human cognitive resources. This is particularly relevant to the current study, as adding emotional design elements, like anthropomorphic features, may either reduce or increase cognitive load, thereby influencing learning outcomes. This theory states that human cognitive resources are limited, especially the capacity and duration of working memory (Candido & Cattaneo, 2025). When a learning task exceeds the capacity of the working memory, it may become overloaded, which resultantly impairs learning outcomes. Within CLT three types of cognitive load are distinguished: intrinsic, extraneous and germane load. Intrinsic load is determined by the inherent complexity of the learning material and the learner's individual knowledge (Lyu & Deng, 2024). It can only be changed by changing what needs to be learned or the learner's knowledge (Hawthorne et al., 2024). Extraneous load is dependent on how the information is presented and what the learner is required to do by the task. This can draw the learner's attention and working memory away from the information to be learned. Germane load regards the active integration of the learned information with prior knowledge, for which motivation is often needed. To optimise learning, the design of the materials should promote germane load, while reducing extraneous and regulating intrinsic load. Valid and reliable methods for measuring cognitive load are still in the making, but one way to assess it is by looking at the perceived difficulty of a task (Krieglstein et al., 2023).

Emotions are a key factor influencing cognitive load (Plass & Kalyuga, 2019). Plass and Kalyuga (2019) have suggested contradicting ways in which emotions may affect cognitive load. Firstly, emotion may present an extraneous cognitive load, as they take up space from the limited working memory capacity. Additionally, it is suggested that emotions may impact memory by broadening or narrowing cognitive resources available for a task, according to Fredrickson's (2001) Broaden and Build Theory of Positive Emotions (Hawthorne et al., 2024). This broadening or narrowing of cognitive resources is directly linked to the facilitation and suppression hypotheses, respectively, and can be understood as either reducing or increasing cognitive load depending on the emotional state induced.

Dual-Coding Theory. Dual Coding Theory, which emphasises the advantages of integrating verbal and visual information for deeper learning, is a crucial theoretical framework in regard to emotional design (Sadoski & Paivio, 2013). Dual Coding Theory is a cognitive theory explaining learning through two channels, namely the one for verbal information, such as language, and one for nonverbal information, like mental imagery (Sadoski & Paivio, 2013). These two channels function independently but are most effective when activated together. This means that dual representation, for example in the form of text and images, enhances memory and understanding. However, there are some nuances to this. If the images are merely decorative, adding no explanatory value to the text, they may distract the learner from the content and be considered extraneous cognitive load. Conductive pictures, in contrast, are characterised as being emotionally supportive of the material and thus enhance learning (Schneider et al., 2016). In this regard, anthropomorphic visuals may serve as emotionally supportive, conductive images that enhance nonverbal processing while also encouraging emotional engagement, thereby aligning with the principles of Dual Coding Theory.

Control-Value Theory of Achievement Emotions. In order to address the current gap in research on the role of anthropomorphic design in static learning materials, one can look at the Control-Value Theory of Achievement Emotions (CVT) by Reinhard Pekrun (2006). The control-value theory of achievement emotions describes how, in a learning context, emotions are influenced by the perceived level of control and the perceived value of learning tasks and their outcomes. Students' emotional responses in learning situations depend on the way they interpret their experiences, that is, their causal attributions of success or failure. These appraisal processes generate **emotions**, which in turn influence learning outcomes (Loderer et al., 2020). CVT defines achievement emotions as “emotions tied directly to achievement activities or achievement outcomes” (Pekrun, 2006). In an academic context, achievement activities refer to the emotions felt during ongoing achievement-related activities, such as frustration felt during a difficult task or interest when learning about a new topic. Resultantly, outcome emotions are the feelings felt towards the outcome of those activities.

Research on CVT has shown that experiencing positive emotions can help learners envision goals, improve in self-regulation and problem-solving (Pekrun & Stephens, 2011). Strong negative emotions, on the other hand may impede academic performance, for example in an exam setting (Pekrun & Stephens, 2011). Emotions can be classified on a bi-dimensional model (of emotions) by Russel (2003), which entails valence (experiences as pleasure vs. unpleasant) and arousal (experienced as activation vs. deactivation). This is in line with CVT as it provides a framework with which emotions and their effect on learning behaviours can be better understood in an educational context. Typical emotions felt in an academic setting include enjoyment, relaxation, frustration, anger, and boredom (Camacho-Morles et al., 2021). Given the importance of achievement-related and outcome emotions in academic performance, further exploration of their influences is needed to better understand how emotions may support or hinder learning. In the context of this study, anthropomorphic features may serve as subtle emotional design cues that enhance perceived task value or control, potentially influencing achievement emotions as described by CVT.

Facial Anthropomorphism in Learning

The relationship between anthropomorphism and memory retention has been studied in the past, but it still warrants further exploration. According to a meta-analysis by Wong and Adesope (2020), anthropomorphism and pleasant colours had an enhancing effect on learning outcomes, including memory retention and transfer of knowledge. These findings were believed to result from the emotional and motivational engagement brought forth by the anthropomorphic design. Such designs may activate social and emotional processing pathways by incorporating visual elements with human-like characteristics, which may make the content more relatable and engaging. Better memory performance may result from this enhanced engagement, which would also promote emotional involvement and may improve cognitive processing and encoding.

According to the Dual Coding Theory, anthropomorphic images function as affective and semantic cues that improve recall and the integration of verbal and nonverbal information (Sadoski & Paivio, 2013). It was also shown that university students had a significant effect on memory retention when learning with anthropomorphic design (Brom et al., 2018). However, there are still inconsistencies in the area, as another study from the meta-analysis revealed no significant effect on retention (Heidig et al., 2015, as cited in Wong & Adesope, 2020). These mixed findings call for more research to clarify when and for whom anthropomorphic design supports memory retention.

Current Study

To help clarify inconsistencies in the field regarding anthropomorphic design, emotions, and retention, this study investigates their relationship. Research suggests that emotionally engaging design elements can enhance cognitive resources and support the retention of information (Plass & Kalyuga, 2019; Knörzer et al., 2016). In order to evaluate this, the study will compare the effects of three types of learning materials, text-only, text with a non-anthropomorphic image, and text with an anthropomorphic image, on learners' emotional responses, memory retention, and perceived task difficulty. In the context of this research, the questions "**How do learners' emotional responses to anthropomorphic design features in learning materials differ compared to non-anthropomorphic and text-only materials?**" and "How do anthropomorphic design features in learning materials affect learners' memory retention and perceived difficulty in comparison to non-anthropomorphic materials and text-only content?" will be addressed.

Based on the extensive literature review, two hypotheses are proposed. Hypothesis 1: Participants in the anthropomorphic condition will report higher levels of positive emotions than those in the non-anthropomorphic and control conditions. Hypothesis 2: Participants in the anthropomorphic condition will perform significantly better on the retention task and will perceive the task as less difficult compared to participants in the non-anthropomorphic and control conditions.

Methods

Participants

A convenience sample of university students was used, as the researcher had the best access to this population of people, and they fit well into the scope of the study. There were two methods employed to recruit participants. The first strategy used was a university research study distribution system, allowing students to participate in research studies and receive study program credits. The second method was a combination of snowball sampling and convenience sampling. Here, participants in the network of the researcher were recruited through Instagram, WhatsApp, and Email and encouraged to forward the study to other students. Exclusion criteria were non-university students and people under the age of 18.

Originally, 75 participants took part in the study. In the final dataset, after cleaning, 64 participants were included. Participants with missing data (N=11) were removed. The mean age of participants was 21.8. The proportion of females was 76.6% and 23.4% for males. The nationality represented most was German, 70.3%, followed by Dutch, 21.9%. The rest of the participants were single students from France, Lithuania, México, Panamá and Romania with 1.6% each. Participants were randomly assigned to one of the three experimental conditions, namely text-only, non-anthropomorphism, and anthropomorphism, using Qualtrics' randomizer function, ensuring even group distribution. There were 20 participants in the control group “text-only”, 21 participants in the non-anthropomorphic image group and 23 participants in the anthropomorphic image group.

Design

A cross-experimental quantitative study was performed with a between-subjects design and a within-subjects design. The between-subjects design entailed the control group of text-only study material, the experimental group with text and non-anthropomorphic images, and the group with text and anthropomorphic images. The within-subjects design entailed the comparison of the PANAS test, once before and once after completing the retention task.

The independent variable in this study is the type of learning material, with the three conditions: text-only (0), text accompanied by non-anthropomorphic images (1), and text accompanied by the anthropomorphic images.

There are two dependent variables. The first dependent variable is the emotional response, measured by the PANAS before and after the learning task. Secondly, memory retention, assessed through the participants’ performance on a 13-item multiple-choice quiz based on the learning material. Additionally, the covariate variable of perceived task difficulty was present in the study.

Materials

Positive and Negative Affect Schedule

To measure participants’ emotional states before and after completing the learning task, the Positive and Negative Affect Schedule (PANAS) was used (Watson et al., 1988). The PANAS is a scale, containing 20 items, 10 for assessing negative affect (e.g. “distressed,” or “irritable”) and 10 for positive affect (e.g. “excited” or “interested”). Participants rated the extent to which they experienced each emotion at the present moment on a 5-point Likert scale ranging from “Very Slightly or Not at all” to “Extremely”. The

PANAS shows very good internal reliability with Cronbach's alpha coefficient scores ranging from 0.86 to 0.90 for the Positive Affect Scale and 0.84 to 0.87 for the Negative Affect Scale (Magyar-Moe, 2009).

Learning Task Text

The text of the learning task was on the topic of the immune system and its function within the body. It concerned the topic of innate and adaptive immunity, including information on physical barriers of the immune system, phagocytic cells, antibodies and memory cells. It was written in an informative manner and created with the help of the AI tool ChatGPT. This topic was chosen to generalize research outcomes, as previous studies on anthropomorphism used similar topics in their work. The text had a length of 669 words with the two subsections "innate immunity" and "adaptive immunity", and a concluding paragraph. The difficulty level was aimed at being appropriate for university students and was generated through ChatGPT. The same text was used throughout all conditions.

