

HOW ADDRESSING MENTAL MODELS IN PRODUCT DESIGN AFFECTS THE SUCCESS OF SUSTAINABLE INNOVATIONS

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INTRODUCTION

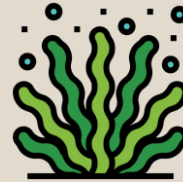
WE USE THE CONCEPT OF MENTAL MODELS TO EXPLAIN APPREHENSIVE BEHAVIOR TOWARDS BIO-BASED PRODUCTS

Theoretical Concept & Relevance of the Study

***Target system:
Algae-based product***



***Applied mental model:
Algae***



“Mental models are naturally evolving models. That is, through interaction with a target system, people formulate mental models of that system. These models need not be technically accurate (and usually are not).”

- 1. Understand the mental model of „algae“*
- 2. Understand how consumers refer to this model when confronted with the target system „algae-based product“*
- 3. Understand how to challenge this mental model to overcome this reference*

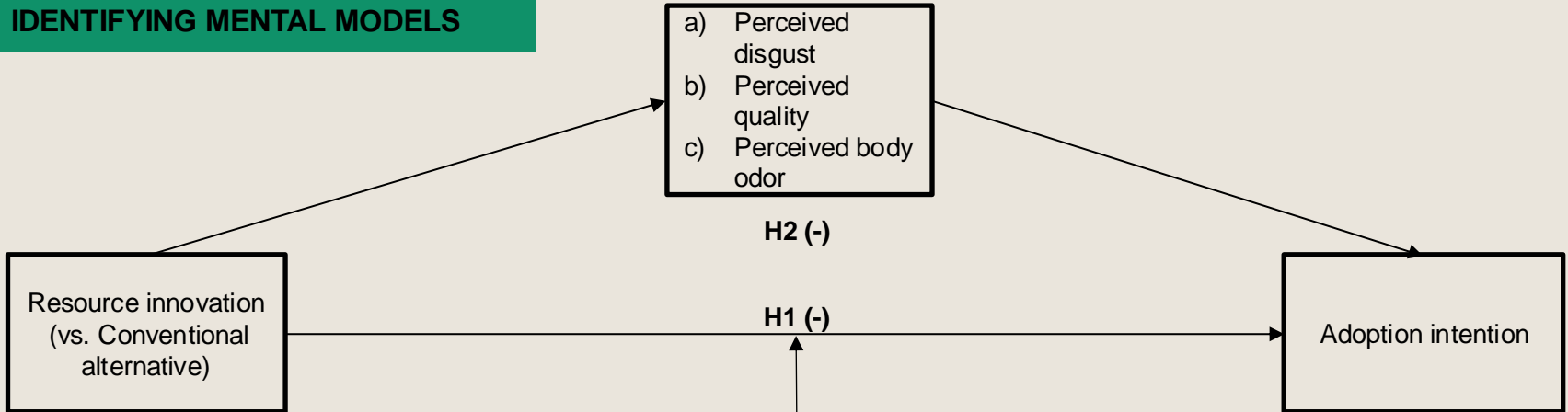


METHODOLOGY

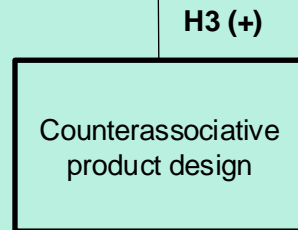
OUR RESEARCH FRAMEWORK COMPRISES 2 STEPS EACH FOLLOWING AN EXPLORE AND TEST DESIGN

Research Framework

1. IDENTIFYING MENTAL MODELS



2. CHALLENGING MENTAL MODELS





IDENTIFYING CONSUMERS' MENTAL MODELS

TO IDENTIFY CONSUMERS MENTAL MODELS WE CONDUCTED THREE QUALITATIVE STUDIES

Overview of Qualitative Studies

Study	Aim	Participants	Outcomes
Focus groups	In-depth understanding of consumers associations towards the resource algae	n = 26, in person at the company's headquarter and flagship store	We found eighteen recurring themes in consumers associations. Those serve as overall dimensions of consumers mental models towards the resource
Free association task	Broader understanding of consumers associations towards the resource algae as manifestations of their mental models	n = 200, online, recruited via Prolific	
Essay task	Understanding consumers' negative mental models about algae as a resource in a consumption context of a resource innovation (i.e., an algae-based T-shirt)	n = 200, online, recruited via Prolific	We found that especially four were strongly associated with the resource innovation in a consumption context. Three of those dimensions are connoted negatively.

