Is there a link between visual perception of communication material and attitudes towards aquaponics? A pilot study using eye-tracking.

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Abstract

Our pilot study examines whether there is a link between visual perception of communication material about aquaponics and attitudes towards this innovative food production technology by combining eye tracking with a subsequent survey. We find generally positive attitudes towards aquaponics, whereby these attitudes tend to depend on the perceived naturalness of the technology. The eye-tracking data indicate a relationship between perceived naturalness of aquaponics and visual attention to text and picture information. We conclude that information contents should be carefully selected and that the demand for naturalness should be considered when designing visual communication material about aquaponics to support the adoption of this technology and its products.

Keywords

aquaponics, attitudes, eye-tracking, gaze behaviour, visual communication

1 Introduction

Aquaponics is an emerging food production technology that combines the production of aquatic organisms and the production of plants in a variety of methods and system designs (Palm et al. 2018). The technology has a high potential for sustainability and, in Europe, it can help to reach EU policy goals by minimising water and nutrient use, utilising areas unfit for other food production systems, facilitating local food production and thus providing new business opportunities (Hoevenaars et al. 2018). However, aquaponics is still considered as an innovation in Europe (Miličić et al. 2017) and, in Germany, the knowledge about the production method is still fairly low (Schröter et al. 2017).

But what are fundamental conditions to make aquaponics production flourish? Innovations fail if they are not accepted by important stakeholders. Key factors in the innovation adoption process are therefore creating awareness and knowledge about the innovation and persuasively communicating the advantages of the innovation. The communication process should be carefully planned, as it is well known that favourable attitudes towards an innovation will facilitate its adoption (Rogers 2003).

In the case of visual communication, attitudes towards the topic presented can be influenced by visual biases (van Loo et al. 2015). These biases are to a large extent the result of environmental factors, but they also arise from personal goals. Depending on these exogenous and endogenous influences, people ignore a smaller or larger part of the information that is available to them at the time of decision making. This implies that the way information is presented always to some extent affects peoples' choices (Orquin et al. 2018).

Therefore, the way of presenting information about aquaponics could be a factor that determines the success or failure of aquaponics. Against this background, we aimed to explore the relationship between visual attention to communication content and attitudes towards aquaponics. From the results, we derive first cautious recommendations for communication strategies and further development of aquaponics.

2 Methods and data

We combined eye-tracking with a subsequent survey to answer our research question. Eighteen subjects (10 female, 8 male) aged from 20 to 47 years (M = 24.8; SD = 6.7) participated in the study. All participants were either employees or students of the department of agriculture of our university.

The study was conducted in the eye-tracking laboratory of our university. We tracked the participants' gaze behaviour with a remote eye-tracker (SMI RED, 250 Hz) while they were looking at information about aquaponics on a computer screen.

After explaining the experimental procedure to the participants, the eye-tracking procedure started with a calibration. Subsequently, three slides with information about aquaponics were presented as visual stimuli to each participant. The participants were asked to simply look at these slides. The first slide contained information about the aquaponics principle. This slide was displayed for 25 seconds. The second and the third slide informed with picture and text elements about two fictitious aquaponics farms. Both slides were shown to each participant for 50 seconds each.

We described one farm as a very modern high-tech farm and the other as a farm that attaches more emphasis to naturalness to find out if different presentations of aquaponics production are associated with different gaze behaviour. We designed the information material in a similar way for each farm (figure 1). We used three pictures for each farm, which we placed on both slides on the left: company building (top), aquaculture (centre), and hydroponics (bottom). On the right side of the slides, we added three text sections that provided information about the corporate philosophy (top), the aquaculture (centre) and the hydroponics (bottom) of each farm.

Figure 1: stimuli used for the eye-tracking procedure; from left to right: stimulus 1 (aquaponics principle), stimulus 2 (high-tech farm), stimulus 3 (farm with emphasis to naturalness)

Within the information material about the farms, we defined each of the aforementioned pictures and text segments as an area of interest (AOI) to be able to analyse the participants gaze behaviour within these AOIs.

Immediately after the eye-tracking procedure, we asked the participants to respond to a tablet-based survey. The survey asked the participants about their attitudes towards aquaponics with four items (figure 2). Using six-point Likert scales, respondents rated whether they would reject or accept the central message of each item.

In the case of the item *'For me, aquaponics is too far from nature'*, the descriptive analysis revealed a correlation between attitudes and gaze behaviour. For further statistical analysis of the eye-

tracking data, we divided the participants into two groups based on the participants' agreement to this item:

- group 1 (n = 9): do quite clearly not agree with the item, point 1 – 2 on the Likert scale
- group 2 (n = 9): do rather agree with the item, point 3 – 5 on the Likert scale

We choose the fixation time as the dependent variable for our analyses as it is assumed that information uptake and processing mainly occurs during this time (Loftus 1972; Geise 2011). We performed Friedman tests to analyse differences in fixation time between the individual text AOIs and between the individual picture AOIs *within* each group. We used Mann-Whitney-U-tests to test differences in the fixation time of each text and picture element *between* the groups.

