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BRINGING AUTOMATION-RELATED COMPLACENCY INTO THE 21ST CENTURY

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Abstract

Complacency potential is an important measure to avoid performance error, such as neglecting to detect a system failure. This study updates and expands upon Singh, Molloy, and Parasuraman's 1993 Complacency-Potential Rating Scale (CPRS). We updated and expanded the CPRS questions to include technology commonly used today and how frequently the participants used this technology. The goal of our study was to update the scale and to explore whether there was a relationship between frequency of use and the responses on the updated CPRS measure, based on the original measure's four subscales: confidence-related complacency, reliance-related complacency, trust-related complacency, and safety-related complacency. We hypothesized that 1) higher use would be related with higher complacency scores in each subscale and 2) lower use would be related with lower complacency scores in each subscale. Our research found that there wasn't a significance between the frequency of use scale question and the subscales.

Bringing Automation-Related Complacency into the 21st Century

Research involving complacency and automation, after an initial interest in the mid-1990s, has been dormant. Given the ongoing fourth industrial revolution which has, at its core, introduced automated technologies in a wide range of areas, complacency measures related to possible human performance breakdowns and error, (i.e. undetected malfunctions on airplanes), needs to be revisited. Today, there is more visible and invisible automation available to consumers than ever, and this technology works more efficiently and reliably than previously. However, greater reliability, increased access, and improved efficacy make complacency more likely, thus the focus of this research.

In 1993, Singh, Molloy, and Parasuraman published a paper introducing the Complacency-Potential Rating Scale (CPRS). The CPRS was created to assess automation-induced complacency in pilots, where complacency can lead to aviation accidents. This measure consisted of four subscales: confidence-related complacency, reliance-related complacency, trust-related complacency, and safety-related complacency (Singh et al., 1993). Singh, Molloy, and Parasuraman's 1993 article established the CPRS in the academic world and used in several research contexts. According to Google Scholar, the article has been cited 203 times, the majority of which occurred in papers published in 2017. (See Figure 1). Many of the citations occurred in recent years, showing a spike of interest in the CPRS.

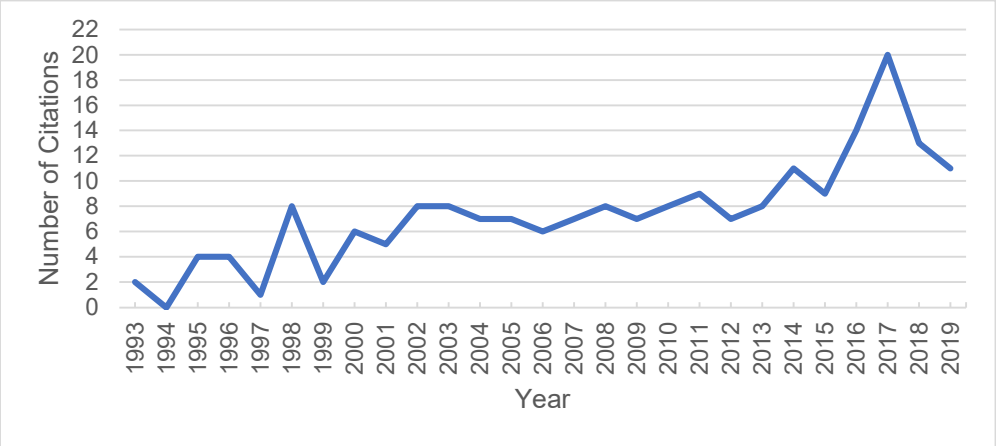

Figure 1. "Automation-Induced 'Complacency': Development of the Complacency-Potential Rating Scale" citations over time.

However, as time has passed, technological developments have greatly improved and use of technology increased. Instead of having automation in a limited capacity in the 1990s, we carry around a computer in our back pockets, and people are increasingly surrounded by and exposed to automation, (i.e. card catalogues). One limitation of Singh, Molloy, and Parasuraman's original CPRS measure was that it was validated with undergraduate students who had less computer experience and usage than today's students and general population. Thus, peoples' perspective on automation in their everyday life might differ from 30 years ago.

