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POPULATION STEREOTYPED ICONS: A STUDY OF AGRARIAN COMMUNITIES IN INDIA

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Abstract

Knowledge transfer is a key factor for increasing agriculture yield especially in developing countries like India. Information Communication Technologies (ICT) is the best platform for knowledge transfer. However, the expertise level of novice users living in India has compromised usage of ICT services. To fill the gap, we suggest for icons to be developed using population stereotype production method. In this study, we first generated population stereotype representations for sixteen different function labels. We then compared the performance and representativeness of these population-stereotyped icons with other ideas. Two separate experiments were conducted. In the first experiment, ninety-two participants from the farming communities were asked to draw images to represent sixteen function labels. In the second experiment, eighty-eight participants were equally distributed into four groups to evaluate the performance and representativeness of all the population-stereotyped representations. This study answered one of the most significant questions regarding the utility of using population-stereotyped ideas for the development of icons in the context of agrarian societies of rural India. The study also offered important practical implications for designing representative icons by using representations developed by different participants during population stereotype production.

Keywords: Population Stereotype; Iconography; Semantic Distance; Assimilation Theory;

1 INTRODUCTION

Agriculture is the principal source of livelihood for 58% of the total workforce in India (Dacmagi 2011). Considering the total population of India as approximately 1.2 billion (Census 2011), the agriculture community covers a large number of people. The Times of India has reported an increased number of farmer suicides due to agrarian reasons (Vishwa Mohan 2014). This is a real life problem and therefore it is critical for us to consider how to improve the probability and life quality of agrarian communities. Accurate and efficient communication regarding farming practices amongst the community is essential for increasing agriculture yield. Knowledge transfer is a key factor for transferring these farming practices (Carrascal et. al. 1995). ICT is a convenient and scalable platform for knowledge transfer. Despite having the understanding that ICT is a platform for knowledge transfer, developers have restricted usage to be for literate population. For instance, ICT kiosk services are available in India but the farmers are reluctant and were heavily reliant on kiosk operators to use them (Srinivasan 2007).

Previous studies suggest that the adoption of icon-based graphical user interface (GUI) is effective for low literate rural communities (Parikh et. al. 2003, Thatcher 2006). However, such icons are subjected to misinterpretation due to factors such as culture (Bourges-Waldegg 1998; Beelders 2008). If we consider the agrarian farmers as an organization, knowledge resides in organizational members, tools, tasks, and their sub-networks (Argote and Ingram, 2000) and much knowledge in organizations is tacit or hard to articulate (Nonake and Takeuchi, 1995). Therefore, the use of icons should not be considered as trivial solve-all for all problems in a user interface. For example, representations of complex functionalities require deep consideration of how the icons should be designed such that it is easily perceivable by farmers (Parikh 2003).

Population stereotype production methodology is a commonly used design methodology to break the gap between users and designers by actively involving users in the process of designing the icons. We assume that the interfaces or icons developed via population stereotype will increase the farmer's confidence when using ICT services to transfer their knowledge. Hence, it is important for us to identify the relevance of these icons to the features represented by the ICT services.

One criterion to determine an easily perceivable icon is through semantic distance (McDougall & Curry 2004). Semantic distance is being referred to as the degree to which icons and its function labels are related (Isherwood 2007). Semantic distance can be defined as the intimacy of the relationship between the representation and the related feature of the mobile application. The relationship can be classified into three types i) direct ii) implied and iii) arbitrary. Direct relationship indicates a very close association between representation and function label. For implied relationship, other indirect connections like analogies, exemplification, etc. are required to understand the meaning of the representation. In the case of arbitrary relationship, the relationship is not obvious, and only previous learning of the meaning or convention will allow users to interpret it correctly (Isherwood 2007; McDougall et. al. 1999). Designing icons that are easily perceivable by these semi-literate users will increase the semantic distance between the icons and its features. (Isherwood 2007). Therefore, it is critical to include semantic distance due to the absence of visual similarity and arbitrary conventions. It becomes the only way for interaction designers to visually represent a concept. It is also being denoted as the strength of referential connections between the semantic information that was accessed during information processing (McDougall et. al. 1999). Icons or interface with a better semantic distance can be a better media for knowledge transfer.

The rest of the paper is organized as follows. It starts with our research objective and research questions. Following that, we will have literature review on past works. Following that, we have the methodology section for experiment one before reporting and discussing the results. Subsequent section describes the methodology for experiment two followed by a discussion of the results obtained. Theoretical and practical implications are presented next before mentioning the limitation of our study and suggestions for future work.