Image Creation and Layout

To create both the non-anthropomorphic and anthropomorphic images for the study, the App "Good Notes" was used on an iPad. Regarding the anthropomorphic design elements, there were two images displayed in the text. Both images were split into four smaller "images" through a grid that halved the image vertically and horizontally (Figures 1 and 2). This was done, as the image showed a biological process and in each grid of the picture, the next step of the process was shown. The anthropomorphic images depicted the work of body cells in a cartoon-like way and included eyes, a mouth and facial expressions. The different parts of the image were labelled. The non-anthropomorphic images were designed in the same way as the anthropomorphic ones, with the exclusion of eyes and mouths (see Figure 1). In all conditions, the same textual content was shown, only the presence or absence of facial features differed in groups 1 and 2. The size, position, and colour scheme were kept the same, to ensure standardization.

Figure 1

The images displayed in the non-anthropomorphic condition (group 1)

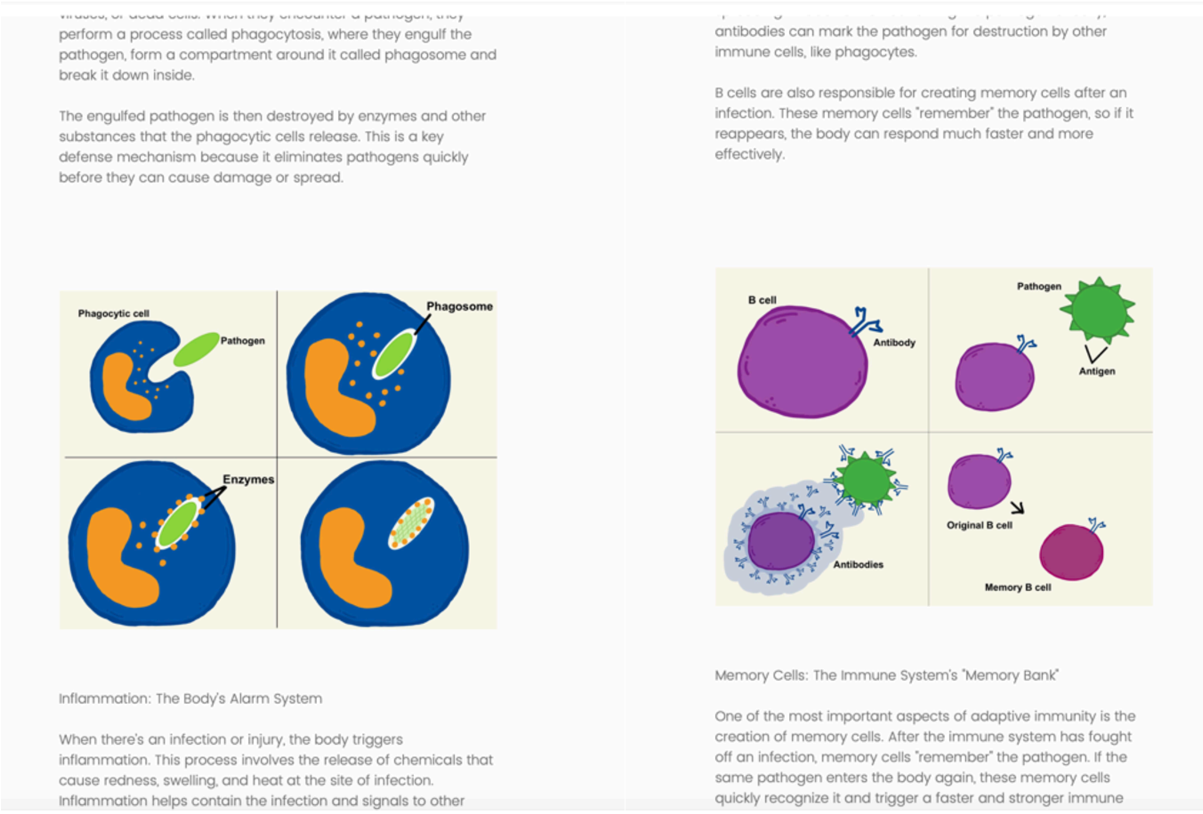
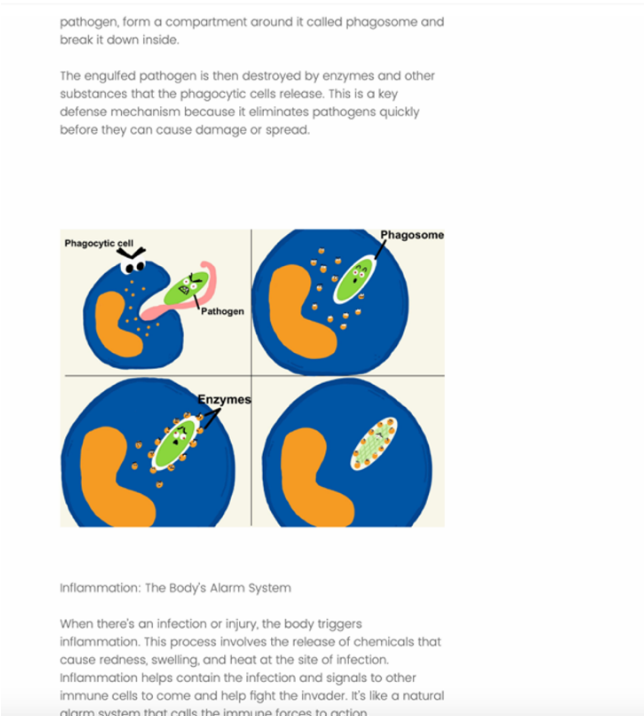


Figure 2

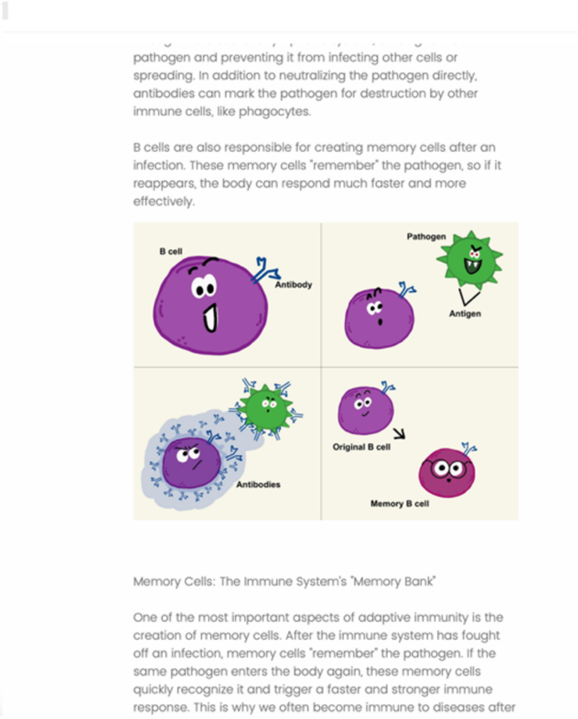
The images displayed in the anthropomorphic condition (group 2)


pathogen, form a compartment around it called phagosome and break it down inside.

The engulfed pathogen is then destroyed by enzymes and other substances that the phagocytic cells release. This is a key defense mechanism because it eliminates pathogens quickly before they can cause damage or spread.

Inflammation: The Body's Alarm System

When there's an infection or injury, the body triggers inflammation. This process involves the release of chemicals that cause redness, swelling, and heat at the site of infection. Inflammation helps contain the infection and signals to other immune cells to come and help fight the invader. It's like a natural alarm system that calls the immune forces to action


pathogen and preventing it from infecting other cells or spreading. In addition to neutralizing the pathogen directly, antibodies can mark the pathogen for destruction by other immune cells, like phagocytes.

B cells are also responsible for creating memory cells after an infection. These memory cells "remember" the pathogen, so if it reappears, the body can respond much faster and more effectively.

Memory Cells: The Immune System's "Memory Bank"

One of the most important aspects of adaptive immunity is the creation of memory cells. After the immune system has fought off an infection, memory cells "remember" the pathogen. If the same pathogen enters the body again, these memory cells quickly recognize it and trigger a faster and stronger immune response. This is why we often become immune to diseases after

Memory Retention Test

The knowledge test was aimed at testing the memory retention of the participants on the learning task text. There were 13 multiple-choice questions included with 4 possible answer choices, testing factual and detailed recall. An example of a test question was "Which of the following is an example of a physical barrier in the immune system?" with the answer choices "A) Phagocytic cells; B) Skin and mucous membranes; C) Antibodies; D) Memory cells". The questions were generated with the help of ChatGPT and then checked for clarity by the researcher. Each question was scored as being worth one point, therefore, the maximum number of possible points was 13. The scoring was done manually, by scoring either 1 point for a correct answer or 0 for an incorrect one.

Difficulty Level Assessment

The perceived level of difficulty was assessed in order to draw inferences about cognitive load. At the end of the survey, there was a final prompt to answer the question "How did you find the task?". The answer choices were ranged on a 4-point scale from "Very Easy" to "Very Difficult", intentionally excluding a neutral midpoint to encourage a directional evaluation of the task. There was an additional “Other” option, where a short text could be written. The question on perceived difficulty was developed by the researcher.

Procedure

Participants were invited to participate in the study via a link on the Instagram story of the researcher, in addition to a link distributed on WhatsApp and in personal contact with university students. Other participants accessed the study through the link provided on the research study website. A laptop, computer or smartphone was needed to take part in the survey. The study took approximately 15 to 20 minutes to complete. When participants clicked on the link of the study on the recruitment platform, they were forwarded to the Qualtrics website, where they first encountered the informed consent form. Here, they were informed about the context of the study, the potential risks involved, their rights as participants and were given the contact of the researchers (see Appendix I). The participants' consent was asked by ticking a box.

Following this, it was asked if the participant was a university student, to confirm the participation requirements. If this was not fulfilled, the participant was unable to continue with the study. Then, three demographic questions were asked about age, gender and nationality. Next, participants were instructed to evaluate their current mood state, by filling out the PANAS. This was expected to take around 5 minutes in total.