There has been little attention to a new version of the CPRS nor focus on whether technology use affects the responses since its initial publication. Merritt et al. published their reformed version of the CPRS early in 2019; the authors focused on workload and monitoring within this new measure, instead of the factors. They also make the scale broad and abstract; i.e., nonspecific versus certain technology-related experiences that are common (Merritt et al., 2019). Merritt et al. started answering the call for more attention to the CPRS. However, there is still question whether they have strayed too far from the original scale by not using factors and technology specific questions. Thus, it appears to be an important scientific goal to develop an

updated CPRS scale that allows raters to describe their experience with technology specific to certain widely available technologies to create an instrument that assesses complacency. In the present study we attempted to address many of the limitations in this work.

Merritt et al. (2019) conceptualizes complacency potential as a product of workload, which may be deriving from the main point of the original survey. Singh, Molloy, and Parasuraman's original measure consisted of factors that included information on workload (1993). Each of these factors are affected by workload when studying complacency within the workplace. However, though the number of tasks is a factor in complacency, concentrating on workload does not allow for the original intent of complacency potential in the scale nor the study of whether technology use affects participants' response to the measure.

Since the Merritt et al. (2019) measure is a nonspecific measure, it would allow for advancing technology; a nonspecific measure can also conceal differences in complacency potential between the technology the participants judge their answers on, such as various levels of automation in cars. The authors also tested their measure on naïve automation users, using Amazon Mechanical Turk (MTurk), which could skew their results. It has been widely debated whether results using the MTurk could be trusted as reliable data. In our study, we address these limitations by formulating the revised questions based on the original complacency potential measure, asking about specific technology within the questions and their use, and giving our measure to participants who are more knowledgeable about everyday automation.

In addition, to place the original 1993 CPRS in today's context of automation use, we have updated and expanded the scale with the goal of making an updated and validated version available for researchers who are interested in studying complacency in automation. In this study, we brought the automation-related complacency measure into the 21st century by incorporating items that are focusing on technology that is widely used today but was not available at the time of the creation of the original instrument. We also included questions about how frequently participants use the technology we referenced to analyze whether this might affect their responses. Thus, in order to update the complacency measure into the current technological state, the questions were updated, expanded on, and analyzed for possible affects of frequent technology use from the previous CPRS to the new CPRS-Revised. We are also exploring the relationship between the complacency scale and how often people use the specific technology we ask about. We hypothesize that 1) higher technology use will be related to complacent responses in all subscales within the CPRS-Revised measure and 2) lower technology use will be related to less complacent responses in all subscales.

Method

Participants

We recruited 99 participants through the University of Utah Department of Psychology Participant Pool for partial course credit. The participants are undergraduate psychology students at the University of Utah, (72 female, mean age 21, age range 18-46 years old).

Materials

This study required the creation of a list of items that are reflective of the different subscales of Complacency-Potential Rating Scale (CPRS) and that assess different attitudes, both favorable and unfavorable, towards automation. The answers included a Likert scale consisting of seven options related to the participants' attitude towards a statement: strongly agree, agree, slightly agree, neither agree nor disagree, slightly disagree, disagree, or strongly disagree. We also addressed how frequently the technology is used by the participant. These answers include daily, 4-6 times a week, 2-3 times a week, once a week, once every other week, once a month, less than once a month, and never. The survey was uploaded onto the Sona system, via a

Qualtrics form, for use by the participants online. The item scale questions consisted of a few statements like the following:

> When I have to find a keyword in an on-line article, scanning/reading the article quickly is more reliable than a computer-aided search. When paying with my credit card at the gas station, I do not take a receipt since the transfer is accurate and error-free. If I need to have a tumor in my body removed, I would choose to undergo computer-aided surgery using laser technology because computerized surgery is more reliable and safer than manual surgery.

The survey was taken, and the results were submitted, through Qualtrics.

Procedure

The development of an online survey consisted of generating/updating a set of scale item questions to assess attitudes towards aspects involving automation, taking into consideration the innovations in technology since the original survey. The survey was presented in three sections: demographic questions, automation-induced complacency measure questions, and frequency of use questions. The experimenters then collected data through a normative sample of data by uploading the study onto the University of Utah Department of Psychology Participant Pool and uploading the survey onto Qualtrics.

After the survey was published, the participants self-selected to participate in the study through the Participant Pool and signed up for one of the 200 participation slots. A link was available to the participants to access the survey through Qualtrics, after the participants had successfully signed up for the study. The participants took the survey online and submitted their answers through the Qualtrics form.

