Cognitive Load and Occupational Injuries

Journée de la Chaire Santé, May 24th, 2019

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Introduction

- The concept of cognitive load:
  - Two-system model of the brain (Kahneman, 2002, 2011):
    - System 1 = "intuitive" system that governs automatic and effortless thoughts
    - System 2 = "cool reasoning system". It is effortful, deliberate and costly. Generates more unbiased and accurate results.
  - Individuals have a mental reserve, called bandwidth (Mullainathan and Shafir, 2013), for the effortful thought required to use System 2. It is composed of 2 elements:
    - Cognitive capacity: psychological mechanisms that underlie our ability to solve problems, retain information and engage in logical reasoning.
    - Executive control underlies our ability to manage cognitive abilities. In particular, it oversees attention allocation and impulse control.
  - Cognitive load acts as a tax on bandwidth.

Introduction

- The literature has investigated the impact of cognitive load on a number of individual outcomes.
- Increasing cognitive load in the lab (Miller, 1956)
  - Keeping in mind 7 (or more)-digit numbers/letters
  - While making decisions
- Evidence that cognitive load reduces cognitive performance (De Jong, 2010).
  - Increases arithmetic mistakes (Deck and Jahedi, 2015) or reduces the ability to spot flawed logical arguments in syllogisms (De Neys, 2006).
  - Reduces the capacity to think logically and solve problems in novel situations (Mani et al., 2013)
  - $\Rightarrow$ Reduces working memory

Introduction

- Cognitive load also has consequences in terms of preferences (see Schilbach et al., 2016 for a review):
  - More risk averse (Benjamin et al., 2013; Deck and Jahedi, 2015; Gerhardt et al., 2016)
  - More impatient (Deck and Jahedi, 2015).
  - Poorer dietary choices (Shiv and Fedorikhin, 1999; Zimmerman and Shimoga, 2014; Byrd-Bredbenner et al., 2016)

- Cognitive load affects the quality of judgement:
  - It reduces the sense of agency (Hon et al., 2013)
  - Under high cognitive load, individuals are more likely to shoot unarmed targets (Kleider and Parrott, 2009) .
  - It increases the racial bias against black people in shooting decisions (Correll et al., 2007)
  - Mock-jurors rely more on stereotypes when mentally burdened (Kleider et al., 2012).

THIS PAPER

- Cognitive load and individual performance.
  - Limited evidence that it reduces the quality of driving (Kruszewski et al., 2018 ; Li et al, 2018)

- We investigate the impact of cognitive load on a dimension of performance that has not been studied yet, i.e. occupational injuries.

- In France:
  - Rate of occupational injuries extremely low by historical standards: 3,3% workers in 2017 (i.e. 633,000 injuries).
  - But the cost is high for the French Social Security System: 8.3 billion € paid for occupational injuries and professional diseases, most of which for occupational injuries.
  - And the human cost is, of course, even higher.

Our research hypothesis

- One of the most common causes of occupational injury is distraction (European Commission, 2009).
- One of the components of bandwidth is executive control which determines our ability to focus and shift attention to work with information in our memory.
- We thus hypothesize that reduced bandwidth due to cognitive load is likely to generate distraction thereby increasing the risk of work accident.

Our Approach

- Contrary to most studies on cognitive load, we use longitudinal data from a household survey.
- We consider that individuals are mentally burdened when they have to keep in mind non-professional preoccupations while working.
- Using time-use information provided by SOEP, we capture cognitive load with the **number of non-professional tasks** (e.g. housework, child care etc.) performed during the weekday, *independent of the time spent on them*.
- Underlying assumption:
  - When individuals perform a large number of those tasks, this requires mental organisation and hence generates preoccupation which keeps part of the individual's working memory busy.
  - In turn, this may create distraction thereby increasing the risk of work injury.

Data: The sample

- SOEP: longitudinal survey following households and all their members aged 16 and above since 1984, first in the Federal Republic of Germany, and since 1990 in the whole of Germany.