Next, a page was displayed giving instructions about the upcoming learning task. Participants were asked to read the text carefully, as they would need to answer questions about it and would not be able to go back to the text, once they entered the learning task, to ensure they could not go back to the text and reread it, and thus skew results. This was done to ensure valid measurement of memory. They were asked to not use any external sources or write notes within the study. After continuing, text was displayed, based on which experimental group the participant belonged to. After this, participants answered the memory retention test questions. There was no time limit for answering the questions, and all questions were displayed on screen at the same time. It was estimated for participants to take 10 to 15 minutes on this part. Next, participants completed the PANAS a second time to assess post-task emotional states. Lastly, participants filled out the difficulty level assessment. These last two parts were estimated to take approximately 5 minutes to complete.

In the end, the debrief screen was displayed, which enlightened participants about the aim of the study in investigating the effect of emotional design in learning, specifically with the use of human-like features. Then the closing screen was shown, which thanked participants for their participation again and provided the contact details of the researchers. The entire research was anonymized.

Data Analysis

Data cleaning and preparation were conducted using Microsoft Excel and RStudio. Missing data were excluded. Then, descriptive statistics including mean, standard deviation, variance, range, and total and mean scores were calculated per group for all relevant variables (e.g., PANAS scores, retention scores, and task difficulty ratings).

For all inferential statistics analyses RStudio was used. Here, a significance level of $p < .05$ was applied to all tests. In order to test hypothesis 1 "Participants in the anthropomorphic condition will report higher levels of positive emotions than those in the non-anthropomorphic and control conditions" a mixed-design ANOVA was conducted. This was done to include the factor time as a variable in the analysis. Therefore, time (pre-task vs. post-task PANAS score) acted as a within-subjects factor, and Group (0= text-only, 1= images, 2= anthropomorphic images) as a between-subjects factor. After the original test, Bonferroni-adjusted pairwise comparisons were used as a post-hoc test to further explore group differences.

To test the second hypothesis, “Participants in the anthropomorphic condition will perform significantly better on the retention task and will perceive the task as less difficult compared to participants in the non-anthropomorphic and control conditions”, a one-way ANOVA test was performed. Here, the independent variable was the experimental group, and the dependent variable was the total score on the knowledge test. To compare the overall performance of each group, the mean retention scores and standard deviations were calculated.

Additionally, a One-way analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference between text-only, non-anthropomorphic and anthropomorphic learning materials on memory retention, controlling for perceived task difficulty. The between-subjects factor was Group (0 = text-only, 1 = non-anthropomorphic, 2 = anthropomorphic), the dependent variable was the test score (memory retention), and perceived task difficulty (self-reported task difficulty, coded from 1 = very difficult to 4 = very easy) was included as a covariate.

Results

Research Question 1: How do learners’ emotional responses to anthropomorphic design features in learning materials differ compared to non-anthropomorphic and text-only materials?

The aim of the first Research Question was to test the differences in learners’ emotional responses between the anthropomorphic design features responses of the PANAS. The descriptives of the variables PANAS scores before and after the memory test per group are presented in the table below (Table 1).

Table 1

Descriptive Statistics of the PANAS Scores per group.

Variable	Mean	SD	Variance	Range		Total score	Mean Score
				Min	Max		
PANAS Positive Mean Before							
Text-only	2.79	0.62	0.38	1.8	4.1	55.8	2.79
Non-anthropomorphic	2.75	0.8	0.63	1.3	4.5	57.8	2.75
Anthropomorphic	2.83	0.69	0.48	1.6	3.9	65.2	2.83
PANAS Positive Mean After							
Text-only	2.67	0.71	0.5	1.4	3.8	53.4	2.67
Non-anthropomorphic	2.3	0.65	0.42	1.4	3.6	48.4	2.3
Anthropomorphic	2.66	0.81	0.65	1.4	4	61.1	2.66
PANAS Negative Mean Before							
Text-only	1.89	0.6	0.36	1	3.1	37.8	1.89
Non-anthropomorphic	1.69	0.62	0.38	1	3.5	35.5	1.69
Anthropomorphic	1.65	0.64	0.41	1	2.9	38.0	1.65
PANAS Negative Mean After							
Text-only	1.75	0.58	0.34	1	3.1	35.0	1.75
Non-anthropomorphic	1.5	0.65	0.42	1	2.7	31.4	1.5
Anthropomorphic	1.61	0.68	0.46	1	3.1	37.1	1.61

In order to test the first hypothesis, “Participants in the anthropomorphic condition will report higher levels of positive emotions than those in the non-anthropomorphic and control conditions”, two mixed-design ANOVA tests were conducted with Time (before, after the memory task) as a within-subjects factor and Group (text-only, image, anthropomorphic) as a between-subjects factor.

For Positive Affect, a statistically significant negative effect of time was found, $F(1, 61) = 10.46$, $p = .002$, which indicates that participants' state of positive affect decreased from before to after the memory task. However, there was no statistically significant interaction between time and group, $F(2, 61) = 1.69$, $p = .193$. This suggests that the change in affect was similar across all three experimental groups.

These findings show that the non-anthropomorphic image group did not score statistically significantly higher on the positive affect scoring of the PANAS after the memory task. This may indicate that anthropomorphic design features did not statistically significantly influence the magnitude of the change of affect compared to other experimental conditions.

The Bonferroni-adjusted pairwise comparisons revealed no statistically significant group differences in the change in positive affect (ps > .28). Neither did it reveal statistically relevant results in pre-task (ps = 1.00) and post-task positive affect scores (ps > .34). These findings indicate that the different forms of learning materials did not lead to significantly different emotional outcomes before or after the task, nor in the extent of emotional change.

Research Question 2: How do anthropomorphic design features in learning materials affect learners' memory retention and perceived difficulty in comparison to non-anthropomorphic materials and text-only content?

The aim of the second research question was to test memory retention and perceived difficulty with anthropomorphic design and compare it to the experimental conditions without anthropomorphism. The descriptives of the variables are the memory retention score and perceived difficulty level per experimental group.

Table 2

Descriptive Statistics of the Variables per group

Variable	N	Mean	SD	Variance	Range		Total score	Mean Score
					Min	Max		
Memory Retention Score								
Text-only	20	10.65	2.13	4.56	7	13	213.0	10.65
Non-anthropomorphic	21	10.48	2.18	4.76	6	13	220.0	10.48
Anthropomorphic	23	10.7	2.34	5.49	3	13	246.0	10.7
Perceived Difficulty Level								
Text-only	20	2.45	0.826	0.682	1	4		
Non-anthropomorphic	21	2.48	0.981	0.962	1	4		
Anthropomorphic	23	2.7	0.974	0.949	1	4		

Note: All values are rounded to two decimal points.

In order to address the second hypothesis, “Participants in the anthropomorphic condition are expected to perform significantly better on the memory retention task and will perceive the task as less difficult than those in the non-anthropomorphic and text-only groups.”, a one-way ANOVA was conducted with Group (0 = text-only, 1 = text + non-anthropomorphic image, 2 = text + anthropomorphic image) as the independent variable and Memory Retention Score as the dependent variable.

The results of the ANOVA revealed no statistically significant difference between group means on memory performance, $F(2, 61) = 0.06$, $p = .944$. The mean scores were M = 10.6 (SD = 2.13) for the text-only group, M = 10.5 (SD = 2.18) for the image group, and M =

10.7 (SD = 2.34) for the anthropomorphic group as seen in table 2. These findings suggest that there were small differences between the experimental groups' performances on the retention task, but not of statistical relevance. Therefore, anthropomorphism did not affect the task performance.

While controlling for perceived difficulty, an ANCOVA was performed to investigate the impact of group condition on memory retention. Memory performance was not affected by design conditions, according to the analysis, which found no significant effect of Group ($F(2, 60) = 0.07$, $p =.93$). However, there was a significant effect of anthropomorphic manipulation on memory retention after controlling for perceived task difficulty, ($F(1, 60) = 11.74$, $p =.001$). This indicates that perceived task difficulty was found to a a significant predictor of retention, regardless of experimental group condition.

Discussion

Summary of Findings

The current study was conducted to further explore whether groups with anthropomorphised images had different emotions and learning outcomes as compared to other conditions and shed light into the research gap in educational psychology. The results of the study showed that there was no statistically significant difference in positive affect between the groups having the text-only, non-anthropomorphic and anthropomorphic design conditions. There was a significant decrease in positive affect after the task, however, the amount of the decrease was not related to or dependent on the group.

The study also explored how anthropomorphic design features impact the performance in a memory retention task. There was a statistically significant effect of perceived task difficulty as a covariate on memory retention on the anthropomorphic condition. This finding indicated that the perceived difficulty of the task was a significant predictor of retention, regardless of group assignment. This means the higher the perceived difficulty was, the better participants scored on the retention task. However, no statistically significant effect of anthropomorphic condition was found on memory retention. In fact, the results of all groups were relatively high and there was no significant difference in performance on the test.

Interpretation of Results

Hypothesis One: Emotions and Anthropomorphism

The data did not support the first hypothesis, which predicted that participants in the anthropomorphic condition would report higher levels of positive affect than students in the non-anthropomorphic image or text-only conditions. After the memory retention task, all groups showed a general decline in positive affect, and there was no statistically significant interaction between time and group, suggesting that the design type had no statistically significant effect on students' emotional reactions.

These results are contrary to a number of previous studies in the field that highlighted the emotional advantages of emotional design elements in multimedia education. Um et al. (2012), for example, showed that emotionally charged learning materials that used anthropomorphic faces, rounded shapes, and vibrant colours effectively raised positive affect, which, in turn, improved understanding and transfer. Likewise, Mayer and Estrella (2014) found that learners exposed to emotional design with human-like faces demonstrated significantly better affective outcomes and retention than those in neutral conditions. This discrepancy may be due to the fact that the images used in the current study were static, and that the above-mentioned studies used a multimedia approach, such as narrated animations and interactive visuals. These formats may have evoked a different effect of anthropomorphic features, than the static materials used in this study. The effect of the emotional design features may have been easier to capture and measure in the previous studies.