3 Results

3.1 Survey results

Most of the participants were positively inclined towards aquaponics production (Figure 2). More than two thirds tended to think that it is a good idea to combine fish and plant production in a recirculating system, that aquaponics has good future prospects and that aquaponics represents a good opportunity for sustainable food production. These participants answered the items with points 4 – 6 on the Likert-scale. The answers to these three items correlate strongly positively with one another, $p < .01$ for all correlations.

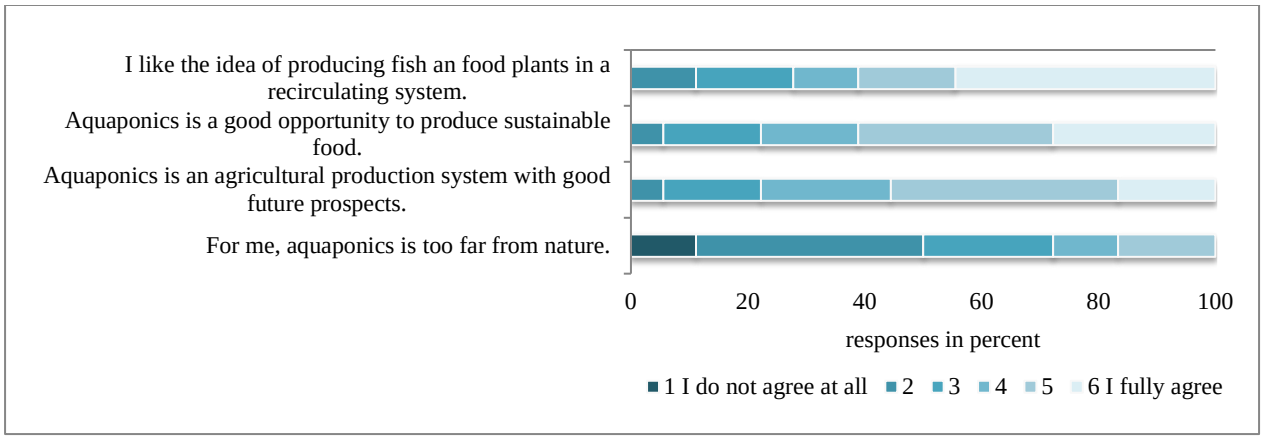

Figure 2: Responses to the items used to determine the participants' attitudes towards aquaponics (n = 18)

The answers to the fourth item, *'For me, aquaponics is too far from nature'*, correlate negatively with the answers to the three aforementioned items, $p > .05$ (table 1). Nobody fully agreed (point 6 on the Likert scale) with this item. Half of the participants quite clearly rejected the statement (points 1 – 2 on the Likert-scale) the other half agreed more with the statement (points 3 – 5).

Table 1: correlations between the responses to the four items used to determine the participants' attitudes towards aquaponics (n = 18)

		Aquaponics is an agricultural production system with good future prospects.	Aquaponics is a good opportunity to produce sustainable food.	I like the idea of producing fish and food plants in a recirculating system.
For me, aquaponics is too far from nature.	r_s	**- .349**	**- .391**	**- .307**
	p	.155	.109	.215
Aquaponics is an agricultural production system with good future prospects.	r_s		**.783****	**.610****
	p		< .001	.007
Aquaponics is a good opportunity to produce sustainable food.	r_s			**.630****
	p			.005

3.2 Eye-tracking results

To get an idea of the participants' gaze behaviour, we generated heat maps for the picture AOIs. These heat maps visualise gaze patterns by altering the colour of the stimulus display based on the amount of attention received (SMI SensoMotoric Instruments 2013). A change in colour from blue - to green - to yellow - and then to red represents an increasing fixation intensity. The heat maps suggest distinct differences in gaze behaviour between the participants who rather rejected the item *'For me, aquaponics is too far from nature'* (group 1) and participants who rather agreed with this item (group 2). These differences are confirmed by the numerical data and can be statistically verified in some cases (table 2). Participants of group 1 fixated all pictures, except the picture of the company building of the high-tech farm, at the median more than one second longer than the participants of group 2 did. These differences are significant or nearly significant for the pictures of the more natural farm. Within the groups, fixation time of the individual pictures differs significantly only in group 1. The participants of this group spent at the median the most time fixating the picture of the aquaculture sector of the more natural farm.

Even if the differences in the fixation time of the text elements between the two groups cannot be statistically proven, participants of group 2 fixated at the median the aquaculture section of the high-tech farm about five seconds longer than participants of group 1 did. This text segment was also the longest fixated text section within group 2.