- We use waves from 1991 to 1998 (except 1992) where available information about time use and occupational injuries are available.

- Sample selection:
  - All employed individuals aged 18 to 64 who have answered the question on occupational injury the year after.
  - Exclusion of individuals in the armed forces.

- Our final sample contains 45,564 observations from 12,020 individuals.

Data: The measure of occupational injury

- Occupational injury is measured with the following question: "In the past year, did you receive medical or hospital treatment due to an occupational accident?" (available between 1987 and 1999, except in 1990 and 1993)

- When the individual answered "yes" to this question at the survey year *t+1*, we coded her as having a work accident during year *t*.

- We then define a dummy variable equal to 1 at year *t* when the individual reported having a work accident during that year.

- All other variables are based on the survey that took place at year t.

DATA: THE MEASURE OF COGNITIVE LOAD

- We proxy cognitive load by the number of non-professional tasks performed by individuals during a typical weekday.

- Since 1991, the various non-professional activities an individual can engage in are consistently listed as:
  - Errands (shopping, trips to government agencies, etc.)
  - Housework (washing, cooking, cleaning)
  - Child care
  - Education or further training (also school, university)
  - Repairs on and around the house, car repairs, garden work

➢ And the time spent on each of them is reported

- Control for total time spent at doing those activities.

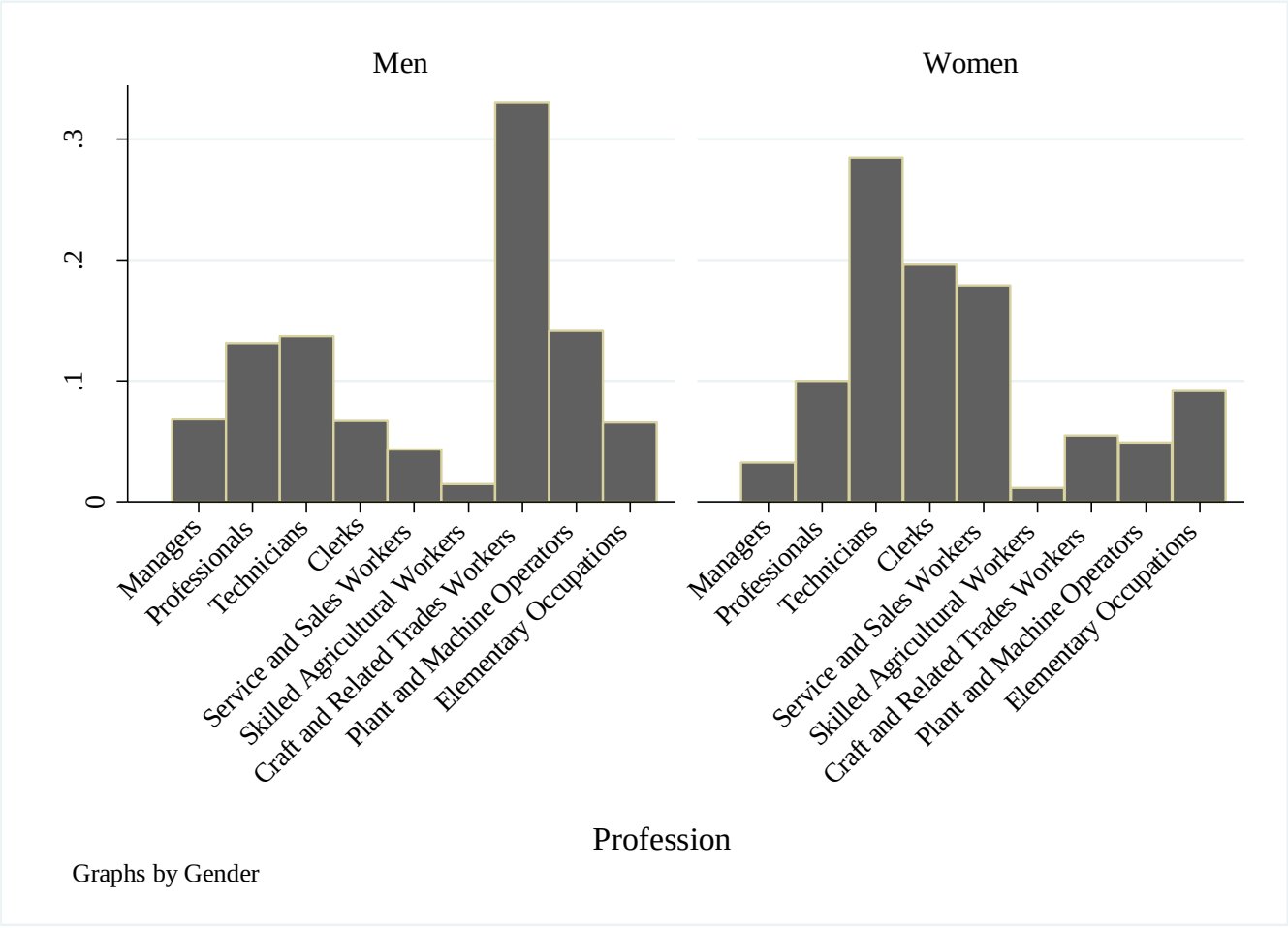
Data: Control variables

- *SOEP* also contains information on a large variety of individual characteristics:
  - Gender
  - Age
  - Years of education
  - Marital status
  - Number of adults in the household
  - Number of children in the household
  - Type of occupation (ISCO 97-1 digit)
  - Type of industry (NACE)
  - Number of hours worked on a typical weekday
  - Tenure