Results

Using the data provided by the participants, the experimenters analyzed the relationship between how frequently the participant used technology and their scores on the CPRS-Revised subscales. The updated questions were first organized into the original survey's subscales: confidence-related complacency, reliance-related complacency, trust-related complacency, and safety-related complacency. Next, we calculated the median score for the frequency of use questions (e.g., Table 1). Only questions with a median ranging between three and six on the eight-point scale were included for division of groups. If the medians are chosen above a six or below a three, then it wouldn't show a distribution for the groups. The experimenters then performed a median split of the participants, into high/low users of technology based on each frequency of use question response. There are two main implications that occur because of this type of grouping. The same participant can be high in one frequency question group and low in another. Another implication is that not all the participants response met the criteria, (i.e. participants who answered the mean were excluded from the groups). Several Welch t-tests were then conducted to identify potential statistical differences between the two groups, high/low use, and their responses on questions within the four subscales. The results are given in Table 1.

Table 1. Mean, Median, and Range of Frequency of Use Questions.

Frequency of Use Question and Technology	**Median**	**Min**	**Max**	**Mean**
Q31 – Computer aided searches	6	0	7	4.62
Q32 – Credit card readers	6	0	7	5.07
Q33 – Banking apps	5	0	7	4.85

Q34 – Alarms	7	0	7	6.58
Q36 – ATMs	1	0	7	1.40
Q37 – Cruise control	1	0	7	1.68
Q38 – Online banking	5	0	7	4.43
Q39 – Online shopping	3	0	7	3.32
Q40 – Parking apps	0	0	7	0.747
Q41 – Phone payment services (e.g. Google Pay)	0	0	7	1.24
Q42 – Devices with cameras	7	0	7	6.76
Q43 – Online grocery shopping	0	0	6	0.485

Based on the criteria outlined above and in Table 1, (i.e., median of technology frequency question needs to fall within range of 3-6), Q31, Q32, Q33, Q38, and Q39 technology use frequency scales were used to perform analyses of the CPRS subscales.

Table 2. Welch T-Test Results.

Question	**Tech Use**	**N**	**Subscale 1 - Confidence**				**Subscale 2 - Reliance**			
			M	df	t	p	M	df	t	p
Q31	High	30	18.53	68.065	0.92	0.3606	16.27	60.934	-0.33	0.7453
	Low	49	17.76				16.53			
Q32	High	31	18.9	70.877	1.17	0.2453	17	68.339	0.83	0.4093
	Low	42	17.92				16.36			
Q33	High	45	18.24	73.352	-0.19	0.8495	16.65	76.764	0.439	0.6618
	Low	37	18.41				16.30			
Q38	High	35	19.06	78.817	1.45	0.151	17	73.515	0.930	0.3555
	Low	47	17.83				16.30			
Q39	High	45	18.87	80.429	0.99	0.3269	16.44	85.28	-0.48	0.6301
	Low	43	18.07				16.79			

Question	**Tech Use**	**N**	**Subscale 3 - Trust**				**Subscale 4 - Safety**			
			M	df	t	p	M	df	t	p
Q31	High	30	18.1	73.749	1.85	0.0680	13.3	69.228	1.48	0.1434
	Low	49	16.14				12.24			
Q32	High	31	16.97	69.19	-0.05	0.9627	13.25	70.614	1.52	0.1337
	Low	42	17.02				12.14			
Q33	High	45	16.58	77.691	-0.80	0.4263	12.71	75.807	-0.40	0.6903
	Low	37	17.46				13			
Q38	High	35	17.09	78.924	0.55	0.5831	13.03	79.301	0.93	0.3528
	Low	47	16.49				12.38			
Q39	High	45	17.8	78.983	1.099	0.2752	13.36	68.881	1.618	0.1102
	Low	43	16.63				12.23			

As shown in Table 2, a Welch t-test was conducted to determine if the high technology use group for Q31, Q32, Q33, Q38, and Q39 were significantly different than the low group on confidence-related complacency, reliance-related complacency, trust-related complacency, and safety-related complacency. The test revealed that there wasn't a significantly difference between the two groups.

Discussion

The goal of the study was to update the Complacency-Potential Rating Scale with currently available technology. We also strived explore the relationship between the updated scale and the frequency in which people use the technology. We predicted that there would be a relationship between the high use group and higher complacency responses in all the subscales. We also predicted that there would be a relationship, across subscales, between the low use group and the lower complacency responses. Our predictions were not supported.

