The Effect of Auditory and Visual Noise on the Performance of Security Critical Tasks

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INTRODUCTION

- Task complexity blame for user failure in security-critical tasks
- Little work has been done to explore the effects of incidental distraction on task performance
- We seek to determine the effect of sensory distraction on the performance of security critical tasks
- We tested 290 subjects performing Bluetooth Pairing
- Subjects were exposed to a auditory or visual stimulus during task performance
- Different stimuli impacted task performance differently
- Both positive and negative effects were observed

MOTIVATION

- Human users considered weakest link in any security protocol
- Human participation in many of these protocols is unavoidable
- Protocols with a human in the loop have undergone extensive testing to create the simplest tasks that still provide acceptable levels of security.
- However impacts of unexpected distractions on user performance in security protocols are unknown.
- We are left with the following questions:
- Can an agent with control over the environment impact completion rates in security critical tasks?
- Can an agent with control over the environment impact completion speeds for security critical tasks?
- Do different stimuli cause different effects?
- Difference in the sense stimulated?
- Difference in the intensity of stimulation?

EXPERIMENT SETUP

- Unattended design to minimize logistical cost of running hundreds of trials
- Subjects shown life-sized video of experimenter "Avatar" projected onto 72" X 48" SmartBoard
- Avatar subjects' sole source of information
- Experimenters could access video recording of subject trials offline

Environment also equipped with:

- 4 Philips Hue SmartBlubs above the area
- 2 Speaker pairs in the front and rear of room

Figure 1: The Experiment setup, side-view

Figure 2: The Experiment setup, rear-view

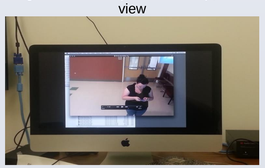

Figure 3: The experimenter's perspective (review only)

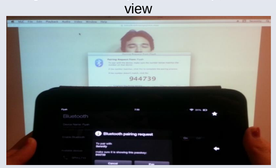

Figure 4: The subject's perspective while pairing

METHODOLOGY

- Subjects entering experiment area activate Avatar
- Avatar briefs subject
- Subjects given 2 minute window to pair their personal Bluetooth device with ours

During pairing process either:

- Nothing happens (control)
- Subject exposed to one of 5 static sound stimuli
- Subject exposed to Looming sound stimulus
- Subject exposed to one of 3 static light stimuli
- Subject exposed to one of 3 dynamic light stimuli

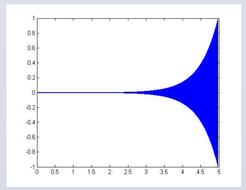

Figure 5: The Looming intensity function

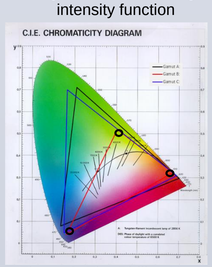

Figure 6: The Philips Hue Color Space (Color values used are encircled)

RESULTS

We collected and analyzed subject failure rates as well as average time for (successful) completion

Table 1: Barnard's Exact Test on Subject Failure Rates

Stimulus	Total Pairings	Successful Subjects	Failed Subjects	Subject Failure Rate	Wald Statistic	Nuisance Parameter	*p*
Control	47	32	15	.32	-	-	-
Baby Crying	24	23	1	0.04	2.65	0.95	0.03
Hammering	36	33	3	0.08	2.58	0.91	0.01
Helicopter	25	24	1	0.04	2.71	0.89	0.01
Saw Revving	22	20	2	0.09	2.05	0.84	0.03
Looming B[b]	21	8	13	0.62	2.32	0.86	0.01
Solid Red Light	20	11	9	0.45	1.02	0.88	0.17
Flickering Red Light	20	9	11	0.55	1.77	0.86	0.04
Solid Blue Light	20	14	6	0.3	0.15	0.05	0.49
Flickering Blue Light	20	8	12	0.6	2.14	0.96	0.03
Solid Yellow-Green Light	22	10	12	0.54	1.79	0.94	0.06
Flickering Yellow-Green Light	20	7	13	0.65	2.51	0.91	0.01

- Static sound stimuli show reduction in failure rate
- Static light stimuli show no change in failure rate
- Both dynamic sound and dynamic light stimuli show increase in failure rate

Table 2: Pairwise T-Test On Subject Completion Times

Stimulus	Mean Completion Time	Standard Deviation	Degrees of Freedom WRT Control	T-Value WRT control	*p*
Control	34.41	13.78	--	--	--
Baby Crying	31.13	10.06	63	0.97	0.35
Hammering	28.82	9.76	74	1.84	0.07
Helicopter	31.33	13.13	63	0.81	0.39
Saw Revving	38.45	17.15	60	0.90	0.38
Looming B[b]	80.75	11.12	38	8.80	< 0.01
Solid Red Light	87.81	24.56	41	9.56	< 0.01
Flickering Red Light	90.44	15.62	39	11.59	< 0.01
Solid Blue Light	106.36	17.39	44	16.32	< 0.01
Flickering Blue Light	91.25	24.11	38	9.61	< 0.01
Solid Yellow-Green Light	90.3	19.08	40	11.1	< 0.01
Flickering Yellow-Green Light	90.29	19.06	37	10.01	< 0.01

- Static sound stimuli did not show significant impact on completion times
- All light stimuli, and dynamic sound stimulus showed increase in completion times

DISCUSSION

- No uniform effect from introduction of sensory stimulation to subjects performing security-critical tasks
- subjects' overall level of sensory arousal guiding factor in task performance
- Moderate stimulation can sharpen attention, improve performance
- Overstimulation divides attention, impairs performance
- Consistent With Yerkes Dodson Law

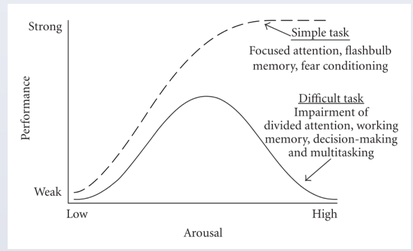

Figure 7: The Yerkes-Dodson Curve

CONCLUSION

- Sensory "distractions" not strictly harmful to the completion of security critical tasks
- Opens up two news spaces.

1.) Framework for the creation of beneficial stimuli as accompaniment to security-critical tasks.

2.)Deliberate overstimulation could be used by an adversarial agent as an attack vector

- Work on identifying the type of stimulation needed to induce failure, and any potential safeguards currently in progress.

REFERENCES

[1] T. Kaczmarek, A. Kobsa, R. Sy, and G. Tsudik. An Unattended Study of Users Performing Security Critical Tasks Under Adversarial Noise. In Proceedings of the NDSS Workshop on Useable Security 2015, pages 14:1-14:12.

ACKNOWLEDGEMENTS

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