1.1 Research Objective

This study aims to close the research gap between the need for icons to be developed though population stereotype ideas and the lack of adaptable ICT services for the agrarian communities by conducting two experiments. The first experiment identifies the population stereotype representations of sixteen different function labels, while the second experiment tests the 'performance' and 'representativeness' of the representations in comparison to the other parallel representation ideas. With that, this study targets to answer the following research questions on using knowledge transfer to help agrarian communities in India:

1. Do icons developed based on the population stereotype ideas perform better on knowledge transfer than icons developed without population stereotype?
2. Do icons developed based on the population stereotype ideas represent the function labels better than other icons developed on the basis of parallel ideas?

2 LITERATURE REVIEW

2.1 Agrarian Community in India

The agrarian community in India consists of both semi-literate and illiterate farmers. These farmers have very different cognitive and metacognitive capabilities to use ICT services (Dacmagi 2011; Medhi 2010). Besides that, these farmers also have limited exposure to technology, which reduces their prior experience with technology (Parmer 2008). The lack of prior knowledge, cognitive and metacognitive skills restrict their learning capabilities, resulting in a very steep learning curve (Medhi et al. 2010). Hence, these farmers will need to overcome a huge learning curve before they can use ICT services independently to transfer their knowledge. Therefore, to increase usage of such ICT services, it is critical for researchers and designers to design the ICT system with easily perceivable interfaces. Easily perceivable interface includes easily perceivable icons, which reduces the learning curve of these semi-literate and illiterate users.

2.2 Iconography

One of the layers of iconography is representational meaning (van Leeuwen & Jewitt 2001). Representational meaning is perceived by an individual from the visual semantic features of the graphic displayed with reference to his or her practical experience. As the semi-literate users have limited exposure to technology, they will need to learn how to use a new application. Icons can assist these users during the learning process (Wiedenbeck 1999).

Adhering to the assimilation theory (Ausubel 1968), meaningful learning happens when an individual perform a certain action to establish realistic connections between fresh information and appropriate anchoring concepts in the long-term memory. After completing the action, a deep cognizance of the underlying principles of the action performed is attained. Upon successful meaningful learning, a person should be able to adapt information in new ways and apply it to different contexts. The assimilation theory proposes that when icons are represented in a concrete, familiar manner, they can help semi-literate users in assimilating new concepts from mobile features to an associated concept in memory.

To design concrete and familiar icons, previous researchers (Greenbaum and Madsen 1993; Martin et. al. 2012) have suggested a population stereotype approach. This approach utilizes cultural convention and common experiences of the target users. Studies have also suggested that the results derived from the performance of icons cannot be generalized across different user populations (Greenbaum and Madsen 1993). Therefore, there is a need to investigate icons for specific populations of prospective users with their direct involvement.

2.3 Population Stereotype Production

The population stereotype production method involves asking a group of representative users to generate pictorials that best represent the function label of interest. The most frequent pictorial representation generated for the particular function label is known as the population stereotype. The stereotype strength is evaluated by the ratio of common responses to the total responses for a function label. The population stereotype strength indicates the extent of agreement among users on the most frequent interpretation of the function label (Howell 1968; Ng et. al. 2012; Schroder 2008).

The rationale behind this technique is that, the drawings that people generate to represent a function label, are the ones they would also most likely understand and recognize (Norman 1988). The population stereotype production method has been frequently used to obtain pictorial representations of verbal labels for the purpose of visual communication (Howell 1968; Jones 1983; Rogers 1987; Schroder et. al. 2008).

3 METHODOLOGY FOR EXPERIMENT ONE

3.1 Measurements

In our study, first we differentiated all representations made by different participants based on the nature of sematic relationship. The representations generated by different participants were categorized into three different categories (Direct, Implied and Arbitary). Table 1 shows different semantic relationships and their examples.

Semantic Relationship	Function Label	Icon
Direct	Connect Headphone/Earphone	
Implied	Search	
Arbitrary	Power On\ Off	

Table 1. Different semantic relationships and their examples.

3.2 Participants

92 participants (24 female) were engaged with the help of a non-profit organization from five different villages in the Indian state of Maharashtra. Table 2 shows the descriptive statistics of the demographic factors of participant.