In general, the findings of the current study may be explained by several contributing factors. Seeing that the PANAS is a self-report measure for measuring general affect, it could be that it does not capture the nuances in affect that may have arisen during the task (Medvedev et al., 2021), (*Counting What Counts*, 2025). Possibly, certain emotions that arose in the task were too brief or subtle for the participants to report after the task (Dudzik & Broekens, 2023). Additionally, it is possible that the task itself was perceived to be too difficult or required a lot of attention, so that possible effects of emotions that could have arisen were overshadowed by the nature of the task (Guo et al., 2022). This may also be linked to the result of the majority of participants stating that they found the task somewhat (44%) or very difficult (8%).

These findings may also be explained by Control-Value Theory of Achievement Emotions (Pekrun, 2006) and Cognitive Load Theory. As CVT states that emotional responses are closely linked to learners' perceived control of the task, the fact that such a high number of people rated the task as very difficult would point towards a low level of perceived control. This low perceived control of performing well on the task may have inhibited the "production" of positive emotions. Additionally, taking the Cognitive Load Theory into account, it is likely that the cognitive demands of the task may have induced a high intrinsic or extraneous load, leaving only minimal capacity to process "secondary" emotions or visual design elements of the task. In this case, the mental effort needed to complete the task itself may have outweighed any possible affective benefits of anthropomorphic features (Guo et al., 2022), (Kirschner & Kirschner, 2012). The lack of differences in emotional responses between the experimental groups may also be explained by this.

Hypothesis Two- Retention, Perceived Task Difficulty and Anthropomorphism

Hypothesis 2, “Participants in the anthropomorphic condition will perform significantly better on the retention task and will perceive the task as less difficult compared to participants in the non-anthropomorphic and control conditions.“, provided interesting research insights in comparison to previous studies. For example, Kaifeng & Pengbo (2024) found that anthropomorphic design elements enhance memory performance and also that participants perceived the experimental conditions with anthropomorphism as easier. On the other hand, Park et al. (2015) did not find a statistically significant effect of anthropomorphism on learning outcomes in their study. Additionally, there was no significant effect of perceived difficulty found. The discordant findings across studies may be due to differing types of study design and the salience of anthropomorphic elements, and more specific characteristics of participants, for example, age, internal mood, and prior knowledge on the subject.

The following interpretations could describe the rejection of Hypothesis 2. First, there was a ceiling effect present in the knowledge test scores, as participants of all groups scored relatively high on the retention task, leaving little room for detecting group-based differences. This suggests that the level of the test might have been too easy. This is, interestingly, still the case despite the majority of the participants stating that they found the test more difficult compared to easier. This finding may point towards a dissonance between perceived difficulty level and actual ability in learning outcomes. In other words, many participants rated the test to be very difficult, however, they scored very high. According to Efklides & Schwartz (2024), this disparity between perceived difficulty and actual performance suggests a metacognitive misalignment, which may be attributed to the interplay between cognitive processes and affective influences.

According to the Control-Value Theory of Achievement Emotions (Pekrun, 2006), learners' emotional and cognitive engagement is shaped by their perceived control over and the value they assign to a task. If participants felt uncertain about their abilities, meaning low perceived control, even when performing well, this may have impacted how they processed the material emotionally and cognitively.

Likewise, more insight may be obtained through the Cognitive Load Theory (Sweller, 1988). The relatively long text, with only a few paragraphs and no bold words may have added unnecessary cognitive load by diverting focus from processing the content to handling structure or layout. Additionally, if participants were not previously familiar with the topic, it may have added cognitive strain on intrinsic load. Even if the cognitive effort eventually resulted in improved encoding and retention, these types of load may have combined to increase the overall cognitive demand and make the task feel more difficult.

Moreover, the finding of the ANCOVA that perceived difficulty was a significant predictor of retention may indicate cognitive misattribution, a phenomenon in which participants mistake their mental effort for difficulty or confusion rather than a sign of deep processing. According to Eitel et al. (2014), even though cognitive effort can improve learning, students often mistake it for a lack of comprehension.

Limitations

Measurement of Memory Retention

There were a number of limitations regarding how memory retention was measured. First, the questions were not known to be a reliable and valid measurement for memory retention. This indicates that the accuracy of the test in measuring the desired concept is unknown. Additionally, a pilot study would have improved the validity of measuring memory retention. Thus, it may have been more difficult to identify actual differences in memory retention between the groups.

The Environment

Another limitation of the study was the nature of the environment in which it was conducted. The fact that the study was online created an uncontrolled environment, so multiple unknown factors may have affected participant behaviour and the findings. For example, as there were no attention checks, it is possible that some participants simply clicked through the survey without fully engaging with the content. It was also possible for participants to look up answers in the knowledge test. Furthermore, participants' level of prior knowledge on the subject was not assessed. This may have had an impact on the outcomes, as people with greater previous knowledge may have performed better or engaged with the materials differently (Jaeger & Cardello, 2022).

Implications and Future Research

Enhancing Emotion Measurement and Design

Enhancing the measurement of emotions could improve the study design of future research. Incorporating more dynamic and in-time emotion tracking techniques could improve affective measurement, thus capturing more nuanced affective states (Medvedev et al., 2021), (*Counting What Counts*, 2025). This could be done by using physiological sensors, eye-trackers or facial expression analysis, in addition to an affect scale measurement. Especially for higher-budget studies, this could be a valuable addition and could provide more detailed feedback than simply pre- and post-task self-report ratings. These methods may allow for a more thorough understanding of learners' emotional experiences by capturing more subtle emotional reactions as well. It could also be useful to explore how emotional reactions differ between static and animated materials. This would help understand whether emotional design has a more noticeable impact in static visuals compared to animated ones (Höffler & Leutner, 2007)."

Improving Memory Task Accuracy and Sensitivity

Creating memory retention tasks with more variation in difficulty level and sensitivity is another important improvement for future research. It is possible that the overly simple design of the multiple-choice questions is connected to the ceiling effect. Therefore, future research may explore a more open-question format or a combination of both. It can also be considered to not only test memory retention, but also knowledge transfer of the learned material onto a problem-solving task, for testing a more in-depth understanding of the topic. In general, a variety of difficulty levels could allow for more differentiated results to be able to distinguish more between the results of the experimental groups. In addition to this, it is advisable to conduct a pre-test before the distribution of the study to ensure clarity and evaluate item clarity, difficulty, and engagement. These adjustments may improve the quality of emotional design studies greatly.

Practical Application

Managing Cognitive Load in Learning Environments

Another practical takeaway is the need to manage cognitive load more effectively in learning environments. This was shown through the ceiling effect in retention scores and the task's high perceived difficulty, which in combination points towards an overloaded intrinsic or extraneous load. The lengthy paragraphs of text also may have played a role in this. Therefore, this emphasises the importance of dividing content into digestible chunks, using formatting tools like headings or bold keywords, and including illustrative materials that aid the understanding of the content in educational practice. By doing this, cognitive demands are not overloaded, and learners are likely to have more capacity to engage with the content.

Supporting Perceived Control to Enhance Emotions and Engagement

The Control-Value Theory of Achievement Emotions (Pekrun, 2006) states that when students feel in control of their learning process and value the task at hand, they will feel more positive emotions and be more engaged. To aid this, careful instructional design, especially in the way learning environments handle task difficulty and feedback, is one way to improve perceived control. Adaptive scaffolding, or gradually increasing task complexity, enables learners to develop competence and confidence gradually, supporting sustained cognitive effort and emotional resilience (Francom, 2018). Furthermore, giving learners prompt, detailed feedback during or right after tasks helps them attribute results to strategy and effort rather than outside influences, which strengthens their sense of agency (Shute, 2008). When combined, these tactics create a classroom atmosphere where students may feel more empowered.

Conclusion

The aim of this study was to explore whether anthropomorphic design elements affect learners' emotional responses and memory retention. According to the results, the experimental groups' affect and performance on the retention task, however, did not differ significantly. Although all groups experienced a general decline in positive affect following the task, this shift was independent of whether anthropomorphic elements were present or not. These results imply that anthropomorphic images, still require more research and improvement in order to be used effectively to enhance learning.

Despite the rejection of the hypotheses, the study nevertheless provides insightful information for educational design. For example, including the possible influence of factors such as perceived difficulty, cognitive load, and learners' sense of control in learning material creation is of high importance. The limitations, such as the absence of attention checks and validated memory retention measures, also showcase areas that future designs need to consider. In order to improve learning, more varied emotional design scenarios, more varied and difficult memory tasks, and more accurate emotion tracking may be included. In this regard, this study expands the current understanding of how to make learning more efficient and engaging while also adding to the continuing conversation about emotional design in education.

References

Berney, S., & Bétrancourt, M. (2016). Does animation enhance learning? A meta-analysis. *Computers & Education*, *101*, 150–167. https://doi.org/10.1016/j.compedu.2016.06.005

Brom, C., Stárková, T., & D'Mello, S. K. (2018). How effective is emotional design? A meta-analysis on facial anthropomorphisms and pleasant colors during multimedia learning. *Educational Research Review*, *25*, 100–119. https://doi.org/10.1016/j.edurev.2018.09.004

Camacho-Morles, J., Slemp, G. R., Pekrun, R., Loderer, K., Hou, H., & Oades, L. G. (2021). Activity Achievement Emotions and Academic Performance: A Meta-analysis. *Educational Psychology Review*, *33*(3), 1051–1095. https://doi.org/10.1007/s10648-020-09585-3

Candido, V., & Cattaneo, A. (2025). Applying cognitive theory of multimedia learning principles to augmented reality and its effects on cognitive load and learning outcomes. *Computers in Human Behavior Reports*, *18*, 100678. https://doi.org/10.1016/j.chbr.2025.100678

Castro-Alonso, J. C., Wong, M., Adesope, O. O., Ayres, P., & Paas, F. (2019). Gender Imbalance in Instructional Dynamic Versus Static Visualizations: a Meta-analysis. *Educational Psychology Review*, *31*(2), 361–387. https://doi.org/10.1007/s10648-019-09469-1

Counting What Counts. (2025, April 17). Impact & Insight Toolkit. https://impactandinsight.co.uk/

Dudzik, B., & Broekens, J. (2023). A Valid Self-Report is Never Late, Nor is it Early: On Considering the "Right" Temporal Distance for Assessing Emotional Experience. *arXiv (Cornell University)*. https://doi.org/10.48550/arxiv.2302.02821

