

Analyzing the Cultural Differences of Control Stereotypes in Operating Water Taps for Facilitating Convenience and Safety

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편리성과 안전성 제고를 위한 급수전(給水栓) 작동 스테레오타입에 대한 문화적 차이 분석

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Abstract

본 연구는 급수전('tap'과 'faucet'은 호환사용)의 종류에 따른 사용자의 조작방향에 대해 우리나라와 다른 나라의 문화적인 차이를 비교한 연구결과이다. 이를 위하여 우리들이 가정과 공공시설의 화장실이나 욕실 등에서 많이 사용하고 있는 냉·온수 일체형 레버형 손잡이 급수전과 냉·온수 분리형 손잡이 급수전을 선정하여 이의 열림 방향에 대한 스테레오타입을 파악하였다. 또한 본 실험결과와 다른 문화권의 자료를 비교하여 이의 차이를 규명함으로써 서로 다른 사용자들이 공감하는 설계방향에 대해 언급하였다. 국외 자료는 연구문헌을 참조하였으며 국내자료는 직접 10대에서 60대 이상까지 6개 연령계층의 남·여 50명씩 총 600명을 할당표본추출 방식으로 선정하여 실험을 통하여 수집하였다. 조사 결과는 각 항목별로 통합 자료, 성별, 연령별, 주손에 따라 빈도분석을 실시하였으며 카이제곱검정을 통해 성별, 연령계층별, 주손(hand dominance)별로 스테레오타입의 기대특성(expectation characteristics)에 대해 문헌을 통해 조사된 연구결과와 상호비교 분석하였다. 분석결과 우리나라 사람은 비교 분석된 다른 나라 사람과 같이 스테레오타입에 대한 통상적인(그러나 동일하진 않음) 문화적인 배경을 공유하고 있음을 알 수 있다. 본 연구결과는 급수전 손잡이 설계에 있어서 서로 다른 문화적인 배경에 따른 보편적 기대와 일치된 설계지침으로서 사용상의 편리성과 안전성을 향상시키는데 유용하게 이용될 수 있을 것이다.

Keywords : Faucet, Water Tap, Expectations, Stereotype, Cultural Difference

1. Introduction

In our daily lives, water is used at home, work, public washrooms or bathhouses for washing purposes.

Various types of water faucets are encountered, the most widely used of which are the single Hot/Cold lever-type faucet handle in <Figure 1> that controls both hot and cold water and separated Hot/Cold faucet handles<Figure 2 & 3>.

The question then arises, which direction should the faucet handle be operated to turn on or off the water? In many cases, the opening direction of water faucets at other houses or public washrooms is not the same as that at home. For example, some single lever-type faucet handles are turned 'Up' to turn on the water, while others are turned 'Down.' Also, separate Hot/Cold faucet handles are generally manufactured to operate in the same directions as those of screws. There

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are, however, some that need to be operated individually, 'Clockwise' or 'Counterclockwise.' This is a typical case of inconsistency because user expectations for operating the faucet handles were not considered at the design stage. Inconsistency of operating direction can be seen among the variety of product lines offered by diverse manufacturers, the result of which is a barrier to product standardization.

Confusion regarding faucet handle operation seems relatively trivial compared to a potentially catastrophic malfunction of power switches. However, inconvenience or outright danger arising from the use of machinery and tools may be eliminated entirely or in part as a result of studies of compatibility among display and control devices encountered in our daily lives.



<Figure 1> Single Hot/Cold lever-type tap handle



<Figure 2> Separate Hot/Cold sink tap handles



<Figure 3> Separate Hot/Cold wall-mounted tap handles

Therefore, general user stereotypes preferred by the majority need to be identified at the design stage and standardized as soon as possible.