WE ASKED FOR THE FIRST WORDS, IMAGES, ASSOCIATIONS THAT COME TO PARTICIPANTS MINDS WHEN THINKING ABOUT ALGAE ...

Free Association Task Data

Dimension	Significant examples	Mentions
Water	water, sea, ocean, pond, lakes, swimming	187
Color	green, blue, dark, brown	166
Texture	slime, slimy, wet, sticky, slippery, gloopy	152
Nature and Plants	plant, seaweed, weeds, fungus	91
Ecology	sustainable, sustainability, natural, environment, organic	35
Unpleasant	dirty, disgusting, unpleasant, gross, nasty, bad	33
Smell	smelly, smell, murky, pungent, fishy, odor	29
Animals	frogs, fish, whales, animals, ducks	28
Food	food, nutritious, edible, superfood, sushi, wakame salad	19
Coastal Areas	rocks, beach, sand, tropical	16
Growth	growth, fast growing, spreading, abundant, lots	16
Health	health, healthy, disease, toxic, danger	16
Life	life, alive, organism, living, bloom	13
Photosynthesis	photosynthesis, oxygen	10
Pollution	pollution, contamination, dirty water	10
Cosmetics	beauty, skincare, cream	7
Size	small, tiny, long	7
Pleasant	cool, good, looks nice	5

... AND CAPTURED THEIR RELEVANCE IN A HYPOTHETICAL CONSUMPTION CONTEXT

Essay Task Data

Associations on algae-based fiber t-shirts			
Dimension	Representative quotes	Valuation (number of mentions)	positive / negative
Ecology	it is meant to be sustainable and good for the environment, part of a uniform that represents eco-friendly values.	33	26 / 7
Texture	this material return back to its natural state and become slimy and disintegrate, it would become very sweaty, sticky and uncomfortable, I felt increasingly uncomfortable in the damp t-shirt.	33	1 / 32
Smell	I also have a fear that it might have an odd natural smell, it may contain smells etc that may not be tolerated by people around me, the algae would leave a strange odor on his skin	31	1 / 30
Water	in water would this material return back to its natural state, don't know the durability of it, if I go in the water whether it will turn to mush, the t shirt i am wearing to have come from the bottom of some swamp	18	0 / 18
Unpleasant	wearing an algae based t-shirt is gross, the way it looks when it is in its natural form disgusts me, I found it very weird and spooked out	17	0 / 17
Color	the colours resembled a swamp, something made from algae will not be dyed with the bold sharp white colour that I need	9	1 / 8
Animals	I will be presenting a compelling source of food to the hungry gulls, I would not wear this t shirt when picking up my animals or going near	6	0 / 6
Health	I am allergic to algae and it makes my body swell up, they contain chemicals that are harmful	5	0 / 5
Pleasant	I imagine that I am at a wedding and want something smart and elegant, material that keeps me cool	4	2 / 2
Nature and Plants	it would probably not cope well in the sun, intrigued by the blend of seaweed and algae	8	3 / 5
Life	made from a living thing, plant and fish life will be compromised	2	1 / 1

EXPERIMENTAL STUDY 1 TESTED THE NEGATIVE MENTAL MODEL EFFECT

Stimuli & Results of Experimental Study 1

An ANOVA on innovation adoption provides support for the **negative mental model effect (H1)**. Participants showed a significantly lower intention to adopt the T-shirt when it was described as made of an algae-based fiber versus made of organic cotton ($M_{\text{algae}} = 4.83$; $SD = 1.49$; $M_{\text{cotton}} = 5.14$; $SD = 1.32$; $p = .030$; $\eta^2 = .012$; $F(1, 397) = 2,582$).

The effect remained robust when the control variables age ($p = .008$) and gender ($p = .627$) were entered to the model ($p = .036$).