Efklides, A., & Schwartz, B. L. (2024). Revisiting the metacognitive and affective model of Self-Regulated Learning: Origins, development, and future directions. *Educational Psychology Review*, *36*(2). https://doi.org/10.1007/s10648-024-09896-9

Eitel, A., Kühl, T., Scheiter, K., & Gerjets, P. (2014). Disfluency meets cognitive load in multimedia learning: Does Harder-to-Read mean Better-to-Understand? *Applied Cognitive Psychology*, *28*(4), 488–501. https://doi.org/10.1002/acp.3004

Francom, G. (2018). Ten Steps to Complex Learning: a Systematic Approach to Four-Component Instructional Design (3rd ed.), by Jeroen J. G. van Merriënboer and Paul A. Kirschner. *TechTrends*, *62*(2), 204–205. https://doi.org/10.1007/s11528-018-0254-0

Guo, X., Zhu, T., Wu, C., Bao, Z., & Liu, Y. (2022). Emotional activity is negatively associated with cognitive load in multimedia learning: a case study with EEG signals. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.889427

Hawthorne, B. S., Slemp, G. R., Vella-Brodrick, D. A., & Hattie, J. (2024). The relationship between positive and painful emotions and cognitive load during an algebra learning task. *Learning and Individual Differences*, *117*, 102597. https://doi.org/10.1016/j.lindif.2024.102597

Heidig, S., Müller, J., & Reichelt, M. (2015). Emotional design in multimedia learning: Differentiation on relevant design features and their effects on emotions and learning. *Computers in Human Behavior*, *44*, 81–95. https://doi.org/10.1016/j.chb.2014.11.009

Höffler, T. N., & Leutner, D. (2007). Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction*, *17*(6), 722–738. https://doi.org/10.1016/j.learninstruc.2007.09.013

Hultberg, P., Calonge, D. S., & Lee, A. E. S. (2018). Promoting long-lasting learning through instructional design. *Journal of the Scholarship of Teaching and Learning*, *18*(3). https://doi.org/10.14434/josotl.v18i3.23179

Jaeger, S. R., & Cardello, A. V. (2022). Factors affecting data quality of online questionnaires: Issues and metrics for sensory and consumer research. *Food Quality and Preference*, *102*, 104676. https://doi.org/10.1016/j.foodqual.2022.104676

Kaifeng, L., & Pengbo, S. (2024). Effectiveness of facial anthropomorphism design for improving multimedia learning outcomes: systematic review and meta-analysis. *Smart Learning Environments*, *11*(1). https://doi.org/10.1186/s40561-024-00332-7

Kirschner, P. A., & Kirschner, F. (2012). Mental effort. In *Springer eBooks* (pp. 2182–2184). https://doi.org/10.1007/978-1-4419-1428-6_226

Krieglstein, F., Beege, M., Rey, G. D., Sanchez-Stockhammer, C., & Schneider, S. (2023). Development and validation of a Theory-Based questionnaire to measure different types of cognitive load. *Educational Psychology Review*, *35*(1). https://doi.org/10.1007/s10648-023-09738-0

Knörzer, L., Brünken, R., & Park, B. (2016). Facilitators or suppressors: Effects of experimentally induced emotions on multimedia learning. *Learning and Instruction*, *44*, 97–107. https://doi.org/10.1016/j.learninstruc.2016.04.002

Lee, J. M., Baek, J., & Ju, D. Y. (2018). Anthropomorphic design: emotional perception for deformable object. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01829

Loderer, K., Pekrun, R., & Plass, J. L. (2020). Emotional foundations of game-based learning. *Handbook of Game-based Learning*. https://opus.bibliothek.uni-augsburg.de/opus4/frontdoor/index/index/docId/68937

Lyu, C., & Deng, S. (2024). Effectiveness of embodied learning on learning performance: A meta-analysis based on the cognitive load theory perspective. *Learning and Individual Differences*, *116*, 102564. https://doi.org/10.1016/j.lindif.2024.102564

Magyar-Moe, J. L. (2009). Positive psychological tests and measures. In *Elsevier eBooks* (pp. 43–72). https://doi.org/10.1016/b978-0-12-374517-0.00003-6

Mayer, R. E. (2020). *Multimedia Learning* (3rd ed.). Cambridge: Cambridge University Press.

Mayer, R. E., & Estrella, G. (2014). Benefits of emotional design in multimedia instruction. *Learning and Instruction*, *33*, 12–18. https://doi.org/10.1016/j.learninstruc.2014.02.004

Medvedev, O. N., Roemer, A., Krägeloh, C. U., Sandham, M. H., & Siegert, R. J. (2021). Enhancing the precision of the Positive and Negative Affect Schedule (PANAS) using Rasch analysis. *Current Psychology*, *42*(2), 1554–1563. https://doi.org/10.1007/s12144-021-01556-3

Mutlu-Bayraktar, D. (2024). A systematic review of emotional design research in multimedia learning. *Education and Information Technologies*. https://doi.org/10.1007/s10639-024-12823-8

Um, E, Plass, J. L., Hayward, E. O., & Homer, B. D. (2012). Emotional design in multimedia learning. *Journal of Educational Psychology*, *104*(2), 485–498. https://doi.org/10.1037/a0026609

Özgür, A., & Altun, A. (2021). Emotional design and engagement with multimedia learning materials in E-Learning. In *Advances in mobile and distance learning book series* (pp. 168–191). https://doi.org/10.4018/978-1-7998-7681-6.ch008

Park, B., Knörzer, L., Plass, J. L., & Brünken, R. (2015). Emotional design and positive emotions in multimedia learning: An eyetracking study on the use of anthropomorphisms. *Computers & Education*, *86*, 30–42. https://doi.org/10.1016/j.compedu.2015.02.016

Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, *18*(4), 315–341. https://doi.org/10.1007/s10648-006-9029-9

Pekrun, R., & Stephens, E. J. (2011). Academic emotions. In *American Psychological Association eBooks* (pp. 3–31). https://doi.org/10.1037/13274-001

Plass, J. L., & Hovey, C. (2021). The emotional design principle in multimedia learning. In *Cambridge University Press eBooks*(pp. 324–336). https://doi.org/10.1017/9781108894333.034

Plass, J. L., & Kalyuga, S. (2019). Four ways of considering emotion in Cognitive Load Theory. *Educational Psychology Review*, *31*(2), 339–359. https://doi.org/10.1007/s10648-019-09473-5

Ploetzner, R., Berney, S., & Bétrancourt, M. (2021). When learning from animations is more successful than learning from static pictures: learning the specifics of change. Instructional Science, 49(4), 497–514. https://doi.org/10.1007/s11251-021-09541-w

Pramono, Y. G. H. (2005). The Role of Static and Animated Pictures That Complement Texts in Supporting Learning. *Kata Journal*, *7*(1), 25–42.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, *110*(1), 145–172. https://doi.org/10.1037/0033-295x.110.1.145

Sadoski, M., & Paivio, A. (2013). Imagery and text. In *Routledge eBooks*. https://doi.org/10.4324/9780203801932

Schneider, S., Nebel, S., & Rey, G. D. (2016). Decorative pictures and emotional design in multimedia learning. *Learning and Instruction*, *44*, 65–73. https://doi.org/10.1016/j.learninstruc.2016.03.002

Sequeira, A. H. (2012). Introduction to concepts of teaching and learning. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2150166

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153–189. https://doi.org/10.3102/0034654307313795

Skulmowski, A., & Xu, K. M. (2021). Understanding Cognitive Load in Digital and Online Learning: A New Perspective on Extraneous Cognitive Load. *Educational Psychology Review*, *34*(1), 171–196. https://doi.org/10.1007/s10648-021-09624-7

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, *6*, 1063. https://ogg.osu.edu/media/documents/MB%20Stream/PANAS.pdf

Wong, R. M., & Adesope, O. O. (2020). Meta-Analysis of Emotional Designs in Multimedia Learning: A replication and extension study. *Educational Psychology Review*, *33*(2), 357–385. https://doi.org/10.1007/s10648-020-09545-x

Appendix

Consent Form

Q1

Dear participant,

Thank you for your willingness to participate in this research study! My name is Zoë Elster and I am from the Faculty of Behavioural, Management and Social Sciences at the University of Twente. This study is part of a research project within the scope of my bachelor's thesis.

This study evaluates the effectiveness of different study materials. For this, a learning task will be presented containing study material, followed by a retention task. The exercise will take approximately 15 minutes to complete.

Note: Please be a university/college student to participate in the study.

Risks: You will be asked to evaluate your current mood, this may potentially cause a mild short-term emotional reaction. Additionally, you will be asked to attempt to retain information of a learning task, which may be mentally exhausting for some. Participants rights: Your participation in this study is entirely voluntary, and you can withdraw at any time.

Data and confidentiality: Your answers in this study are anonymised and will remain confidential. The University of Twente stores the data for approximately ten years. Moreover, ethical approval was gained by the ethics committee of the University of Twente.
Ethical request number: 250454.

If you have any further questions, please contact me or my supervisor:
z.s.elster@student.utwente.nl
l.hogenkamp@utwente.nl

Please tick the appropriate box: I have read and understood the study information above or it has been read to me. I am aware of the risk this study contains. Additionally, I consent voluntarily to participate in this study and understand that I can withdraw from the study at any time without having to give a reason.

- Yes
- No

Page Break

Import from library
Add new question

Demographics

Q2
In the following, you are asked to answer some personal questions.
Are you a university/college student?

- Yes
- No

Page Break

Q3
What is your age?
Add page break

Q4
What is your gender?

- Male
- Female
- Non-binary / third gender
- Prefer not to say

Add page break

Q5
What country are you from?

PANAS

Q6
Firstly, you will be asked to evaluate your current mood state, by filling out the following scale.

Indicate the extent to which you feel this way, right now.