Table 2: Heat maps for visualising fixation intensity within the picture AOIs and fixation time in seconds for the individual picture and text AOIs; data separated by participants who quite clearly not agree with the item '*For me, aquaponics is too far from nature'* (group 1; n = 9) and participants who rather agree with this item (group 2; n = 9)

	company description high-tech farm	**aquaculture high-tech farm**	**hydroponics high-tech farm**	**company description natural farm**	**aquaculture natural farm**	**hydroponics natural farm**	*p*-value (within group)[1]
heat map group 1							
heat map group 2							
Pictures							
Fixation time group 1 Median [LQ – UQ]	**1.19** [0.77 – 1.91]	**2.79** [1.38 – 4.08]	**2.98** [1.92 – 4.85]	**2.57** [2.20 – 2.91]	**3.11** [2.60 – 3.57]	**2.44** [1.79 – 3.53]	*.002*
Fixation time group 2 Median [LQ – UQ]	**1.79** [0.69 – 2.30]	**1.40** [0.32 – 2.27]	**1.58** [0.61 – 3.42]	**1.19** [0.44 – 2.22]	**1.60** [0.84 – 3.03]	**1.06** [0.83 – 1.62]	*.472*
p-value (between groups)[2]	*.796*	*.161*	*.136*	*.019*	*.050*	*.011*	
Text							
Fixation time group 1 Median [LQ – UQ]	**6.18** [5.69 – 6.80]	**9.32** [7.90 – 11.02]	**10.92** [8.79 – 11.05]	**7.62** [6.47 – 8.66]	**8.38** [6.93– 10.12]	**9.68** [8.09 – 12.25]	*.001*
fixation time group 2 Median [LQ – UQ]	**6.12** [5.86 -11.81]	**14.53** [9.69 – 16.61]	**8.78** [8.42 – 10.26]	**7.99** [6.50 – 9.37]	**10.92** [8.51 – 12.47]	**11.26** [9.07 – 12.94]	*.070*
p-value (between groups)[2]	*.730*	*.190*	*.297*	*.436*	*.161*	*.863*	

[1] Friedman-test; [2] Mann-Whitney-U-test

4 Discussion

The general positive attitudes towards aquaponics show the participants' open-mindedness towards this new sustainable food production method. However, this open-mindedness seems to be linked to the perceived naturalness of the production system. This may be due to a 'nature bias' which describes in this context the misperception that 'natural' food production should be an essential aspect of sustainable food production (Muller et al. 2017).

In our study, the perceived naturalness of aquaponics differed between the participants, although all participants obtained the same text and picture information. These differences are somewhat surprising, because all participants had the same professional background and were familiar with intensive farming methods. Participants who paid more attention to the pictures perceived aquaponics as more natural. Perhaps these participants liked the general idea of aquaponics, as described with the first slide, 'at first sight'. As a consequence they were possibly less critical against the specific production design and had no reason to read the text very intensively. In answering the questionnaire, these participants may have primarily recalled the information that was presented last ('recency effect') and made their assessment against that backdrop (Orquin et al. 2018). Participants who were less interested in the pictures and more interested in the text could be more sceptical about innovations in general or (new) intensive food production methods. These participants seemed to be especially interested in the text section about the aquaculture of the high-tech farm. Possibly, this text passage in conjunction with the pictures of the high-tech farm notably

confirmed their caveats, and as a result of a 'Halo-effect' of this information they rated aquaponics in general as too far from nature. It is equally conceivable that for these participants 'natural' fish production should always be associated with open water (e.g. outdoor ponds) and that 'natural' plant production should always be linked to soil. This preference for naturalness in agricultural food production is an issue that is often neglected in aquaponics research and development – but the perceived naturalness of aquaponics could notably influence public acceptance of this innovative food production method. A very up-to-date publication on acceptance of livestock farming clearly demonstrates that a lack of naturalness is the most important reason for low acceptance of livestock housing. In the eyes of the society, 'naturalness' includes besides access to daylight and fresh air also the possibility of animals living in accordance with their specific needs (Kühl et al. 2019). This also seems to be true for aquaculture, even if people commonly have lower demands on standards under which animals with a lower position on the phylogenetic scale (e.g. fish) are kept compared to other livestock like mammals (Cornish et al. 2016). For example, the participants of a study of Feucht and Zander (2015) preferred a natural environment for aquaculture production. They were rather sceptical towards recirculating aquaculture systems, even if they were explained that these systems are sustainable. Fish welfare was heavily doubted and the participants associated these systems with 'mass animal husbandry'. Thus, the authors concluded that communicating sustainable aquaculture is an important, but challenging, task.