Demographic Factor	Range	Mean	Std. Dev.
Age	19-67 years	36.55	12.36
Years of Formal Education	1-13 years	5.61	3.40
Years of Farming Experience	1-45 years	13.92	10.45
Years of Experience with Mobile	1-10 years	4.45	2.34

Table 2. Descriptive statistics of the demographic factors.

None of the participants reported any work experience in design or drawing activities. Each participant gave verbal informed consent at the beginning of the study. During the consent procedure, participants were told that they would be required to be engaged in an icon design exercise for about 20 to 30 minutes.

3.3 Function Labels

We sought to identify population stereotypes of sixteen different function labels. The labels were a noun, noun phrase or verb. The labels suggested both entity (physical and conceptual) and events (activity and process) (Nakamura and Traitler 2012). The 16 labels were distributed into two groups equally. Participants were randomly assigned to any one of the two groups. Group 1 consisted of 8 function labels that were common in information systems. Group 2 consisted of 8 function labels that were related to the agriculture context as seen in Table 3.

Group1		Group2	
R1	Search	R9	Rainfall
R2	Profile	R10	Crop Rotation
R3	Help	R11	Pest Infestation
R4	Delete	R12	Water Equipment
R5	Save	R13	Farm Location
R6	Settings	R14	Market Rate
R7	Alert	R15	Labors Availability
R8	Message	R16	Soil Quality

Table 3. Sixteen different function labels.

3.4 Instruments

We have developed 2 different questionnaires for the production of the drawings of 16 different function labels. Each questionnaire contained specific lexical words of the function labels. Questionnaire issued to each of the participants contained instructions for label typed in 'Hindi', and spaces for the function labels to be drawn. 92 participants are distributed into 2 groups and each group was assigned to one questionnaire.

3.5 Procedure

Before the commencement of the icon production exercise, each of the participants was asked 5 different questions regarding their 'level of formal education', 'age', 'number of years of experience in farming', 'usage of mobile phone' and 'usage of a personal computer or any other electronic communication devices'. Each of the participants was assigned based on their answers to the questionnaire to avoid any confounding effect that may arise due to the uneven distribution of the above mentioned user factors. For instance, people with different level of formal education might interpret the icons differently. Along with that, female participants were also distributed equally between the 2 groups.

For each of the 16 function labels, the participants were asked to draw the first picture that came to their mind as quickly as possible. They were then asked to draw the other ideas that came to their mind subsequently. The participants were encouraged to draw more than one representation as different ideas related to each function label came to their mind. In cases where participants showed reluctance to draw, they were encouraged to write the way they wanted the representation to be. Participants who failed to think of any drawing ideas about the representation of a function label were asked to keep the drawing space blank. The degree of drawing difficulty is estimated for each function label by the ratio of the number of participants who failed to draw to the total number of drawings produced for that function label.

There were 2 groups of judges who were interaction designers, communication designers and design science researchers of a university. They participated in the analysis of the representations produced by different participants. Each group consisted of 4 group members. Every group was made up of 2 interaction designers, 1 communication designer and 1 design science researcher. Two groups were responsible for 2 different kinds of analysis. The first group of judges was responsible for categorizing all the representations produced by different participants. They were responsible for making categories, which contained unique ideas suggested by different participants. In order to perform this task properly, they were provided with a list of criteria. The list included i) the extent to which each of the drawings shared 'featural characteristics' and ii) a subjective judgment of the similarity of the ideas expressed. The list of criteria helped them to differentiate between the different ideas represented through similar representations and same idea represented through apparently different representations. Each judge was required to provide a definition of each category and mention minimum three common and requisite features of each category, which are different from other categories. The inter rater agreement score of Cohen's kappa is 0.78, above the required threshold (Cohen's kappa >0.75) (Cohen 1960).

The second group of judges were responsible for differentiating all the representations in 3 different categories. These three different categories are 'direct semantic relationship', 'implied semantic relationship' and 'arbitrary semantic relationship'. All the judges, who belonged to the second group, went through the same specific academic literature to learn about all three different semantic relationships and their examples. Each judge sorted all the representations separately. The inter-rater agreement score of Cohen's kappa is 0.91, above the required threshold (Cohen's kappa >0.75) (Cohen 1960).

3.6 RESULTS AND DISCUSSION

The 92 participants created 779 drawings (excluding all representations that contain texts) for 16 different function labels. There were 2 groups, each consisting of 4 judges made independent assessments of the participants' drawings on different criteria. For the current analysis, all the textual depictions and representations containing texts are not considered.