	Very Slightly or Not at all	A little	Moderately	Quite a bit	Extremely
Interested					
Distressed					
Excited					
Upset					
Strong					
Guilty					
Scared					
Hostile					
Enthusiastic					
Proud					
Irritable					
Alert					
Ashamed					
Inspired					
Nervous					
Determined					
Attentive					
Jittery					
Active					
Afraid					

Page Break

Import from library
Add new question

Learning Task instruction

Q28
Important information:

In the next part of the survey, you will be shown a text. Please read it carefully, as you will be asked a few questions about its content afterward. It is important that you do not look up any information online or use any external sources to answer the questions. Please also do not take any notes.

Thank you.

Note that once you finish reading the text, you will not be able to return to the previous page.

Import from library

Add new question

Add Block

Learning Task- Control Group

Control Group

Understanding the Immune System: How Our Body Defends Itself

The immune system is a complex network of cells, tissues, and organs that work together to protect the body from harmful invaders, such as bacteria, viruses, and other pathogens. The immune response can be divided into two main types: innate immunity and adaptive immunity. Both are crucial for keeping us healthy, and they work together to fight off infections and provide long-term protection.

1. Innate Immunity: The First Line of Defense

Innate immunity is the body's initial, rapid response to harmful invaders. It's the first defense mechanism that kicks in when the body detects infection or injury. Unlike adaptive immunity, which is specific and learns over time, innate immunity provides a broad, non-specific defense.

Physical Barriers: Our First Wall of Protection

The skin and mucous membranes (like those in the nose and mouth) act as physical barriers that prevent pathogens from entering the body. Think of these as walls or shields that stop harmful invaders from crossing into more sensitive areas.

Phagocytic Cells: The Body's "Pac-Man" Defenders

Phagocytic cells, including macrophages and neutrophils, are specialized immune cells that play a crucial role in the innate immune response. These cells act like the body's "clean-up crew," constantly patrolling for harmful invaders, such as bacteria, viruses, or dead cells. When they encounter a pathogen, they perform a process called phagocytosis, where they engulf the pathogen, form a compartment around it called phagosome and break it down inside.

The engulfed pathogen is then destroyed by enzymes and other substances that the phagocytic cells release. This is a key defense mechanism because it eliminates pathogens quickly before they can cause damage or spread.

Inflammation: The Body's Alarm System

When there's an infection or injury, the body triggers inflammation. This process involves the release of chemicals that cause redness, swelling, and heat at the site of infection. Inflammation helps contain the infection and signals to other immune cells to come and help fight the invader. It's like a natural alarm system that calls the immune forces to action.

2. Adaptive Immunity: Targeted and Long-Term Defense
While innate immunity provides immediate protection, adaptive immunity is a more targeted, specialized defense that develops over time. It's responsible for identifying specific pathogens and "remembering" them, so the body can respond more effectively in the future.

B Cells and Antibodies: Specialized Fighters

B lymphocytes, or B cells, are a type of white blood cell found in the adaptive immune system. Their primary role is to produce antibodies, which are proteins that specifically target and neutralize pathogens such as bacteria and viruses.

When a B cell encounters a pathogen (or more specifically, the foreign molecules called antigens found on the pathogen's surface), it becomes activated and begins to produce antibodies that are specific to that pathogen. These antibodies circulate through the blood and lymphatic system, binding to the pathogen and preventing it from infecting other cells or spreading. In addition to neutralizing the pathogen directly, antibodies can mark the pathogen for destruction by other immune cells, like phagocytes.

B cells are also responsible for creating memory cells after an infection. These memory cells "remember" the pathogen, so if it reappears, the body can respond much faster and more effectively.

Memory Cells: The Immune System’s "Memory Bank"

One of the most important aspects of adaptive immunity is the creation of memory cells. After the immune system has fought off an infection, memory cells "remember" the pathogen. If the same pathogen enters the body again, these memory cells quickly recognize it and trigger a faster and stronger immune response. This is why we often become immune to diseases after being exposed to them once (like chickenpox or the flu).

Conclusion: A Coordinated Defense System

Together, innate and adaptive immunity form a comprehensive defense system. Innate immunity acts quickly to protect us from harm, while adaptive immunity provides targeted, long-lasting protection. By working together, these two systems keep the body safe from a wide range of threats, ensuring we remain healthy and resilient.

Import from library

Add new question

Learning Task- Anthropomorphic Condition

Group 1

Understanding the Immune System: How Our Body Defends Itself

The immune system is a complex network of cells, tissues, and organs that work together to protect the body from harmful invaders, such as bacteria, viruses, and other pathogens. The immune response can be divided into two main types: innate immunity and adaptive immunity. Both are crucial for keeping us healthy, and they work together to fight off infections and provide long-term protection.

1. Innate Immunity: The First Line of Defense

Innate immunity is the body’s initial, rapid response to harmful invaders. It’s the first defense mechanism that kicks in when the body detects infection or injury. Unlike adaptive immunity, which is specific and learns over time, innate immunity provides a broad, non-specific defense.

Physical Barriers: Our First Wall of Protection

The skin and mucous membranes (like those in the nose and mouth) act as physical barriers that prevent pathogens from entering the body. Think of these as walls or shields that stop harmful invaders from crossing into more sensitive areas.

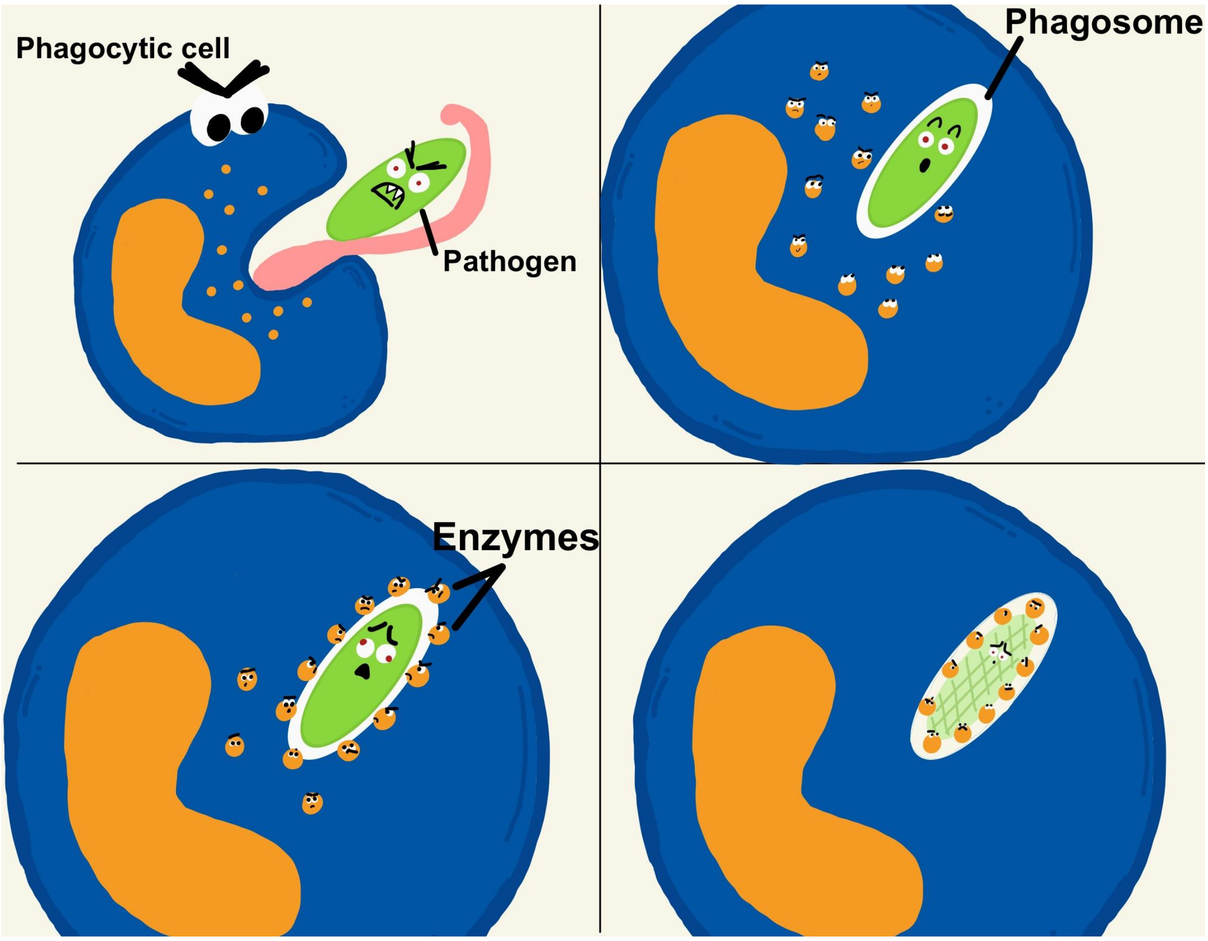
Phagocytic Cells: The Body’s "Pac-Man" Defenders

Phagocytic cells, including macrophages and neutrophils, are specialized immune cells that play a crucial role in the innate immune response. These cells act like the body's "clean-up crew," constantly patrolling for harmful invaders, such as bacteria, viruses, or dead cells. When they encounter a pathogen, they perform a process called phagocytosis, where they engulf the pathogen, form a compartment around it called phagosome and break it down inside.

The engulfed pathogen is then destroyed by enzymes and other substances that the phagocytic cells release. This is a key defense mechanism because it eliminates pathogens quickly before they can cause damage or spread.

Add page break

Group 1.1



Group 1.2

Inflammation: The Body’s Alarm System

When there’s an infection or injury, the body triggers inflammation. This process involves the release of chemicals that cause redness, swelling, and heat at the site of infection. Inflammation helps contain the infection and signals to other immune cells to come and help fight the invader. It’s like a natural alarm system that calls the immune forces to action.