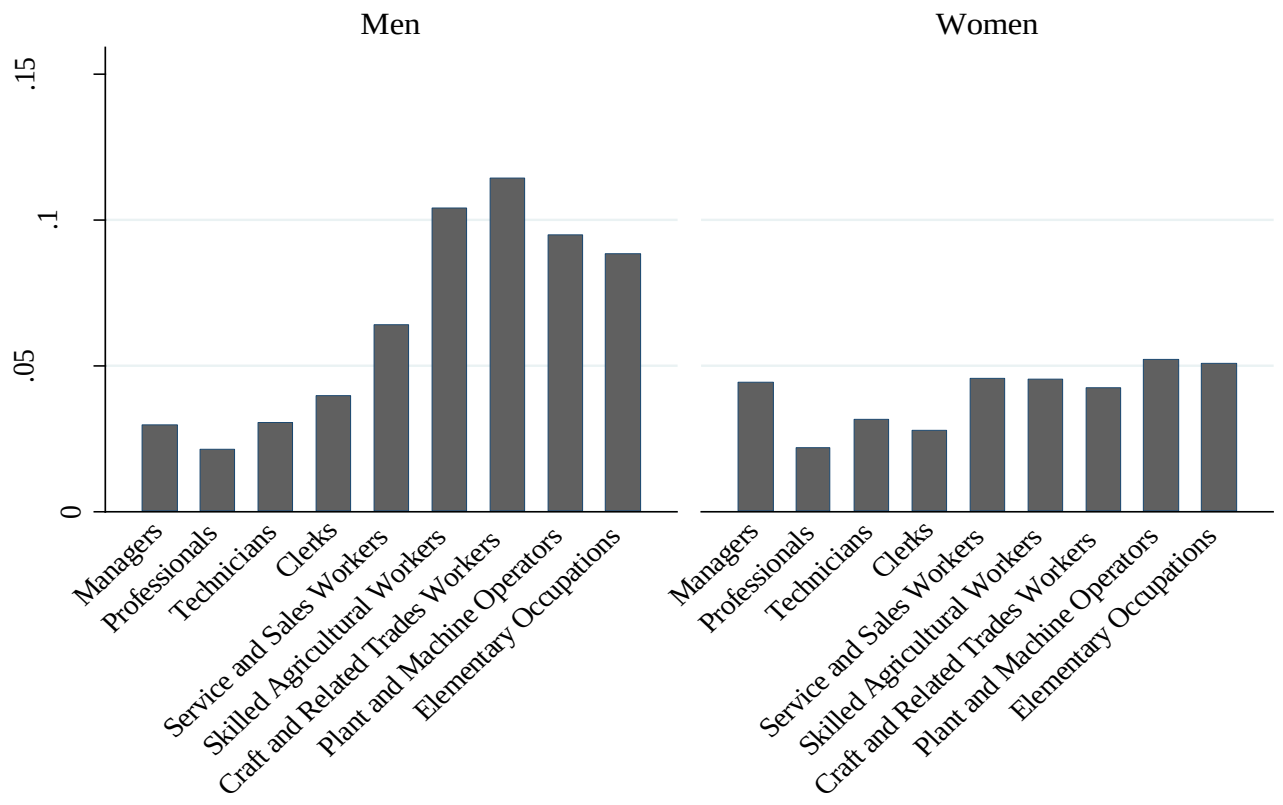
DESCRIPTIVE STATISTICS

Variables	Whole sample (n=45,564)	Men (n=26,262)	Women (n=19,302)
	Mean	Mean	Mean
Occupational Injuries	0.058	0.073	0.036
Number of non-professional tasks (0 to 5)	2.38	2.12	2.73
Large number of non-professional tasks (≥4)	0.155	0.129	0.190
Hours worked per day	8.87	9.57	7.91
Total number of hours spent on non-professional tasks per day	4.00	2.99	5.39
Women	0.424	-	-
Age	38.6	39.1	37.9
Couple	0.774	0.789	0.754
Years of education	11.6	11.7	11.5
Number of children in household	0.77	0.84	0.68
Number of adults in household	2.35	2.39	2.30
Years of tenure	9.5	10.5	8.1
Occupations			
Managers	0.053	0.068	0.033
Professionals	0.118	0.131	0.100
Technicians	0.200	0.137	0.285
Clerks	0.122	0.067	0.196
Service + shop workers	0.101	0.043	0.179
Skilled agricultural workers	0.013	0.015	0.011
Craft and trade workers	0.214	0.331	0.055
Plant + machine operators	0.102	0.142	0.049
Elementary occupations	0.077	0.066	0.092