The participants developed a variety of original ideas for the drawings, largely influenced by context, action and communication. The representations had concrete objects, depiction of personal analogies, abstract forms, instances of related events, prototypical and diversified examples, as well as religious and local historical symbols. The number of drawing ideas per function label ranges from 12 (R4-Delete) to 32 (R5- Save). The population stereotype strength for different function labels varied from 10.20% (R5 -Save) to 59.09% (R6- Settings).

From the results, we observed that some of the labels had one clean population stereotype. Examples of the function labels are 'Help', 'Settings', 'Message', 'Rainfall', 'Pest Infestation', 'Farm Location' and 'Market Rate'. For the function labels 'Search', 'Profile', 'Delete', 'Crop Rotation', 'Water Equipment', 'Labors Availability' and 'Soil Quality', other strong contenders were observed along with the population stereotype. 'Save' and 'Alert' functional labels had low stereotype strength because many parallel ideas competed with each other.

For few of the function labels, we observed the presence of quite a few numbers of different categories. For example, 'Save (32)', 'Alert (29)', 'Profile (27)' and 'Search (26)' the number of independent categories was quite high. This can be attributed to the polysomic (having multiple meanings) nature or high level of general meaningfulness of the function labels [17]. This suggests that there are many features of the function labels that were neither necessary nor sufficient but yet important to the concept.

All the representations drawn for 16 different function labels were also classified among the 3 mutually exclusive categories what were mentioned earlier by the judges of the second group. Out of a total of 779 representations, 461 representations were regarded as having 'direct semantic relationship', 180 having 'implied semantic relationship' and 138 representations were having 'arbitrary semantic relationship'.

This outcome indicated that the participants chiefly produced representations, which depict a direct semantic relationship with the function label. This is similar to Jone's [19] findings, which are quite opposite to the icon characteristics that were considered for icon design guidelines [16]. Jones [19] reported that, there is a strong preference of subjects to concretize the concept in some manner. She suggested that the subjects generally have a tendency to look for and develop representations, which suggested concrete objects. According to Paivio 1971, this process happens by means of associative chaining, though the directness depends on the idiosyncratic associative frequency in the participants' experience. Jung and Myung 2006 also reported strong preferences of Korean users toward icons that represented real objects. Interestingly, for implied semantic relationship, participants adopted single as well as combinations of representation strategies to depict different function labels (Nakamura 2012). Table 4 shows the number of different ideas, stereotype strength and degree of drawing difficulty for each function label.

	Function Label	Number of drawing ideas	Stereotype strength (%)	Degree of drawing difficulties (%)
R1	Search	26	19.23%	1.9%
R2	Profile	27	18.0%	6.0%
R3	Help	22	32.65%	0.0%
R4	Delete	12	25.92%	1.85%
R5	Save	32	10.20%	4.08%
R6	Settings	14	59.09%	11.36%
R7	Alert	29	17.39%	13.04%
R8	Message	21	25.00%	10.41%
R9	Rainfall	18	48.14%	0.00%
R10	Crop Rotation	16	19.56%	4.34%
R11	Pest Infestation	15	29.09%	5.45%
R12	Water Equipment	16	23.07%	0.00%
R13	Farm Location	14	43.47%	4.34%
R14	Market Rate	18	25.0%	6.81%
R15	Labors Availability	14	28.26%	8.69%
R16	Soil Quality	21	15.90%	9.09%

Table 4. Number of drawing ideas, stereotype strength, degree of drawing difficulty for each function label.

4 METHODOLOGY FOR EXPERIMENT TWO

4.1 Measurements

We have collected 2 types of data through the experiment- i) performance data and ii) preference data. The performance data were collected through the participants' performance of task 1. The preference data were collected from the participants' response to task 2.

4.1.1 Performance Data

The primary purpose of collecting the performance data through task 1 is to compare the performance of the population stereotype version of each icon with other three different versions of the same icon. Each correct match between the icon and its function label is coded as '1' while each wrong match as well as no match is coded as '0'. The analysis of this data helps us to check if the population stereotype version of each icon is the best performing version of each function label. Along with that, the performance data analysis results allow us to compare the performance of different versions of each icon with their representativeness.