2. Adaptive Immunity: Targeted and Long-Term Defense

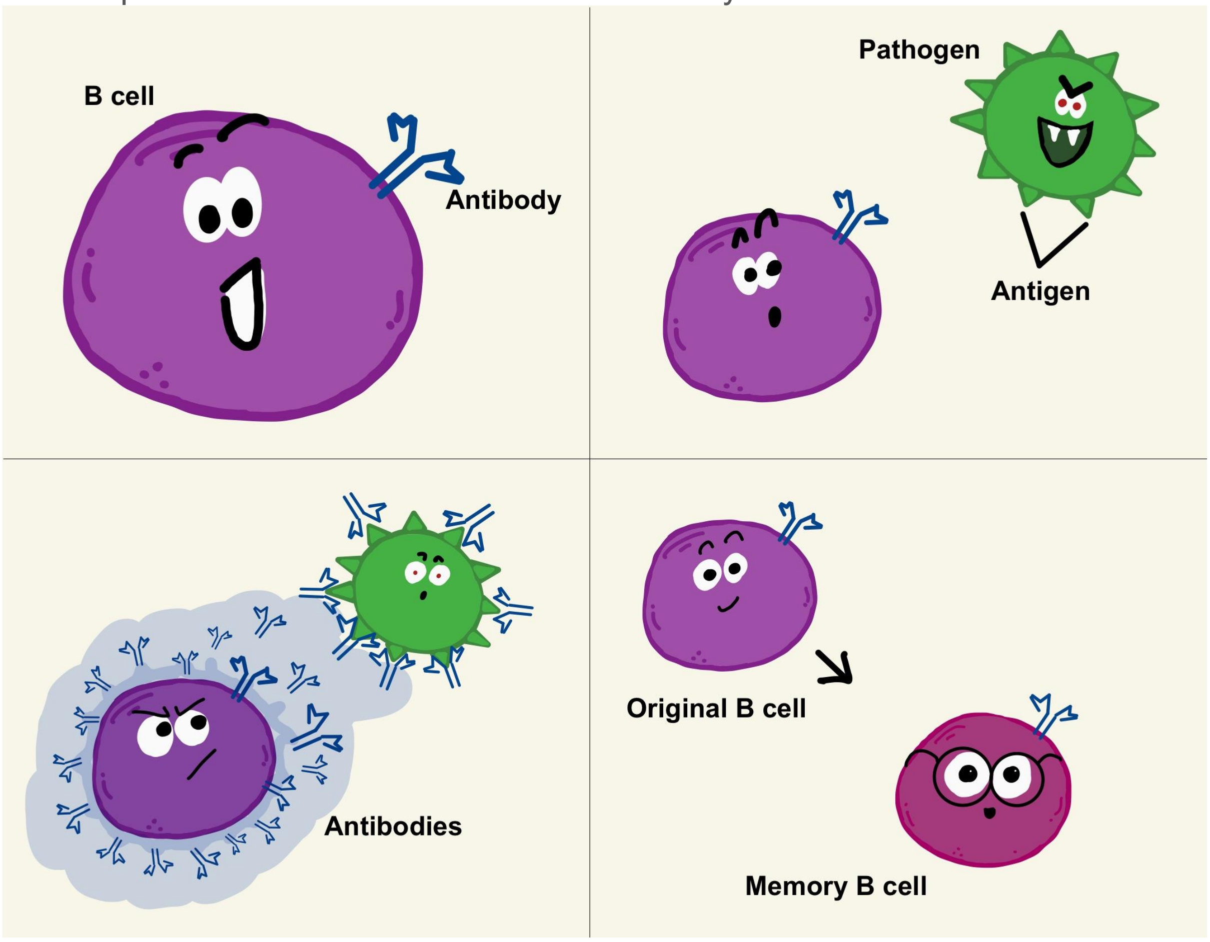
While innate immunity provides immediate protection, adaptive immunity is a more targeted, specialized defense that develops over time. It’s responsible for identifying specific pathogens and "remembering" them, so the body can respond more effectively in the future.

B Cells and Antibodies: Specialized Fighters

B lymphocytes, or B cells, are a type of white blood cell found in the adaptive immune system. Their primary role is to produce antibodies, which are proteins that specifically target and neutralize pathogens such as bacteria and viruses.

When a B cell encounters a pathogen (or more specifically, the foreign molecules called antigens found on the pathogen's surface), it becomes activated and begins to produce antibodies that are specific to that pathogen. These antibodies circulate through the blood and lymphatic system, binding to the pathogen and preventing it from infecting other cells or spreading. In addition to neutralizing the pathogen directly, antibodies can mark the pathogen for destruction by other immune cells, like phagocytes.

B cells are also responsible for creating memory cells after an infection. These memory cells "remember" the pathogen, so if it reappears, the body can respond much faster and more effectively.



Group 1.3

Memory Cells: The Immune System’s "Memory Bank"

One of the most important aspects of adaptive immunity is the creation of memory cells. After the immune system has fought off an infection, memory cells "remember" the pathogen. If the same pathogen enters the body again, these memory cells quickly recognize it and trigger a faster and stronger immune response. This is why we often become immune to diseases after being exposed to them once (like chickenpox or the flu).

Conclusion: A Coordinated Defense System

Together, innate and adaptive immunity form a comprehensive defense system. Innate immunity acts quickly to protect us from harm, while adaptive immunity provides targeted, long-lasting protection. By working together, these two systems keep the body safe from a wide range of threats, ensuring we remain healthy and resilient.
Import from library
Add new question

Learning Task- Non- Anthropomorphic Images

Understanding the Immune System: How Our Body Defends Itself

The immune system is a complex network of cells, tissues, and organs that work together to protect the body from harmful invaders, such as bacteria, viruses, and other pathogens. The immune response can be divided into two main types: innate immunity and adaptive immunity. Both are crucial for keeping us healthy, and they work together to fight off infections and provide long-term protection.

1. Innate Immunity: The First Line of Defense

Innate immunity is the body’s initial, rapid response to harmful invaders. It’s the first defense mechanism that kicks in when the body detects infection or injury. Unlike adaptive immunity, which is specific and learns over time, innate immunity provides a broad, non-specific defense.

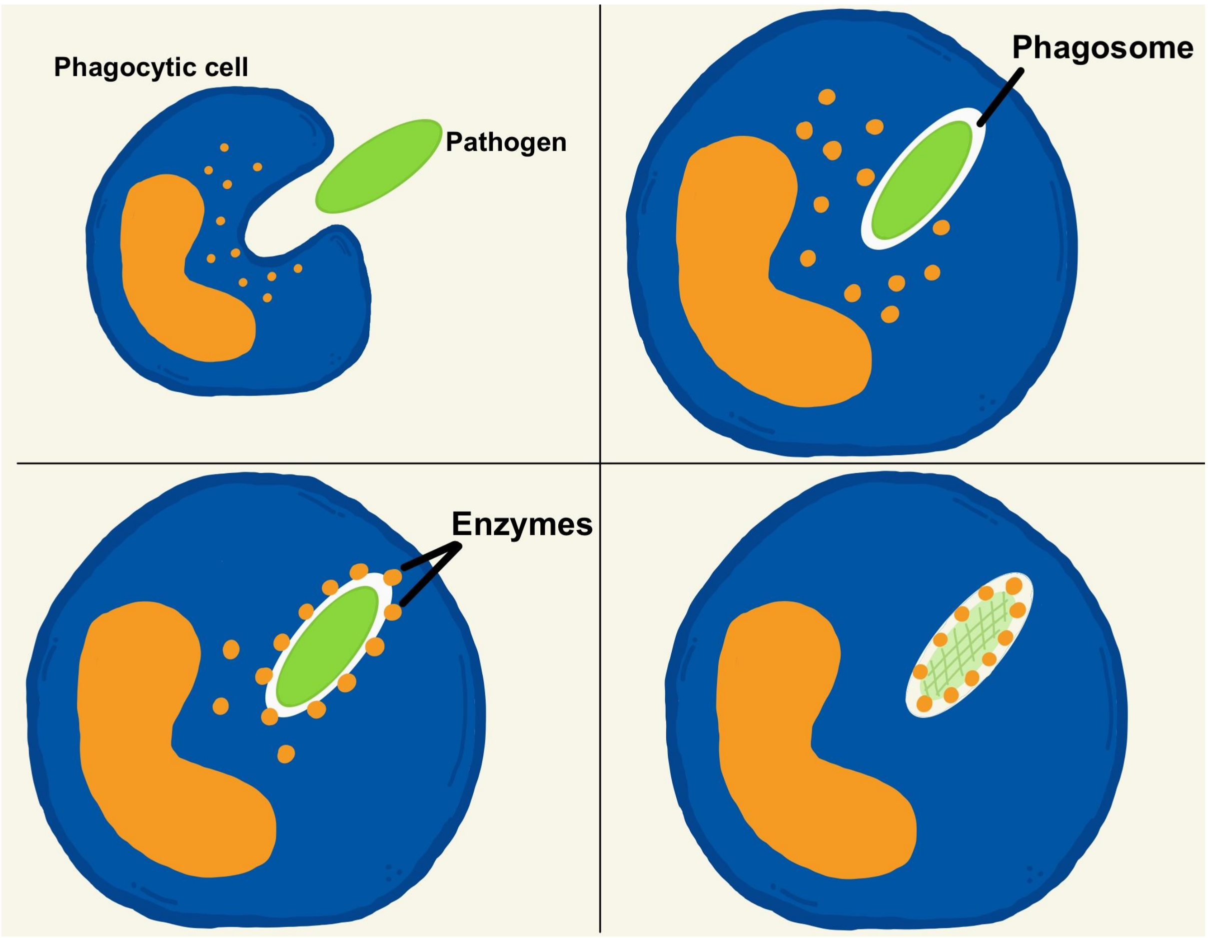
Physical Barriers: Our First Wall of Protection

The skin and mucous membranes (like those in the nose and mouth) act as physical barriers that prevent pathogens from entering the body. Think of these as walls or shields that stop harmful invaders from crossing into more sensitive areas.

Phagocytic Cells: The Body’s "Pac-Man" Defenders

Phagocytic cells, including macrophages and neutrophils, are specialized immune cells that play a crucial role in the innate immune response. These cells act like the body's "clean-up crew," constantly patrolling for harmful invaders, such as bacteria, viruses, or dead cells. When they encounter a pathogen, they perform a process called phagocytosis, where they engulf the pathogen, form a compartment around it called phagosome and break it down inside.

The engulfed pathogen is then destroyed by enzymes and other substances that the phagocytic cells release. This is a key defense mechanism because it eliminates pathogens quickly before they can cause damage or spread.
Add page break



Inflammation: The Body’s Alarm System

When there’s an infection or injury, the body triggers inflammation. This process involves the release of chemicals that cause redness, swelling, and heat at the site of infection. Inflammation helps contain the infection and signals to other immune cells to come and help fight the invader. It’s like a natural alarm system that calls the immune forces to action.