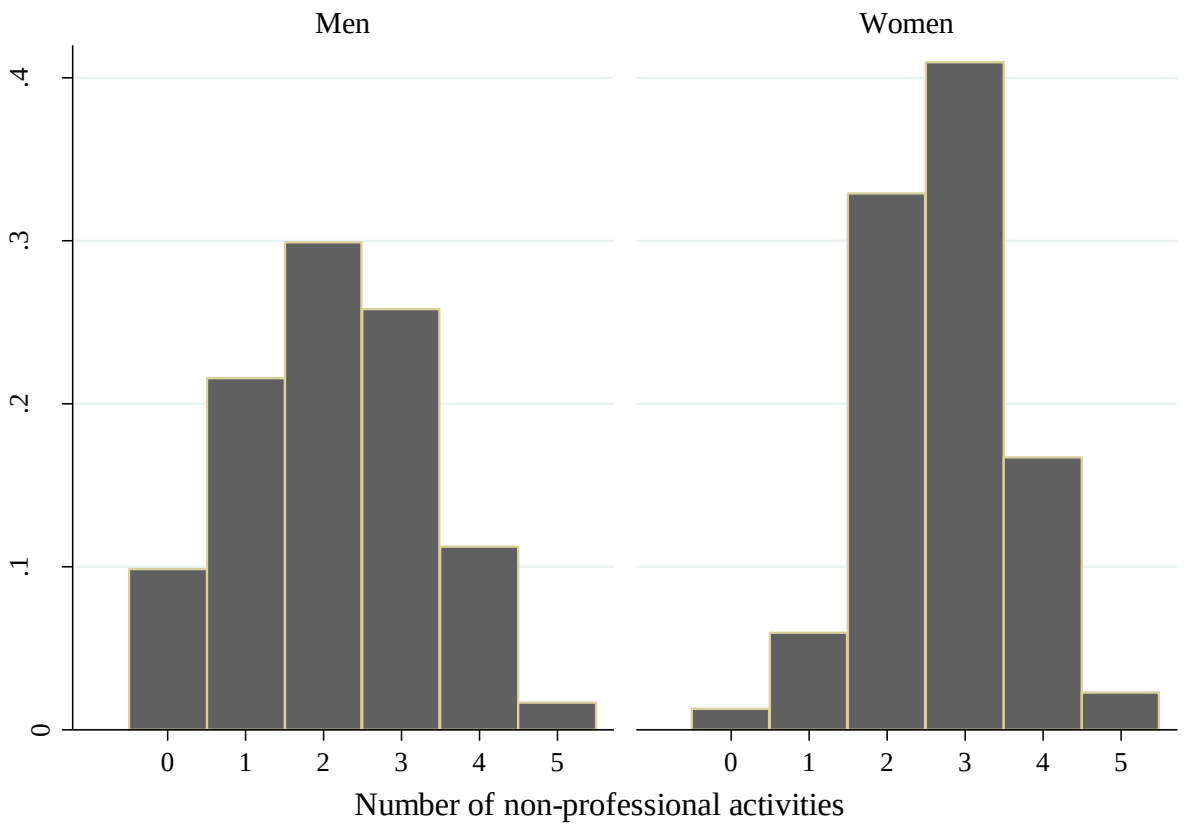
Descriptive statistics: Occupational structure by gender