4.1.2 Preference Data

If the particular version of the population-stereotyped icons best represents the concept express by their function label, ranking data collected in response of task 2. The icon version with rank 1 is assigned a score of '4' while the versions with rank 2, 3 and 4 are assigned scores of '3', '2' and '1' respectively. The analysis of this data helps us to find if the particular version of the population-stereotyped version of each icon is actually considered as the best representative of the function label by different participants. Besides that, this data also helps us to check if the version of each icon which performs best during task 1 is also considered as the most representative of the function label in comparison to other three different versions.

4.2 Experimental Study

The second experiment is conducted to investigate the performance and representativeness of population stereotype versions of sixteen different icons in comparison to other competitive representations of the same icon.

4.3 Participants

88 participants (28 female) were recruited with the help of the same non-profit organization from six different villages in the Indian state of Maharashtra. All participants were farmers who typically own 1 to 3 acres of land. None of the participants were part of the previously conducted population stereotype generation experiment. All the subjects were capable of reading short instructions in Hindi. Each participant gave verbal informed consent at the beginning of the study. Table 5 shows descriptive statistics of different demographic factors of the participants.

Parameters	**Range**	**Mean**	**Std. Dev.**
Age	18-72 years	38.6	11.9
Number of years of formal education	4-15 years	8.94	3.42
Number of years of experience in farming	1-41 years	12.2	9.37
Number of years of experience with mobile phone	1-9 years	4.78	2.2

Table 5. Descriptive statistics of different demographic factors of the participants.

4.4 Experimental Design

The experiment was designed with a between subject design. 4 different groups of subjects were used to evaluate performance and representativeness of four different versions of each of 16 icons. Each group consisted of 22 different participants (7 female). Each participant performed 2 different icon evaluation related tasks. They performed the tasks in exactly the same given order.

4.5 Procedure

In the beginning, the participants were given a brief verbal introduction about the nature of the survey. They were instructed on the procedure of completing the questionnaire. The moderator then provided the survey questionnaire to each of the participants. There were two specific sections in each questionnaire that were designed to capture individuals' preference and performance with different versions of icons. Each of the 2 sections was assigned into 2 different tasks. In the first task, the participant was asked to match different versions of icons with their correct function labels. In the second task, the participant was asked to rank 4 different versions of 16 icons based on their representativeness of the function label. There was no time limit imposed on completing the tasks, but no participant took more than 20 minutes to complete both the tasks.

4.6 Experimental Material

We designed 4 different versions of each of the icons based on the results gathered from the population stereotype generation experiment. Different participants designed the 4 different versions of each icon based on the 4 most frequent and unique ideas represented during the population stereotype production experiment. Among the 4 different versions of each icon, V1 represented the population stereotype. V2, V3 and V4 of the icon represented the ideas with second highest, third highest and fourth highest stereotype strength respectively. In total, we had 4 different versions of 16 different icons, which meant 64 unique representations. Table 6 shows all four different versions of sixteen different icons. V1 of each icon represents the population stereotype version.

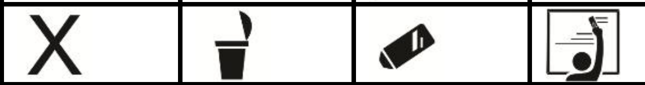
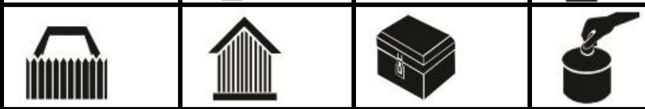
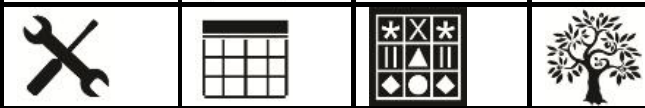
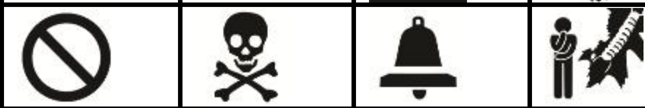
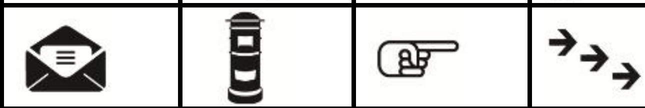
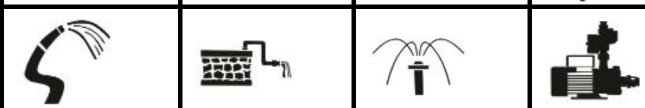
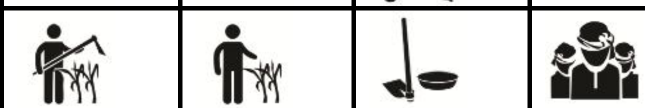
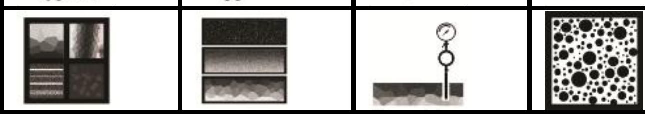
No	Function Label	V1	V2	V3	V4
R1	Search				
R2	Profile				
R3	Help				
R4	Delete				
R5	Save				
R6	Settings				
R7	Alert				
R8	Message				
R9	Rainfall				
R10	Crop Rotation				
R11	Pest Infestation				
R12	Water Equipment				
R13	Farm Location				
R14	Market Rate				
R15	Labors Availability				
R16	Soil Quality				