There have been some studies about water faucets ('taps' and 'faucets' are used interchangeably) published in the literature. Smith[10], Evans[4], Evans and Kwok[5], Hoffmann et. al.[6], and Hoffmann and Evans[7] reported on control stereotypes of water faucets. Their findings suggested that the generalizable stereotype for conventional faucets(i.e., cross taps) is 'counterclockwise for ON' Evans[4] noted differences in the operation of hot-and-cold faucets which existed between Australia and other countries as well as benefits of using strong stereotypes. Evans and Kwok,[5] reported that the established plumbing convention for conventional in Australia taps is anticlockwise for increase for both hot(left) and cold(right) taps, and high degree of standardization applies. This high degree of standardization is not seen in other countries, notably the United States. Hoffmann, et. al.[6] studied to determine stereotypes for tap operation when the taps were in different planes relative to the operator. They found that there were differences between the stereotypes used for conventional faucets and those operated by levers with their spindles vertical.

Verhagen et al.[11] found, in a simple knob-turning test by asking the subjects to rotate a knob or knobs, twelve out of thirteen of their groups preferred clockwise with their preferred hand, with the non-preferred hand, results were evenly divided.

However, in turning two knobs simultaneously with both hands, they observed that there was a tendency for most groups of subjects to use symmetrical(i.e., one hand clockwise and the other counterclockwise) movements of the two hands.

In this paper, the position and direction stereotypes that Koreans and other peoples from different cultural background typically expect when operating various types of water faucet handles were investigated and data regarding their preferences were compared. To do this, single Hot/Cold lever type and separate Hot/Cold round-shaped faucet handles were selected, as they are the most widely used in households and public washrooms or bathhouses to investigate the operating direction of users according to the type and installation position of the water faucet handle.

Especially, the operating direction of turning two knobs simultaneously with both hands for separate Hot/Cold round-shaped faucet handles was investigated. Then stereotypes for the opening direction were established and design criteria shared by the majority of users were offered.

2. Details and method of study

A total of 600 subjects were selected to participate in the study. The group was evenly subdivided into 6 age groups, starting from the teens to over 60. Each age group therefore consisted of 100 participants, which were evenly divided among males and females.

Faucet handle types that are widely available and prevalent in households and buildings were selected as test devices such as those in <Figure 1~3>.

While pencil-and-paper tests are simple to devise and administer(Smith[10]), they may not reveal genuine stereotypes sufficiently well in specific cases to be used with confidence(Evans and Kwok[5]).

Chan and Chan[3] noted that a real hardware test should be used whenever possible for determination of design parameters of control panels. Therefore, to facilitate subjects' understanding by providing as close as realistic situation, wooden sink mock-ups were built so that the actual water faucets of <Figures 1~3> could be mounted for the tests.

Each survey was conducted on a one-to-one basis to minimize errors. First, the age, dominant hand(handedness), then gender was asked of the subject and written down. The next step was to determine user expectation stereotypes. Three water faucet mock-ups were shown to the subject one by one starting from Lever Tap, Sink Tap, and Wall-mounted Tap consecutively. Each subject was then asked to turn on the water(operate to 'Open' direction) which were the water facet mounted on mockup sinks that has no water supplied. The handles of water faucet were turned so that they could be operated in either direction. The surveyor stood by for observation and wrote down one operating direction for each response: Up(↑) or Down(↓) for the single lever type handle defined as 'Lever Tap' and Inner(↷), Outer(↶), Clockwise(↻) or Counterclockwise(↺) for the separate

Hot/Cold sink type defined as 'Sink Tap' and the separate wall type defined as 'Wall-mounted Tap', with the stipulation that both handles be operated simultaneously.

3. Results of user expectations

Currently, the most widely used water faucet handles in Korea are the single-lever Hot/Cold type and the separated Hot/Cold type having two handles. Turning the single lever to the left(counterclockwise) provides hot water while turning it to the right(clockwise) provides cold water. With the separated type faucet having two handles, the handle positioned to the left provides hot water, while the one on the right provides cold water.

Generally speaking, Hot/Cold round-shaped <Figure 2> and cross-shaped faucet handles are all turned 'Counterclockwise' to turn on water. Hoffmann et. al.[6] support this convention that single and dual cross tap arrangements should use counterclockwise rotation of the control for increase flow. In other words, they are consistent with the general operating directions of screws or bottle caps, which loosen to the left and tighten to the right. Nevertheless, the opening direction of water faucet handles that are manufactured and widely distributed both locally and internationally is mostly incongruous(Evans[4]).