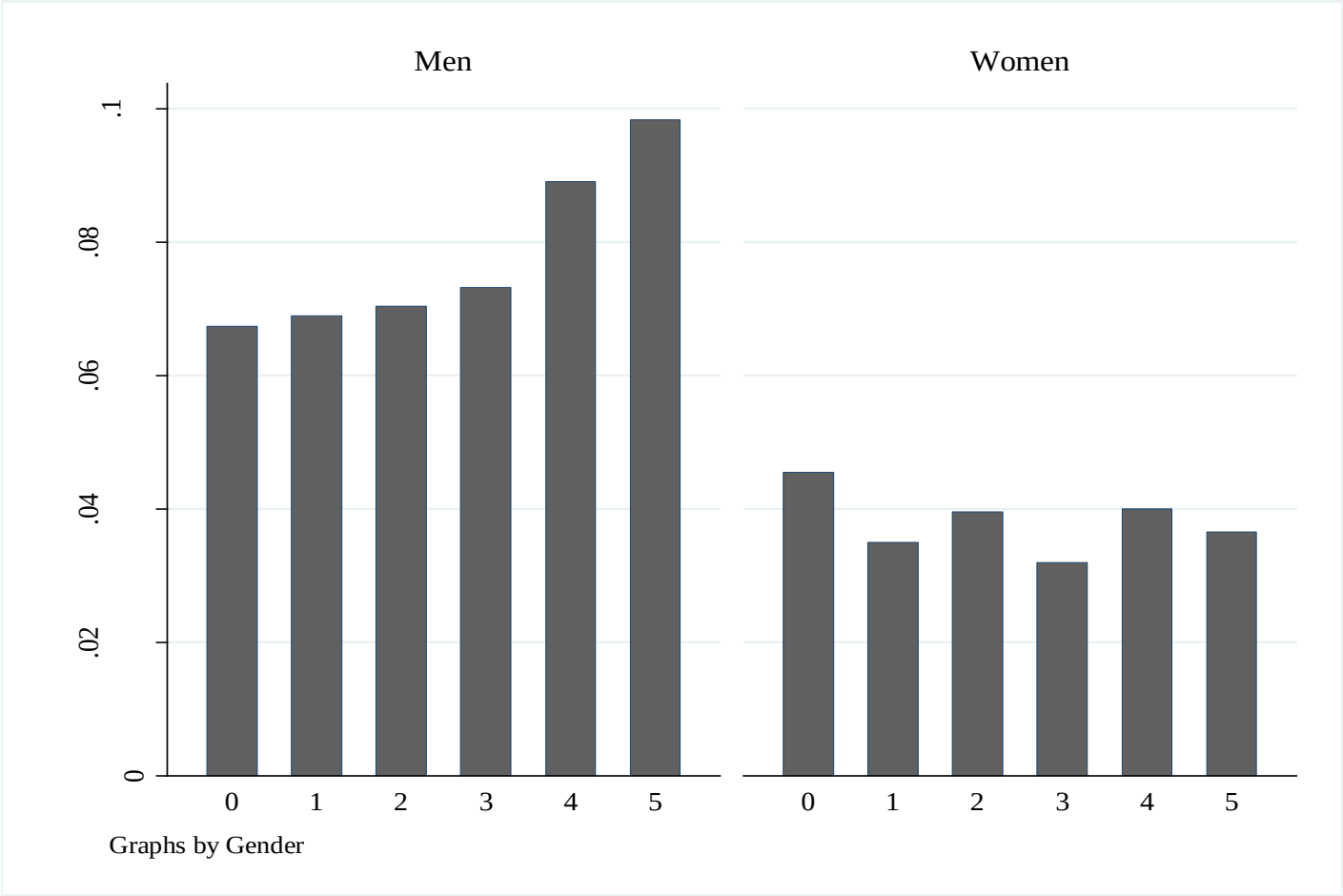
Descriptive statistics: Occupational injuries by gender and occupation