Table 6: All four different versions of sixteen different icons

Each participant was provided with one questionnaire, which included 2 different types of tasks related to icon evaluation. We designed 4 different questionnaires to check the performance and representativeness of 4 different versions of 16 different icons. The first section of each questionnaire contained a few closed-survey questions which included questions related to age, number of years of formal education, experience with mobile phone, number of years of doing farming, annual family income, etc. of individual participants. In the first task, the participants were asked to connect the icon with the appropriate function label by drawing a straight or curve line between them. In the second task, each participant was asked to rank 4 different versions of each icon based on the extent they were able to represent the particular function label. The most representative version should be rewarded with rank 1 while the least representative version with rank 4. No 2 different versions could occupy the same rank. For task 2, all 4 different versions of each of the 16 individual icons were provided. Along 4 different questionnaires, the content for task 2 did not change. Table 7 describes the content design of each of the questionnaire.

Task	**Questionnaire 1**	**Questionnaire 2**	**Questionnaire 3**	**Questionnaire 4**
1	Version 1 and 4 of 8 icons belonging to Group 2	Version 1 and 4 of 8 icons belonging to Group 1	Version 2 and 3 of 8 icons belonging to Group 2	Version 2 and 3 of 8 icons belonging to Group 1
2	Version1, 2, 3 and 4 of all icons belonging to Group 1 and 2	Version1, 2, 3 and 4 of all icons belonging to Group 1 and 2	Version1, 2, 3 and 4 of all icons belonging to Group 1 and 2	Version1, 2, 3 and 4 of all icons belonging to Group 1 and 2

Table 7. Description of the contents of each of the four different questionnaires.

5 RESULTS AND DISCUSSION

Since the participants' performance related data for different versions of icons is coded categorically, we conducted Fisher Exact tests to compare performance between 4 different versions of each icon. Representativeness scores of 4 different versions of each icon were normally distributed (Shapiro-Wilk test $p>0.05$). To compare representativeness scores of four different versions of each icon, we conducted univariate analysis of variance (post-hoc analysis) along with Bonferroni correction. Table 8 presents a complete overview of all test results for task1and task 2.

Icon	Task	Mean Scores (V1, V2, V3 and V4)	V1vs V2	V1vs V3	V1vs V4
R1 Search	T 1		n.s.	n.s.	P<.05
	T 2	1.87, 2.57, 3.35, 2.28	P<.05	P<.05	P<.05
R2 Profile	T 1		n.s.	n.s.	n.s.
	T 2	2.00, 2.94, 2.16, 3.05	P<.05	n.s.	P<.05
R3 Help	T 1		P<.05	P<.05	n.s.
	T 2	2.39, 1.65, 2.68, 3.32	P<.05	n.s.	P<.05
R4 Delete	T 1		n.s.	n.s.	n.s.
	T 2	2.70, 2.62, 1.95, 2.85	n.s.	P<.05	n.s.
R5 Save	T 1		n.s.	n.s.	n.s.
	T 2	2.08, 2.10, 3.30, 2.60	n.s.	P<.05	P<.05
R6 Settings	T 1		P<.05	P<.05	P<.05
	T 2	3.39, 1.92, 2.11, 2.58	P<.05	P<.05	P<.05
R7 Alert	T 1		n.s.	n.s.	n.s.
	T 2	2.17, 2.85, 3.07, 1.98	P<.05	P<.05	n.s.
R8 Message	T 1		n.s.	n.s.	n.s.
	T 2	2.34, 2.38, 3.20, 2.12	n.s.	P<.05	n.s.
R9 Rainfall	T 1		n.s.	P<.05	n.s.