To inquire about the production status of water faucets, product research was conducted in 50 or so households, public washrooms and bathhouses along with dealers, distributors and manufacturers in the market. Results reveal that 78% of the single lever type handles are operated in the 'Up' direction to turn on water. Meanwhile, most Japanese products operate in the opposite(Down) direction to get water.

The lever type handle shown in <Figure 1>, however, of which the 'Open' direction is readily discerned, seems much easier to operate than round-shaped or cross-shaped faucet handles. Evans and Kwok[5] reported that the generalizable stereotype for this arrangement of lever operated faucets is 'forward for ON.' This may be because operation in the opposite direction would lead to the tap handle(and the hand) striking the wall behind the basin.

Exchanging them with lever type handles may prevent uncomfortable hand and wrist movements required by

the round- or cross-shaped handles, however barriers do exist such as differing preferences for various types of handles, not to mention the relatively higher cost of lever type handles and the inconvenience of having to replace the entire faucet should the lever handle break.

Separate Hot/Cold water faucets are relatively low in price and considered more reliable, so they are already found in many places. Special locations and purposes may also require their installation. It is thus deemed essential that manufacturers consider and incorporate user expectations at the design stage.

3.1 User expectations in general

<Table 1> shows the results from this study and others for the overall user expectations of operating directions of the faucet handle. To turn water on, 63% responded Up for Lever Tap, proving to be the stronger stereotype compared to Down.

For Sink Tap and Wall-mounted Tap, with the stipulation that both handles be operated simultaneously, 51.5~54.0% responded by turning the handles in the outer direction(i.e., counterclockwise for the hot water handle and clockwise for the cold water handle). This result is inconsistent to that of products currently prevalent in the market, which are mostly designed to operate in one direction. 19.2~22.7% of respondents turned the handles counterclockwise, which is the most widely preferred operating direction, thus proving to be the second strongest stereotype. On average, as the faucet handle on the left is for hot water and the right for cold water, the general expectations for round- or cross-shaped types is that the right handle should be operated counterclockwise to turn on the cold water. However, when both handles were operated simultaneously, subjects were confused about which direction the handles should be turned, i.e. clockwise or counterclockwise?

Hoffmann, et. al.[6] studied the stereotype strengths for different arrangements of dual cross taps without the stipulation that both handles be operated simultaneously.

Although it is not directly comparable, the results showed that the 10%(clockwise for both), 66%(counterclockwise for both), 10%(clockwise for the left and counterclockwise for the right), 14%(counterclockwise for the left and clockwise for the right) responded for taps mounted on the top surface.

<Table 1> User expectations(%) of operating direction in different studies

Classification	Operating direction	Turning two taps simultaneously	Hoffmann [6]	Smith[10]		
				Engineer	Women	Human Factors
Lever Tap	Up	63	-	-	-	-
	Down	37	-	-	-	-
Sink Tap	Inner	11	10	23	20	13
	Outer	54	14	13	26	16
	C*	13	10	17	34	22
	CC**	22	66	47	20	49
Wall-mounted Tap	Inner	12	0	-	-	-
	Outer	51	10	-	-	-
	C	18	24	-	-	-
	CC	19	66	-	-	-

* Clockwise, ** Counterclockwise, - Data not available

For taps mounted on the front, 24%, 66%, 0%, 10% in that order. The strength of the stereotype was stronger in the counterclockwise direction for both arrangements.

Smith[10] also studied the stereotype strengths of dual cross taps for different group of people(i.e., engineer, women, human factors). The stereotype of counterclockwise for both taps was stronger in this sample(66%) than in the data of Smith[10] for a USA sample(41%).

3.2 User expectation by age stratification

There were no comparable other studies exist for the expectation by age difference. The results from this study are displayed in <Table 2>.

The strongest stereotype was unified in all age stratifications: 'Up' for Lever Tap, and 'Outer' for Sink Tap and Wall-mounted Tap. In particular, subjects in their 40s and 50s responded consistently in the order of 'Outer,' 'Counterclockwise', 'Clockwise' and 'Inner,' while responses from other age s stratifications varied somewhat.