Descriptive statistics: Distribution of the number of non-professional tasks by gender



Descriptive statistics: Occupational injuries by number of tasks and gender



EMPIRICAL STRATEGY

- To investigate the impact of cognitive load – as measured by performing a large number of non-professional tasks – on the risk of occupational injuries, we estimate the following model:

$$OI_{it} = \beta_0 + \beta_1 Many\_Tasks_{it} + X_{it}\beta_2 + \gamma_t + \varepsilon_{it}$$

- $\boldsymbol{OI_{it}}$: a dummy variable equal to 1 if individual *i* had to be treated for an occupational injury at year *t* and 0 otherwise

- $\boldsymbol{Many\_Tasks_{it}}$: a dummy indicator equal to 1 if individual *i* performed a large number of non-professional tasks (≥4) on weekdays at year *t* and 0 otherwise
- $\boldsymbol{X_{it}}$: a vector of individual characteristics
- $\boldsymbol{\gamma_t}$: time fixed effects

- $\boldsymbol{\varepsilon_{it}}$: Error term assumed to be independent from $Many\_Tasks_{it}$ and X_{it} (OLS)
- $\boldsymbol{\varepsilon_{it} = \alpha_i + \nu_{it}}$: Error term where ν_{it} assumed to be independent from $Many\_Tasks_{it}$ and X_{it} (FE)

Main results

	(1)	(2)	(3)	(4)	(5)	(6)
Method	OLS	OLS	OLS	FE	FE	FE
Sample	All	Males	Females	All	Males	Females
Dependent variable	Occupational Injury	Occupational Injury	Occupational Injury	Occupational Injury	Occupational Injury	Occupational Injury
Many non-professional tasks	0.021***	0.023***	0.014***	0.013***	0.013*	0.012**
	(0.004)	(0.006)	(0.004)	(0.005)	(0.007)	(0.005)
Females	-0.014***	-	-		-	-
	(0.003)					
Years of education	-0.000	-0.000	-0.001			
	(0.001)	(0.001)	(0.001)			
Tenure	-0.000***	-0.000	-0.001**	-0.001	-0.001*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Hours worked	0.004***	0.005***	0.004***	0.001	0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Hours on non-prof tasks	0.001	0.001	0.000	0.000	0.001	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
1-digit industry dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
Age, household characteristics	yes	yes	yes	yes	yes	yes
Observations	45,564	26,262	19,302	45,564	26,262	19,302
(within) R-squared	0.025	0.027	0.006	0.002	0.003	0.002