	T 2	2.87, 2.97, 1.72, 2.46	n.s.	P<.05	P<.05
R10 Crop Rotation	T 1		n.s.	n.s.	n.s.
	T 2	2.86, 2.22, 2.50, 2.50	P<.05	n.s.	n.s.
R11 Pest Infestation	T 1		n.s.	n.s.	n.s.
	T 2	2.20, 2.44, 2.44, 3.00	n.s.	n.s.	P<.05
R12 Water Equipment	T 1		n.s.	n.s.	n.s.
	T 2	1.93, 2.91, 2.15, 3.10	P<.05	n.s.	P<.05
R13 Farm Location	T 1		n.s.	n.s.	n.s.
	T 2	2.46, 2.32, 2.75, 2.55	n.s.	n.s.	n.s.
R14 Market Rate	T 1		n.s.	n.s.	n.s.
	T 2	2.65, 2.57, 2.52, 2.39	n.s.	n.s.	n.s.
R15 Labors Availability	T 1		P<.05	P<.05	P<.05
	T 2	2.78, 2.37, 2.63, 2.36	n.s.	n.s.	n.s.
R16 Soil Quality	T 1		n.s.	n.s.	n.s.
	T 2	2.55, 2.61, 2.10, 2.83	n.s.	P<.05	n.s.

Table 8. A complete overview of all test results for task1and task 2 for all four different version of icons (V= Version, T= Task, n.s.= not significant).

From the results, we found that the population stereotype version significantly outperforms the other 3 different versions of the same icon for only two icons (‘Settings’ and ‘Labors Availability’). The population stereotype versions perform better than the other versions of the same icon, but the performance differences were not significant for ‘Message’, ‘Crop Rotation’, ‘Rainfall’ and ‘Soil Quality’. Interestingly, for ‘Water Equipment’, the performance of the population stereotype version is worst among all different versions of the same icon.

Regarding representativeness, the population stereotype version is considered significantly more representative of the function label than the rest of the three different versions for only the ‘Settings’ icon. For ‘Farm Location’, ‘Market Rate’, and ‘Labors Availability’, the population stereotype versions were considered as the most representative, though their representativeness scores were not significantly higher than the other versions. Conversely, the population stereotype version of ‘Search’ was judged as significantly less representative version among the four different versions. The population stereotype version of the icons with the labels ‘Profile’, ‘Save’, ‘Pest Infestation’ and ‘Water Equipment’ was judged as the least representative among the 4 different versions, though the differences were not that pronounce.

These results suggest that, irrespective of the function label-representation imagery association, the best representative idea was sometimes judged as being unique or more idiosyncratic than the one which the general consensus of drawings represents (Rogers et. al. 1987). According to Jones 1983, this might occur because one person might produce a drawing that encompasses the essential meaning of a certain abstract concept more efficiently than the other participants. Another probable explanation was the lack of drawing skills, which might prevent participants from producing drawings that they prefer (Szlichcinski 1980). This implies that, people share similar ideas on how different function labels were best represented in a pictorial form but were unable to depict them effectively. Szlichcinski also argued that the representation produced most frequently might not necessarily be the most easily comprehended representation. The nature of the function label could significantly contribute to such issues. It could be argued that certain function labels might be polysomic in nature; therefore they might not present any strong population stereotype for such function labels. Consequently, the performance and representativeness of population stereotype versions of such icons cannot be considerably better than the other representations.

6 THEORETICAL AND PRACTICAL IMPLICATION

Theoretically, our study answers one of the most significant questions regarding population stereotype, which asks the actual utility and advantage of the population stereotype version of icons over other non-stereotype ideas. Our study answers the question in context of the rural agricultural communities of India. Therefore, in the context of interface design, it addresses one of the primary reasons of failure of ICT development in developing regions - ‘the design-actuality’ gap (Heeks 2002). It clarifies the role of participatory development and community-centered approach in developing digital system interfaces targeted at rural communities in developing countries like India. In this regard, we have two very distinctive points that clearly suggests the importance of our study. Firstly, agriculture is the principal source of livelihood for almost 58% of the total workforce of India (Dacmagi 2011). Considering the total population of India, the agricultural communities cover a really large number of people (Census 2011).