<Table 2> User expectations(%) by age group

Classification	Operating direction	Age group					
		10s	20s	30s	40s	50s	Over 60s
Lever Tap	Up	63	57	61	64	68	65
	Down	37	43	39	36	32	35
Sink Tap	Inner	13	10	11	7	11	13
	Outer	45	60	56	57	52	54
	C	15	7	10	11	13	19
	CC	27	23	23	25	24	14
Wall-mounted Tap	Inner	13	9	11	13	8	16
	Outer	45	55	56	51	57	45
	C	23	16	21	16	11	19
	CC	19	20	12	20	24	20

3.3 User expectations by gender

As shown in <Table 3>, user expectations by gender were in line with the overall trend. The stronger stereotype for Lever Tap was the 'Up' direction regardless of gender, but the degree of expectation was higher for males than for females. Similar preferences for Sink Tap and Wall-mounted Tap were displayed for both genders with no significant difference.

According to Evans and Kwok[5], no differences were found between males and females for both conventional and lever operated taps. Smith[10], however, found differences between males and females. Evans and Kwok[5] noted that the difference between these findings may be due to the higher degree of standardization in Australian plumbing, and a correspondingly stronger stereotype for both sexes.

<Table 3> User expectations by gender

Classification	Operating direction	Gender			
		Male		Female	
		Response	Percent	Response	Percent
Lever Tap	Up	209	69.7	169	56.3
	Down	91	30.3	131	43.7
Sink Tap	Inner	29	9.7	36	12.0
	Outer	164	54.7	160	53.3
	C	36	12.0	39	13.0
	CC	71	23.7	65	21.7
Wall-mounted Tap	Inner	34	11.3	36	12.0
	Outer	152	50.7	157	52.3
	C	51	17.0	55	18.3
	CC	63	21.0	52	17.3

3.4 User expectations by dominant hand

The composition of dominant hand revealed that fifty-three subjects were left-handed(including both-handed), which accounts for 8.8% of the total count of 600. This is consistent to Barsley's[1] study on the left-handed population of the world(8~10%). Distribution by gender manifests slightly more left-handed males(52.8%) than females(47.2%), and relatively more in the 20s and 30s by age stratification.

Regardless of dominant hand, 'Up' was the strong stereotype for Lever Tap, but the degree of expectation was higher by right-handed than left-handed subjects. For Sink Tap and Wall-mounted Tap, left-handed subjects showed a relatively higher expectation for both handles operating in the inner direction than clockwise.

Bradley[2] found that significant differences between right- and left-handed subjects in a single knob-turning test. However, Verhagen et al.[11] found no significant differences between right- and left-handed subjects in a single and two knobs-turning tests and Evans and Kwok[5]. Accordingly, the statistical differences between right- and left-handed subjects might be dependant on the experimental conditions and the target population.

3.5 Verification of independence among expected value distributions by chi-squared test

A chi-squared test was administered to verify independence among expected value distributions<Table 4>.

<Table 4> Chi-squared test verification of independence among expected value distributions

Classification		Lever Tap	Sink Tap	Wall-mounted Tap
Age distribution (Youth vs. Elderly)	Value	2.406	5.123	4.544
	DF	1	3	3
	p-value	.121	.163	.208
Gender (Male vs. Female)	Value	11.440	1.188	1.341
	DF	1	3	3
	p-value	.001	.756	.719
Hand dominance (Right vs. Left)	Value	1.020	3.461	2.578
	DF	1	3	3
	p-value	.312	.326	.461

A significant difference was not evident between youths(20s~30s) and the elderly(50s~over 60s) regarding handle direction and position, nor was any found with regards to dominant hand distribution.

There was, however, a significant difference between genders regarding Lever Tap. The operating directions of the faucet handle differed between 'Up' or 'Down' according to gender.

3.6 Analysis of user expectation trend by installment position

Further analysis was done to identify differences in response according to installation position(Sink Tap or Wall-mounted Tap).