2. Adaptive Immunity: Targeted and Long-Term Defense

While innate immunity provides immediate protection, adaptive immunity is a more targeted, specialized defense that develops over time. It’s responsible for identifying specific pathogens and "remembering" them, so the body can respond more effectively in the future.

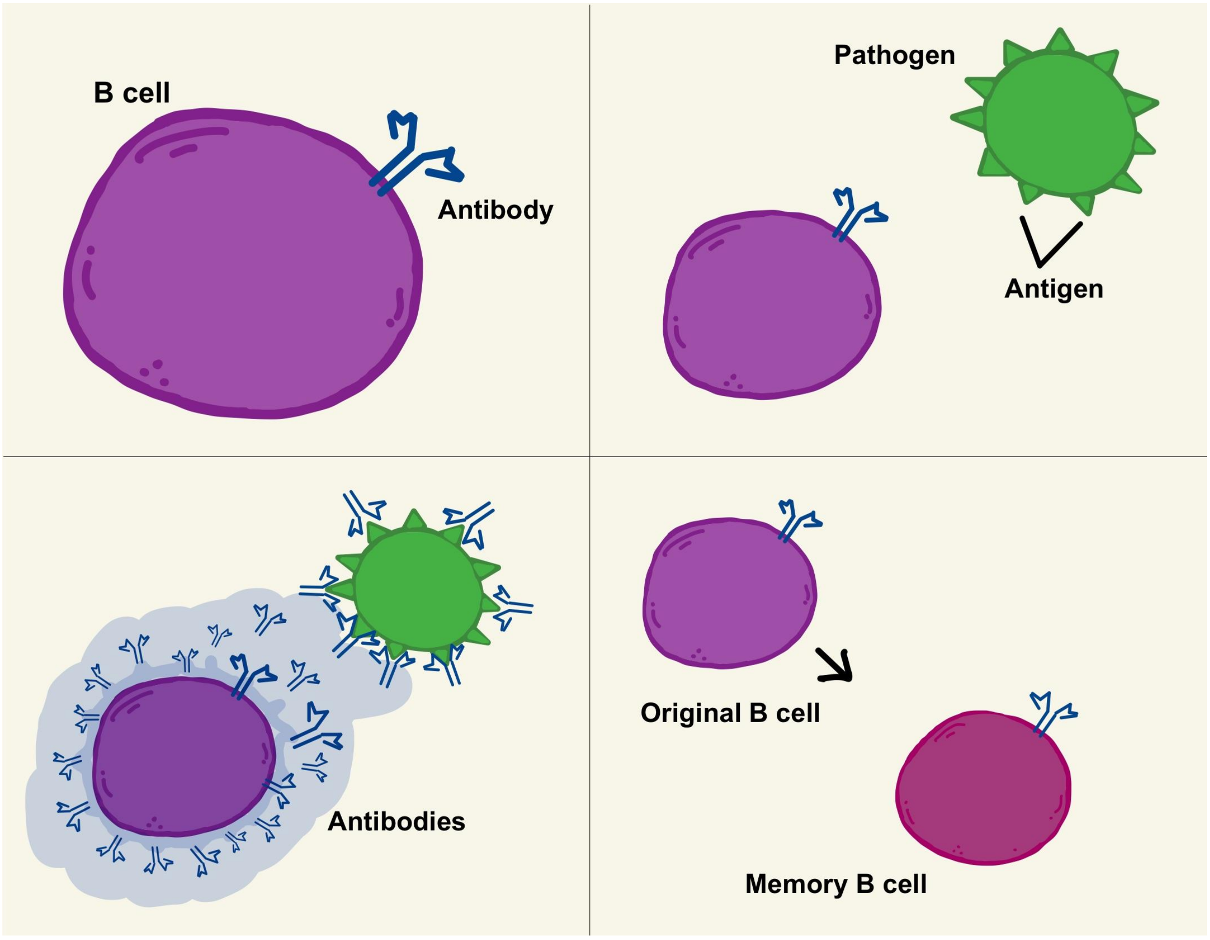
B Cells and Antibodies: Specialized Fighters
B lymphocytes, or B cells, are a type of white blood cell found in the adaptive immune system. Their primary role is to produce antibodies,

which are proteins that specifically target and neutralize pathogens such as bacteria and viruses.

When a B cell encounters a pathogen (or more specifically, the foreign molecules called antigens found on the pathogen's surface), it becomes activated and begins to produce antibodies that are specific to that pathogen. These antibodies circulate through the blood and lymphatic system, binding to the pathogen and preventing it from infecting other cells or spreading. In addition to neutralizing the pathogen directly, antibodies can mark the pathogen for destruction by other immune cells, like phagocytes.

B cells are also responsible for creating memory cells after an infection. These memory cells "remember" the pathogen, so if it reappears, the body can respond much faster and more effectively.

Add page break



Memory Cells: The Immune System’s "Memory Bank"

One of the most important aspects of adaptive immunity is the creation of memory cells. After the immune system has fought off an infection, memory cells "remember" the pathogen. If the same pathogen enters the body again, these memory cells quickly recognize it and trigger a faster and stronger immune response. This is why we often become immune to diseases after being exposed to them once (like chickenpox or the flu).

Conclusion: A Coordinated Defense System

Together, innate and adaptive immunity form a comprehensive defense system. Innate immunity acts quickly to protect us from harm, while adaptive immunity provides targeted, long-lasting protection. By working together, these two systems keep the body safe from a wide range of threats, ensuring we remain healthy and resilient.
Import from library
Add new question

Memory Assessment

In the following part you will be asked a series of questions based on the previous test, to assess your retention of the material.
Add page break

1. What is the primary role of innate immunity?

- A) To target specific pathogens and provide long-term protection
- B) To provide a rapid, non-specific defense against pathogens
- C) To produce antibodies against pathogens
- D) To "remember" previous infections for faster response

2. Which of the following is an example of a physical barrier in the immune system?

- A) Phagocytic cells
- B) Skin and mucous membranes
- C) Antibodies

- D) Memory cells

3. What is the role of phagocytic cells like macrophages and neutrophils?

- A) To "eat" and destroy harmful pathogens
- B) To produce antibodies that target pathogens
- C) To trigger inflammation
- D) To store information about past infections

4. What is the purpose of inflammation in the immune response?

- A) To help produce antibodies
- B) To prevent pathogens from entering the body
- C) To signal immune cells to come to the site of infection and contain it
- D) To create memory cells for future protection

5. What do B lymphocytes (B cells) produce to fight off pathogens?

- A) Memory cells
- B) Phagocytic cells
- C) Antibodies
- D) Inflammatory chemicals

6. How do memory cells contribute to the immune response?

- A) They help destroy pathogens during the first encounter
- B) They remember pathogens and allow for a faster response if the pathogen returns
- C) They trigger inflammation to alert the body
- D) They produce antibodies during an infection

7. What is the key difference between innate and adaptive immunity?

- A) Adaptive immunity provides immediate protection, while innate immunity is slower.
- B) Innate immunity is specific to pathogens, while adaptive immunity is broad and non-specific.
- C) Adaptive immunity is present from birth, while innate immunity develops over time.
- D) Innate immunity provides broad, rapid protection, while adaptive immunity provides targeted, long-term protection.

8. Why is adaptive immunity considered "targeted"?

- A) It involves the creation of general antibodies for all types of pathogens.
- B) It "remembers" specific pathogens and responds more effectively when they return.
- C) It works slower but produces immediate protection.
- D) It produces antibodies that attack all pathogens equally.

9. Which part of the immune system is responsible for the body's first, rapid response to infection?

- A) B lymphocytes
- B) Innate immunity
- C) Adaptive immunity
- D) Memory cells

10. What do phagocytic cells do when they encounter a pathogen?

- A) They engulf and destroy the pathogen.
- B) They produce antibodies.
- C) They trigger the production of memory cells.
- D) They create inflammation at the site of infection.

11. Which of the following is a characteristic of adaptive immunity?

- A) It is present at birth and provides immediate protection.
- B) It is a non-specific defense mechanism.
- C) It targets specific pathogens and has a long-term protective effect.
- D) It does not require previous exposure to pathogens to function.

12. How do antibodies produced by B cells help protect the body?

- A) By destroying infected cells
- B) By creating memory of past infections
- C) By signaling inflammation at the infection site
- D) By binding to pathogens and neutralizing them

13. What happens to the immune response after a pathogen has been encountered once?

- A) The immune system forgets the pathogen.
- B) The body relies only on innate immunity for future defense.
- C) The immune system creates memory cells that recognize the pathogen for faster future responses.
- D) The body stops producing antibodies.

Import from library
Add new question

PANAS- Post Task

Indicate the extent to which you feel this way, right now.

	Very Slightly or Not at all	A little	Moderately	Quite a bit	Extremely
Interested					
Distressed					
Excited					
Upset					
Strong					
Guilty					
Scared					
Hostile					
Enthusiastic					
Proud					
Irritable					
Alert					
Ashamed					
Inspired					
Nervous					
Determined					
Attentive					
Jittery					
Active					

	Very Slightly or Not at all	A little	Moderately	Quite a bit	Extremely
Afraid					

Perceived Difficulty

How did you find the learning task?

- ☐ Very difficult
- ☐ Somewhat Difficult
- ☐ Somewhat Easy
- ☐ Very Easy
- ☐ Other

Import from library
Add new question

Debrief

Debrief:
Thank you for participating in this study. This research investigated how emotions influence learning, specifically whether adding emotionally engaging design elements to learning materials affects memory and understanding. In particular, we examined whether including images with human-like features (e.g., faces or expressions) leads to improved recall compared to more neutral materials. This is called anthropomorphic design. Your responses will help us better understand the role of emotional design in educational settings.

Import from library
Add new question

End of Survey

Thank you for your participation! You have finished the survey.

Your response has been recorded.

If there are any concerns, do not hesitate to contact us:

z.s.elster@student.utwente.nl

l.hogenkamp@utwente.nl