Our pilot study indicates that the communication of aquaponics could be a challenging task too. It is necessary to communicate the advantages of the production method in an appropriate way to support its adoption. However, our results show that the same content of visual communication material on aquaponics can have different effects on different people – even though these people have a similar professional background and are familiar with intensive farming methods. Thus, one solution could consist in developing target group oriented communication strategies combined with target group oriented production methods. For a part of the society intensive fish farming and hydroponics may be wholly appropriate if it is sustainable and/or the products are cheap. These people are not deterred by pictures of intensive farming systems and they need relatively little information. Other people may have greater demands on, e.g., animal welfare – they probably will not accept intensive farming methods and need more information. Therefore, food chain actors and policy makers should find ways that satisfy the public need for information but do not lead to information overload and that convince the majority of the society of the advantageousness of aquaponics. In the case of visual communication, these actors need to remember that visual biases can influence the assessment of aquaponics and, as a consequence, the acceptance of the production method and its products.

5 Conclusions

The results of our pilot study suggest a link between visual perception patterns of text and picture information and attitudes towards aquaponics. If the intention of visual information is not only to inform but also to support the adoption of aquaponics, picture design as well as text content of communication material should be carefully considered in advance to avoid unfavourable visual biases. In this context, it may be expedient to emphasise the use of natural cycles in aquaponics production. Besides the design of communication material, it might be advisable to consider society's desire for naturalness in agricultural food production when developing and implementing aquaponics production.

In order to develop target-group oriented strategies for aquaponics production and communication, it may be helpful to combine eye-tracking with other neuroeconomic methods that allow monitoring of brain activity. This combination of methods could help to gain deeper insights into the motivations behind different behavioural patterns and thus may help to avoid erroneous trends in aquaponics development and communication.

References

Cornish, Amelia; Raubenheimer, David; McGreevy, Paul (2016): What we know about the public's level of concern for farm animal welfare in food production in developed countries. *Animals* 6 (11): 74.

Feucht, Yvonne; Zander, Katrin (2015): Of earth ponds, flow-through and closed recirculation systems — German consumers' understanding of sustainable aquaculture and its communication. *Aquaculture* 438: 151–158.

Geise, Stephanie (2011): Eyetracking in der Kommunikations- und Medienwissenschaft. Theorie, Methode und kritische Reflexion. *SCM Studies in Communication and Media* (2): 149–263.

Hoevenaars, Kyra; Junge, Ranka; Bardocz, Tamas; Leskovec, Matej (2018): EU policies. New opportunities for aquaponics. *Ecocycles* 4 (1): 10–15.

Kühl, Sarah; Gauly, Sarah; Spiller, Achim (2019): Analysing public acceptance of four common husbandry systems for dairy cattle using a picture-based approach. *Livestock Science* 220: 196–204.

Loftus, Geoffrey R. (1972): Eye fixations and recognition memory for pictures. *Cognitive Psychology* 3 (4): 525–551.

Miličić, Vesna; Thorarinsdottir, Ragnheidur; Santos, Maria; Hančič, Maja (2017): Commercial aquaponics approaching the European market. To consumers' perceptions of aquaponics products in Europe. *Water* 9 (2): 80.

Muller, A.; Ferré, M.; Engel, S.; Gattinger, A.; Holzkämper, A.; Huber, R. et al. (2017): Can soil-less crop production be a sustainable option for soil conservation and future agriculture? *Land Use Policy* 69: 102–105.

Orquin, Jacob L.; Perkovic, Sonja; Grunert, Klaus G. (2018): Visual Biases in Decision Making. *Applied Economic Perspectives and Policy* 118 (1): 73.

Palm, Harry W.; Knaus, Ulrich; Appelbaum, Samuel; Goddek, Simon; Strauch, Sebastian M.; Vermeulen, Tycho et al. (2018): Towards commercial aquaponics. A review of systems, designs, scales and nomenclature. *Aquaculture International* 39 (4): 510.

Rogers, Everett M. (2003): Diffusion of innovations. 5. ed., Free Press trade paperback ed. New York NY u.a: Free Press.

Schröter, Iris; Hüppe, Jan-Hendrik; Lorleberg, Wolf; Mergenthaler, Marcus (2017): Kenntnisse über Aquaponik und Zahlungsbereitschaft für Fisch nach dem Besuch einer Polykulturanlage mit Aquaponik. Notizen aus der Forschung, Fachbereich Agrarwirtschaft, Soest (70/2017).

SMI SensoMotoric Instruments (Ed.) (2013): BeGaze Manual. Version 3.3. Teltow, Boston.

van Loo, Ellen J.; Caputo, Vincenzina; Nayga, Rodolfo M.; Seo, Han-Seok; Zhang, Baoyue; Verbeke, Wim (2015): Sustainability labels on coffee. Consumer preferences, willingness-to-pay and visual attention to attributes. *Ecological Economics* 118: 215–225.