When using the left handle to turn on the hot water of Sink Tap, 459(77%) subjects turned the handle counterclockwise as opposed to 141(23%) subjects who turned it clockwise. Thus, counterclockwise proved to be the stronger stereotype. When using the right handle to turn on the cold water of Wall-mounted Tap, 420(70%) subjects preferred clockwise, while 180(30%) subjects opted for counterclockwise. Here, clockwise proved to be the stronger stereotype. It can therefore be concluded that the installation position of faucet handles was a relevant factor with the left handle but not the right handle.

4. Discussion and conclusion

In our daily environment, tools and devices should be user-friendly and trouble-free with directions that are easy to follow. As such, we need to understand how people handle objects, what errors are frequently made, and choices made over others.

Based on the results, a stereotype standard for the opening direction was investigated according to appropriate operating direction and installation position. It should be noted that the conclusions drawn are culturally specific and may be of little relevance to people in other cultures. The following suggestions were made as to water faucet designs.

1. The single Hot/Cold lever type with one faucet handle should be designed to be lifted 'Up' to turn

on the water, as this was manifested as the strongest stereotype.

2. The separate Hot/Cold type with two faucet handles that are presently used in many countries mostly operate Counterclockwise to turn on the water. However, this study finds that when the two handles are operated simultaneously, the Outer direction(i.e., counterclockwise for the hot water handle and clockwise for the cold water handle) manifests as the strongest stereotype. Therefore, it is recommended that the lever type handles be mounted in places requiring separate Hot/Cold type handles. Not only do they operate consistently in the Counterclockwise direction, but also display high visibility of the Open/Close position by handle position.

3. A significant difference was observed between male and female stereotypes for the single Hot/Cold lever type handle. But this result does not violate the compatibility relationship that the degree of expectation was higher for males than for females. It is therefore not necessary that gender be a factor for consideration so as other countries. Meanwhile, a significant difference did not exist between stereotypes of youth and the elderly or dominant hands. These factors need not be figured into consideration as well.

4. Operating directions by installation position differed with the left handle but not the right handle.

In general, counterclockwise was preferred for the left handle while clockwise for the right handle. It seems suffice to say that the same operating direction may be designed for different installation positions.

The results of Hoffmann and Evans[7]'s studies are not directly comparable to this study. Because this study was asking subjects turn two handles of separate Hot/Cold type water faucet simultaneously, not independently and also their studies used different water taps.

Sanders and McCormick[9] mentioned that in some circumstances it may be necessary to violate one compatibility relationship to take advantage of another one in the design of some systems. Therefore, the water faucets that are to be turned simultaneously, it is necessary to violate the generalizable stereotype for conventional faucets.

Although fairly clear-cut population stereotypes do exist for certain control display relationships, these are by no means universal(Sanders and McCormick[9]).

When there is no strong population stereotype or when relevant principles are in conflict, a designer still needs to make a design decision. One approach is to design control-display relationships to match existing relationships found in other systems likely to be used by the intended population. That is, standardization can substitute for a population stereotype. Another approach is to select a relationship that is logical and explainable. At least then it will be easier to train people to use the system even if the logic was not apparent to them before training. When there is no clear-cut stereotype to adopt, there is no previous experience to follow, and there are no logical principles to use, then empirical tests of possible relationships should be carried out with the intended user population to serve as the basis for a design decision.

The results of this study should prove to be useful for designing water faucet handles that operate consistently to universally prevalent user expectations.

Visibility is the most valued principle in designing any device. In other words, key parts of operation should be laid out in a clear and easy to comprehend fashion with appropriate instructions(Norman[8]).

Unfortunately, water faucet handles to date seem to lack operational visibility and appropriate instructions.

Future designs should enhance visibility and be in accordance with strong stereotypes, and standardized as soon as possible. Moreover, attaching a redundant code to the water faucet handle, such as an Open/Close label, Red/Blue color coding for hot and cold water or some other appropriate marks or signs may reduce trials-and-errors. All the better, such labels should act as design factors to enhance overall aesthetics.

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