There were some limitations in the study's sampling and design. One limitation to this study was our sample was not very large sample of participants at 99 individuals, and we only studied undergraduate psychology students. Due to this sampling limitation, we cannot generalize the results to the entire population. With increasing technological advances, automation-induced complacency should ultimately be measured in everyday life, as well as in a variety of work environments. Since the study was investigative and showed differences, and lack of differences, between the high/low use groups, we cannot determine a direction of cause between frequency and complacency potential. Also, we assumed that the subscales of the revised CPRS are the same as the original measure. The factors could have shifted as we updated the questions and with the advancement in technology. In future studies, it would be important to include a more representative and larger sample of the general public into the sampling process, to analyze direction of cause, and to conduct a factor analysis to determine whether the subscales have shifted.

A goal of this study was understanding how frequently the technology is used by a participant is related to responses to complacency potential scales. Even though we did not find a significant correlation, there may still be a relationship between frequency of use and the subscales. This study also offers researchers an updated CPRS that incorporates everyday technology and its use. We suggest that researchers should include technology that they are specifically interested in, as well as frequency of use questions, to develop the CPRS within their field of interest. Also, as a revised CPRS continues to be developed, special attention should be given to possible factor shifts and how these new factors might be related with frequency of use.

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Appendix
Updated Complacency-Potential Rating Scale

Survey: New CPRS Portion

Subscale 1: Confidence-Related Complacency

Q12. When paying with my credit card at the gas station, I do not take a receipt since the transfer is accurate and error-free.

Q16. Automated systems in modern aircraft, such as the automatic landing system, have made traveling by air safer.

Q19. Automated devices in medicine save time and money in the diagnosis and treatment of disease.

Q23. I think that automated devices used in medicine, such as CT-scans and ultrasound, provide very reliable medical diagnosis.

Q26. When paying for a product in a store, phone payment services (e.g. Google Pay, Apple Pay, Samsung Pay, etc.) is more reliable than a credit card.

Subscale 2: Reliance-Related Complacency

Q11. When I have to find a keyword in an on-line article, scanning/reading the article quickly is more reliable than a computer-aided search.

Q17. ATMs provide a safeguard against the inappropriate use of a person's bank account by dishonest people.

Q18. Automated devices in banking have made work easier for both employees and customers.

Q20. Even though the automatic cruise control in my car is set at a speed below the speed limit, I worry when I pass a police radar speed-trap in case the automatic control is not working properly.

Q25. The alarms on my phone are reliable than an alarm clock to wake me up.

Subscale 3: Trust-Related Complacency

Q21. Bank transactions have become safer with the introduction of computer technology for the transfer of funds.

Q22. I would rather purchase an item online using a computer or cell phone than dealing with a sales representative on the phone because my computer/cell phone-based order is more likely to be correct.

Q24. When trying to find an empty parking space, I would use an app to show me the location.

Q27. When using a device with a camera, such as a laptop, I trust the device to notify me if the camera is on and recording.

Q29. When paying for a privately purchased item (e.g. KSL Classifieds), I trust that an app payment system (e.g. Venmo) will deliver the money accurately.

Subscale 4: Safety-Related Complacency

Q13. If I need to have a tumor in my body removed, I would choose to undergo computer-aided surgery using laser technology because computerized surgery is more reliable and safer than manual surgery.

Q14. I feel safer depositing a check using my phone and the bank’s app than with a human teller.

Q15. I have to be at a meeting at a certain time. To make sure that I am on time, I would program an alarm on my phone rather than monitoring the time by myself.

Q28. When purchasing groceries through a grocery shopping service, such as Smith’s ClickList, I double check that I got everything I ordered even though the app says the order is complete.

Survey: Frequency of Use Portion

Answer choices: Daily, 4-6 times a week, 2-3 times a week, once a week, once every other week, once a month, less than once a month, never.

Q31. How often do you use computer aided searches, such as 'Ctrl F'?

Q32. How often do you use credit card readers?
Q33. How often do you use banking apps to manage money (e.g. depositing checks, checking account balance, etc.)?
Q34. How often do you use alarms on your phone?
Q35. How often do you travel in an airplane?
Q36. How often do you use ATMs?
Q37. How often do you use automatic cruise control in a car?
Q38. How often do you use online banking services?
Q39. How often do you use online shopping websites?
Q40. How often do you use parking apps?
Q41. How often do you use phone payment services (e.g. Google Pay, Apple Pay, Samsung Pay)?
Q42. How often do you use devices with cameras, such as cellphones or laptops?
Q43. How often do you use online grocery shopping services (e.g. Smith's Clicklist)?