New T-Shirt Made of Algae-based Fiber



Core Features:

- Material: 100 % **algae-based fiber**
- Regular crew neck fit
- Comfortable material
- Colorways: white, grey

New T-Shirt Made of Organic Cotton



Core Features:

- Material: 100 % **organic cotton fiber**
- Regular crew neck fit
- Comfortable material
- Colorways: white, grey

EXPERIMENTAL STUDY 2 INVESTIGATED THE MEDIATING ROLE OF VARIABLES DERIVED FROM OUR QUALITATIVE STUDIES

Stimuli & Results of Experimental Study 2

Innovation adoption. $M_{\text{algae}} = 4.86$; $SD = 1.54$; $M_{\text{cotton}} = 5.30$; $SD = 1.32$; $p = .002$; $\eta^2 = .023$; $F(1, 401) = 4,920$.

Perceived disgust. $M_{\text{algae}} = 2.27$; $SD = 1.50$; $M_{\text{cotton}} = 1.33$; $SD = .79$; $F(1, 401) = 26.800$; $p < .001$; $\eta^2 = .134$

Perceived body odour. $M_{\text{algae}} = 4.00$; $SD = 1.15$; ($M_{\text{cotton}} = 4.65$; $SD = 1.09$; $F(1, 401) = .300$; $p < .001$; $\eta^2 = .079$

Perceived quality. ($M_{\text{algae}} = 4.62$; $SD = 1.32$) than when described as organic cotton fiber ($M_{\text{cotton}} = 5.61$; $SD = 0.94$; $F(1, 401) = 21.109$; $p < .001$; $\eta^2 = .159$).

Mediation analysis. The mediation analysis revealed a significant indirect total effect ($b = .85$, $SE = .10$, $CI [95\%]: .6531$ to $1,0516$) with significant indirect effects of perceived disgust ($CI [95\%]: .0085$ to $.2372$), as well as perceived unpleasant body odor ($CI [95\%]: .0380$ to $.2091$), and lower perceived quality ($CI [95\%]: .4543$ to $.8003$).

Consequently, we find support for H2.

New T-Shirt Made of Algae-based Fiber



Core Features:

- Material: 100 % algae-based fiber
- Long Sleeves
- Relaxed Fit
- Colorways: Blue, White, Black

About the T-shirt:
This long-sleeve t-shirt is made using 100 % sustainably sourced **algae-based fiber**. (Micro)-algae is a multifunctional, renewable resource and is gentle to the environment.

New T-Shirt Made of Organic Cotton



Core Features:

- Material: 100 % organic cotton
- Long Sleeves
- Relaxed Fit
- Colorways: Blue, White, Black

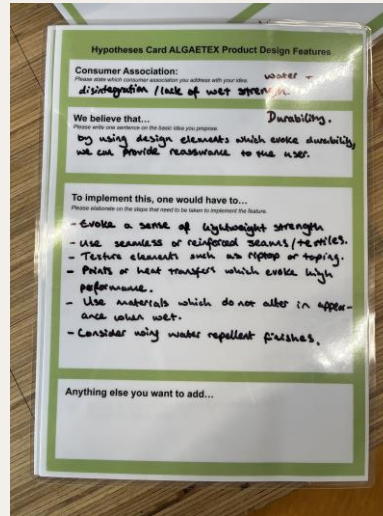
About the T-shirt:
This long-sleeve t-shirt is made using 100 % sustainably sourced **organic cotton**. Organic cotton is a multifunctional, renewable resource and is gentle to the environment.



CHALLENGING AND OVERCOMING CONSUMERS' MENTAL MODELS

IN A FOCUS GROUP SETUP EXPERTS DEVELOPED COUNTERASSOCIATIVE PRODUCT DESIGN FEATURES

Impressions from the Expert Focus Groups



1 Associations on consistency - Product design features to counteract high disgust				
	Category	Definition	Significant examples	Valuation (number of mentions)
1.1	air flow structures	Experts discussed to apply air flow structures, i. e. meshes, cut outs, slits, to increase breathability and ventilation of bio-based textiles.	utilize design functions to increase breathability (mesh) (Group 1, Notes on product design card) open back (Group 2, Notes from discussion)	12
1.2	lightweight and breathable materials	Experts discussed to use lightweight and breathable materials to create bio-based textiles that feel airy on the skin.	should feel airy (Group 1, Notes from discussion) light, should not go to hot, not too thick (Group 2, Notes from discussion)	10
1.3	dry and soft feeling materials	Experts discussed to use materials that feel dry and soft to create a bio-based textiles that feel comfortable on the skin.	brushing for comfort feeling (soft) (Group 1, Notes on product design card) quick dry (Group 2, Notes from discussion)	9
1.4	adaptive materials	Experts discussed to use materials that adapt to different conditions to create bio-based textiles that feel good on the skin in different conditions.	climate proof (Group 1, Notes from discussion) phase change material (Group 1, Notes from discussion)	6
1.5	loose fit	Experts discussed to apply loosely fitting cuts to create bio-based textiles that do not sit too close on the body.	no second skin (Group 1, Notes from discussion) not close on body, wider (Group 2, Notes from discussion)	4