Note. Robust standard errors clustered at the individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Main Results (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Method	OLS	OLS	OLS	FE	FE	FE
Sample	All	Males	Females	All	Males	Females
Occupations (ref. Managers)						
Professionals	-0.008	-0.007	-0.017	0.003	0.011	-0.022
	(0.005)	(0.006)	(0.011)	(0.009)	(0.010)	(0.019)
Technicians	0.005	0.002	-0.007	-0.001	0.009	-0.029*
	(0.005)	(0.006)	(0.010)	(0.009)	(0.010)	(0.017)
Clerks	0.010*	0.016**	-0.010	0.013	0.032**	-0.019
	(0.005)	(0.007)	(0.010)	(0.010)	(0.013)	(0.017)
Service + sales workers	0.026***	0.029***	0.007	0.011	-0.008	-0.002
	(0.006)	(0.010)	(0.010)	(0.011)	(0.018)	(0.018)
Skilled agricultural workers	0.033**	0.051**	-0.004	0.017	0.030	-0.019
	(0.016)	(0.023)	(0.019)	(0.027)	(0.032)	(0.050)
Craft and trade workers	0.069***	0.078***	0.004	0.035***	0.046***	-0.001
	(0.006)	(0.007)	(0.012)	(0.011)	(0.013)	(0.024)
Plant + machine operators	0.055***	0.065***	0.013	0.029**	0.046***	-0.019
	(0.007)	(0.008)	(0.013)	(0.012)	(0.014)	(0.024)
Elementary occupations	0.047***	0.060***	0.016	0.028**	0.047***	-0.014
	(0.007)	(0.009)	(0.011)	(0.012)	(0.016)	(0.020)
1-digit industry dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
Observations	45,564	26,262	19,302	45,564	26,262	19,302
(within) R-squared	0.025	0.027	0.006	0.002	0.003	0.002

Note. Robust standard errors clustered at the individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Main Results: using the number of non-professional activities

Method	(1) OLS	(2) OLS	(3) OLS	(4) FE	(5) FE	(6) FE
Sample	All	Males	Females	All	Males	Females
Number of non-professional tasks – 0 to 5 (Ref = 3)						
0 tasks	-0.012**	-0.017**	0.006	-0.007	-0.008	0.021
	(0.006)	(0.008)	(0.014)	(0.007)	(0.010)	(0.018)
1 task	-0.010**	-0.012**	-0.004	-0.000	0.001	-0.001
	(0.004)	(0.006)	(0.006)	(0.005)	(0.007)	(0.007)
2 tasks	-0.003	-0.006	0.003	0.001	0.002	0.002
	(0.003)	(0.005)	(0.004)	(0.004)	(0.006)	(0.004)
4 tasks	0.019***	0.019***	0.014***	0.012***	0.010	0.013**
	(0.004)	(0.007)	(0.004)	(0.005)	(0.007)	(0.005)
5 tasks	0.034***	0.043***	0.017*	0.034***	0.054***	0.008
	(0.009)	(0.015)	(0.010)	(0.011)	(0.017)	(0.013)
Occupational dummies	yes	yes	yes	yes	yes	yes
1-digit industry dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes	yes	yes
Observations	45,564	26,262	19,302	45,564	26,262	19,302
R-squared	0.025	0.028	0.006	0.002	0.004	0.002

Note. All specifications include 9 occupational dummies (minus 1). Robust standard errors clustered at the individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Main Results: number of non-professional activities excluding education and training