Secondly, researchers (Guastello 1989; Nakamura 2012) mentioned about the limitation of generalization of icon performance results. Therefore, there is a clear need of considering design and performance of icons for a specific population of prospective users.
Practically, for interface designers our study clearly suggests the advantages and limitations of population stereotype production. It is quite evident that icons developed based on the ideas having highest stereotype strengths are not the icons that perform and represent the concept best. This is one of the primary limitations of the population stereotype production. The population stereotype production method has some critical advantages. It does reveal different representation strategies of the community members and levels of consensus about different parallel ideas regarding a particular concept. This is of immense importance to interaction designers as it helps them to understand the whole spectrum of ideas regarding a particular function label, and how community members make different representation strategies. Previous research (McDougall 1999) has already showed that the users’ knowledge structure depends on the type of icons presented in the interface. We argue that understanding of participants’ representational strategies about a particular concept provides interaction designers the opportunity to pick a better visual representation for designing appropriate icons. Specifically, interaction designers can get considerable help where concretization of the concept through visual similarity is not possible. They can look at the different representational strategies adopted by the participants and represent the concept indirectly by different means of semantic association. Interaction designers can also take advantage of the ideas generated by the participants in other manners. Firstly, they can identify the cultural marking (e.g. convention) and geographical specificity (e.g. context) that might mediate the representations. By identifying those, mediations interaction designers can either use them for more effective visual communication or avoid them for clearer encoding and decoding of the visual information i.e. icon. For example, to represent the function label ‘Save’ interaction designers can avoid using representations like ‘Swastika’ and ‘Shield and Swords’ to bypass cultural marking though the participants produced those concepts to represent ‘Save’.

Secondly, interaction designers can also combine different ideas, to come up with icons that are built by combining strengths of different ideas, if possible. For example, for the function label ‘Search’, the representation of ‘magnifying glass’ and ‘the plant’ can be combined. An icon can be developed which may include both the plant and the magnifying glass to represent ‘Search’ in context of agriculture. An interaction designer can have higher confidence in the combined representation than the individual ones. (see Figure 2)

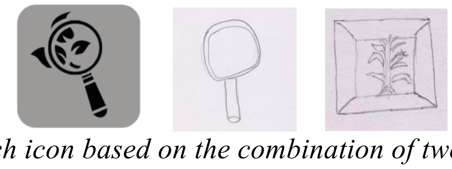


Figure2. Proposed search icon based on the combination of two different representation ideas.

Thirdly, as the population stereotype production method reveals the whole spectrum of ideas about a specific concept. With the help of that, interaction designers can design more intuitive navigation paths. For example, to help the community members in understanding the concept of ‘profile’ and ‘profile-related information’, interaction designers can start with the visual of an identity card. Subsequently, to provide the option of choosing a profile picture, interaction designers can use the icon that depicts a portrait. To represent the function ‘insert/edit profile information’, the icon showing a document and a pencil can be used. (see Figure 3)

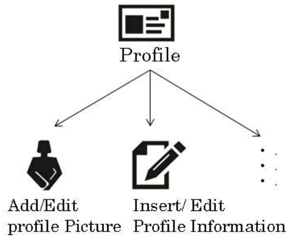


Figure3. Different representations of profile icon for different sub functions and navigations.

Finally, different representations can also be used to represent different sub-functions related to the main function. It may also help interaction designers to teach new abstract concepts to the community members.

7 LIMITATION AND SUGGESTIONS FOR FUTURE WORK

We note that this study has certain limitations. Individual, geographical and cultural differences will affect the population stereotype production and stereotype strength. Therefore, though our design approach is scalable, our results might not be scalable to other significantly different cultures and geographical locations. Users’ objectives, personality traits and the usage context are also expected to affect the population stereotype production and evaluation. Future studies are therefore required to address such issues to check the applicability of the findings of our study.

In our study, we measured the performance of different icon versions based on the correct matching of icons with their function labels. Though this is a commonly accepted method for testing icon’s performance [38], it might be more appropriate to check the task performance of different users while using different versions of the icons in realistic scenarios.

Finally, the population stereotype method helps designers to find the answers to questions which generally ask ‘what’. The method is limited in providing answers to questions that ask ‘how’ or ‘why’. To obtain answers of ‘how’ and ‘why’ questions, detailed discussions with the participants is required. In this regard, interaction designers can use ‘think aloud protocol’ along with population stereotype production to find the reasons behind making of a particular representation.

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