2 Associations on smell - Product design features to counteract unfavorable body odor				
	Category	Definition	Significant examples	Valuation (number of mentions)
2.1	antimicrobial or additive treatments	Experts discussed to apply antimicrobial treatments, perfumes or plant extracts to chemically ensure that bio-based textiles smell fresh.	blended fabrics with yarns that are naturally antimicrobial (Group 1, Notes on product design card) Fiber: link/bond the algae product, fiber with fragrant plant-based substances (peppermint/rose) (Group 2, Notes on product design card)	18
2.2	air flow structures	Experts discussed to apply air flow structures, i. e. meshes, cut outs, slits, to increase breathability and ventilation of bio-based textiles.	cutout for ventilation -> sporty look? (Group 2, Notes on product design card) make it a mesh structure, breathable (Group 2, Notes from discussion)	13
2.3	bright colorways	Experts discussed to apply bright colorways to create bio-based textiles that are perceived as fresh.	by avoiding blue + green (algae/ocean association colors) (Group 1, Notes on product design card) Color: avoid dirty shades, use bright colors (Group 2, Notes on product design card)	9
2.4	luxury signals	Experts discussed to apply luxury signals to create bio-based textiles that are perceived as high fashion.	making the algae "luxurious/sexy:") would remove the association of a "bad" smell (Group 2, Notes on product design card) Archetypes: slip dresses, more fashionable styles (Group 2, Notes from discussion)	9
2.5	prints	Experts discussed to apply prints to create bio-based textiles that create associations to other positively associated domains	Aim for technical/futuristic prints + graphics (Group 1, Notes on product design card) moving abstract designs, print of a fragrant element (Group 2, Notes on product design card)	8

3 Associations on water - Product design features to counteract low quality				
Category	Definition	Significant examples	Valuation (number of mentions)	
3.1 weatherproof materials	Experts discussed to use weatherproof materials to create bio-based textiles that are clearly made to resist water, wind and other conditions.	I would play with the water sport aesthetics (scuba neoprene suit, finns, bathing towel, mermaids) (Group 1, Notes from discussion) GoreTex Look and Feel, Windbreakers (Group 2, Notes from discussion)	25	
3.2 durable feeling materials	Experts discussed to use durable feeling materials, i. e. stretchy, thick, dry, shiny, to create bio-based textiles that are perceived as designed to be durable.	certain thickness of the material to show robustness (Group 1, Notes from discussion) quick dry (Group 2, Notes on product design card)	21	
3.3 technical prints and shapes	Experts discussed to apply technical prints and shapes to create bio-based textiles that are perceived as technically developed for performance.	by presenting a bold, brave, inorganic, lab inspired aesthetics we will get rid of those negative connotations (Group 1, Notes on product design card) color or technical graphics (innovation) (Group 1, Notes from discussion)	17	
3.4 reinforcement signals	Experts discussed to apply reinforcement signals, i.e. seams, hardware, tips create bio-based textiles that have specific features associated with high quality.	reinforcement on seams evoke durability (Group 1, Notes from discussion) bonded seams, acquaguard tips (Group 2, Notes on product design card)	15	
3.5 performance branding and products	Experts discussed to use performance branding and products to create bio-based textiles that profit from the performance aspect associated with existing brands and product categories.	by marking it part of an established quality standard people will associate & expect a good product (Group 2, Notes on product design card) High performance run shirt (Group 1, Notes from discussion)	13	
3.6 bright colorways	Experts discussed to apply bright colorways to create bio-based textiles that are perceived as strong.	color bright strong colorful (Group 1, Notes from discussion) visual impactful colorways -> Neons, busy/bright prints (Group 2, Notes on product design card)	8	