Method	(1) OLS	(2) OLS	(3) OLS	(4) FE	(5) FE	(6) FE
Sample	All	Males	Females	All	Males	Females
Number of non-professional tasks – 0 to 5 (Ref = 3)						
0 tasks	-0.015***	-0.018**	-0.004	-0.008	-0.008	0.012
	(0.006)	(0.008)	(0.012)	(0.007)	(0.010)	(0.015)
1 task	-0.013***	-0.015**	-0.003	-0.001	-0.000	0.000
	(0.004)	(0.006)	(0.006)	(0.005)	(0.007)	(0.008)
2 tasks	-0.005*	-0.008	0.001	0.001	0.001	0.003
	(0.003)	(0.005)	(0.004)	(0.004)	(0.006)	(0.005)
4 tasks	0.021***	0.027***	0.012**	0.015***	0.016*	0.011*
	(0.005)	(0.008)	(0.005)	(0.006)	(0.009)	(0.007)
Occupational dummies	yes	yes	yes	yes	yes	yes
1-digit industry dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes	yes	yes
Observations	45,564	26,262	19,302	45,564	26,262	19,302
R-squared	0.025	0.028	0.006	0.002	0.004	0.002

Note. All specifications include 9 occupational dummies (minus 1). Robust standard errors clustered at the individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Results: By type of occupation (FE results)

Sample	All	Males	Females
Dependent variable	Occupational Injury	Occupational Injury	Occupational Injury
		Panel A - Low-risk occupations	
Many non-professional tasks	0.004	-0.000	0.005
	(0.005)	(0.008)	(0.006)
Individual controls	yes	yes	yes
1-digit industry dummies	yes	yes	yes
Year dummies	yes	yes	yes
Observations	22,438	10,593	11,845
Within R-squared	0.002	0.005	0.002
		Panel B.1 - High-risk occupations	
Many non-professional tasks	0.023**	0.020*	0.026**
	(0.009)	(0.012)	(0.013)
Individual controls	yes	yes	yes
1-digit industry dummies	yes	yes	yes
Year dummies	yes	yes	yes
Observations	23,126	15,669	7,457
Within R-squared	0.003	0.005	0.009

Note. Individual controls include gender (in the whole sample), age and age squared, years of education, marital status, the number of children and of adults in the household, 9 occupational dummies (minus one), tenure, the number of hours worked and the number of hours spent on non-professional activities. Robust standard errors clustered at the individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Results: By type of occupation and educational level (FE results)

Sample	All		Males		Females	
Dependent variable	Occupational Injury		Occupational Injury		Occupational Injury	
	Panel B.2 - High-risk occupations, by level of education					
	Low educ.	High educ.	Low educ.	High educ.	Low educ.	High educ.
Many non-professional tasks	0.026***	0.010	0.023*	0.010	0.030**	0.008
	(0.010)	(0.019)	(0.013)	(0.025)	(0.014)	(0.030)
Individual controls	yes	yes	yes	yes	yes	yes
1-digit industry dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
Observations	19,521	3,605	13,248	2,421	6,273	1,184
Within R-squared	0.004	0.009	0.006	0.011	0.012	0.027

Note. Individual controls include gender (in the whole sample), age and age squared, years of education, marital status, the number of children and of adults in the household, 9 occupational dummies (minus one), tenure, the number of hours worked and the number of hours spent on non-professional activities. Robust standard errors clustered at the individual level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Conclusion

- In this paper, we complement the standard analyses of cognitive load in the lab, by investigating its impact on occupational injuries using survey data.
- We show that cognitive load increases the risk of occupational injury for both males and females.
- The effect is stronger for individuals in high-risk occupations and, among those, for low-educated workers.
- These findings suggest that, in high-risk jobs, distraction increases the risk of occupational injury, but that a high-enough educational level may help individuals cope with the cognitive burden imposed by multi-tasking.
- More research is certainly needed in this area but this primarily requires collecting relevant information in surveys.

Conclusion

Thank you for your attention.