FINALLY, WE TESTED ONE OF THE DEVELOPED COUNTERASSOCIATIVE PRODUCT DESIGN FEATURES

Stimuli & Results of Experimental Study 3

A 2 (algae vs. polyester) \times 2 (counterassociative product design vs. baseline) ANOVA on adoption intention revealed no significant effects of both material ($p = .061$; $M_{\text{algae}} = 4.95$; $SD = 1.31$; $M_{\text{polyester}} = 4.75$; $SD = 1.55$) and counterassociative product design ($p = .702$; $M_{\text{design}} = 4.87$; $SD = 1.56$; $M_{\text{baseline}} = 4.83$, $SD = 1.30$).

However, the results reveal a significant interaction effect between material type and counterassociative product design ($p = .002$; $\eta^2 = .016$; $F = (1, 601) = 18,128$).

The results remained robust when the control variables age ($p = .232$) and gender ($p = .386$) were entered to the model ($p_{\text{interaction}} = .002$; $p_{\text{material}} = .074$; $p_{\text{counterassociative design}} = .702$).

Hence, we find support for H3.

New Running Shirt Made of Algae-based Fiber



Core Features:

- Material: 100 % algae-based fiber
- **NEW!** With a durable odor control finish and antimicrobial treatment that prevents smells and creates longer freshness
- Lightweight and breathable fit
- Colorways: Green, White, Black

About the T-shirt:

This running shirt is made using 100 % sustainably sourced **algae-based fiber**. (Micro)-algae is a multifunctional, renewable resource and is gentle to the environment.

New Running Shirt Made of Recycled Polyester



Core Features:

- Material: 100 % recycled polyester
- **NEW!** With a durable odor control finish and antimicrobial treatment that prevents smells and creates longer freshness
- Lightweight and breathable fit
- Colorways: Green, White, Black

About the T-shirt:

This running shirt is made using 100 % recycled polyester. Recycled polyester is a multifunctional resource that is more gentle to the environment.



IMPLICATIONS

OUR RESEARCH OFFERS SEVERAL THEORETICAL CONTRIBUTIONS TO THE FIELDS OF INNOVATION AND PRODUCT DESIGN

Theoretical Contributions

(1)

We expand the understanding of mental models to the context of sustainable innovations

(2)

We introduce implicit consumer feedback into NPD and product design

(3)

We help to understand the cognitive mechanisms driving innovation success

COUNTERASSOCIATIVE PRODUCT DESIGN MATTERS AND IMPLICIT CONSUMER FEEDBACK IS A VALUABLE SOURCE OF INFORMATION

Practical Implications

(1) We show that infusing NPD with feedback based on consumers' mental models leads to concrete product design features that significantly enhance product perceptions (i.e., counterassociative product design).

Source: PPRMINT™
PPRMINT™ Oil Treatment
PPRMINT™ is a durable odor control finish and broad-spectrum antimicrobial treatment that enables our products to stay fresher for longer.



(2) Our research uncovers that implicit feedback beyond actual consumer needs and concrete product features is often overlooked. We provide empirical approaches to capture information that is otherwise not openly expressed such as essay writing, FAT etc.



THANK YOU FOR YOUR ATTENTION!

Please reach out for feedback and questions to:

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found here:**

www.biotextfuture.de



OVERVIEW OF MEASURES FOR DV AND MEDIATORS

For all measures we applied 7-point Likert scales

Innovation adoption (Study 1 $\alpha = .833$,
Study 2 $\alpha = .915$, Study 3 $\alpha = .895$)

To me, adopting this product is...

- (1) probable/ improbable
- (2) unlikely/ very likely
- (3) impossible/ possible

Perceived body odor

Wearing this T-shirt would make me smell...
(extremely unpleasant/ extremely pleasant).

Perceived disgust ($\alpha = .972$)

Wearing this T-shirt makes me feel...

- (1) disgusted
 - (2) unclean
 - (3) dirty
 - (4) gross
- (unlikely/ likely)

Perceived quality ($\alpha = .944$)

- (1) the likelihood that the T-shirt would be reliable is... (very low/ very high)
- (2) the likelihood that the T-shirt is dependable is... (very low/ very high)
- (3) this T-shirt seems to be durable (strongly disagree/ strongly agree)
- (4) this T-shirt seems to be of... (very poor quality/ very high quality)