Next Generation 911
Supporting public safety communicators using artificial intelligence

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Faculty/Presenter Disclosure

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  - Faculty of Engineering and Applied Science (Electrical and Computer Engineering)
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  - CIPSRT Scholar in Residence (Technology and Innovation)
  - Research support
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Disclosure of Commercial Support/Bias

- This program has not received financial or in-kind support from any commercial organization in any form

- Potential for conflict(s) of interest:
  - Dr. Czarnuch has not received payment/funding from any organization
  - No product(s) are being discussed in this program

- No biases exist for this project

Learning Objectives

- At the conclusion of this activity, participants will be able to better understand:

  - the current evidence on public safety communicators' mental health in Canada;

  - the potential implications and impact of Next Generation 911 on public safety communicators in Canada; and

  - the role that artificial intelligence (AI) may play in reducing this impact.

Introduction: The CRTC and NG911

- In 2017 the Canadian Radio-television and Telecommunications Commission (CRTC) directed all Canadian telephone companies to upgrade their infrastructure and networks
  - Required to support Next Generation 911 (NG911).

- Specifically, the upgrades must support NG911 services:
  - voice communication by June 30, 2020;
  - text messaging by December 31, 2020; and
  - provision for video streaming and images.

- Telephone companies are responsible, with CRTC oversight, for the construction, operation, and maintenance of the NG911 networks.

Introduction: Communicators and NG911

- The CRTC does not have a mandate beyond the technology upgrade
  - The CRTC upgrade does not explicitly consider the impact NG911 will have on:
    - call centres; or
    - public safety communicators (e.g., call takers and dispatchers for 911, police, fire and ambulance)

- The effects NG911 will have on communicators are not known
  - This includes communicator mental health

Introduction: Communicators and NG911

- What we do know:
  - Canadian communicators are already exposed to high levels of occupational trauma
    - Predominantly through exposure to potentially traumatic events
  - Recent data shows that:
    - 48.4% of communicators screen positive for at least one mental disorder
    - Diagnostic rates of 10.1% in the general population.

- Text messages, images and video information will impact risk for trauma through increased occupational exposure to new forms of potentially traumatic events:
  - both from the content (e.g., graphic images); and
  - the abruptness of the information
    - e.g., immediate image data vs. calls in which information is obtained over time
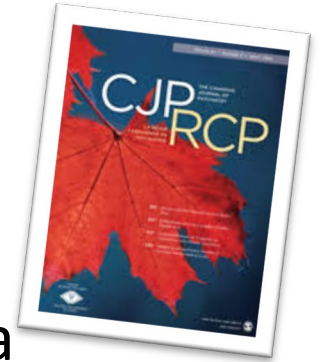
What do we currently know about public safety communicators?

Turning to the literature

What can science tell us?

The Current Landscape in Canada

- Mental Disorder Symptoms Among Public Safety Personnel in Canada
  - Canadian Journal of Psychiatry
    - Freely available to all online (DOI: 10.1177/0706743717723825); www.cipsrt-icrtsp.ca

- PSP-category-specific estimates of "positive screens" for each mental disorder based on well-established tools
  - PCL-5, PHQ-9, GAD-7, SIPS, PDSS-SR, AUDIT, and others

- Participant answers to the questions were similar to answers given by people who had been diagnosed by an interviewer
  - Implies participants might also be diagnosed if interviewed
  - There is no way to know without conducting clinical interviews

Prevalence of Mental Disorder Symptoms Among Canadian PSP

Positive Screening Percentages for Recent Mental Disorders Based on Self-Report Measures								
	General Pop.	Total Sample	Mun /Prov Police	RCMP	Correctional Workers	Fire	Paramedics	Call Centre
PTSD	~1.1-3.5	23.2	19.5	30.0	29.1	13.5	24.5	18.3
Major Depressive Disorder	~4-7	26.4	19.6	31.7	31.1	20.2	29.6	33.2
Gen. Anxiety Disorder	~3	18.6	14.6	23.3	23.6	11.7	20.5	18.0
Social Anxiety Disorder	~6.7	15.2	10.0	18.7	18.3	11.0	20.0	16.9
Panic Disorder	~1.6	8.9	5.9	12.0	12.2	5.1	10.3	7.6
Alcohol Use Disorder	~7-25	5.9	5.8	3.9	6.8	8.0	6.1	7.2
Any other self-reported		1.7	–	1.6	4.0	–	1.9	–
Any mood disorder		29.0	21.3	34.7	35.3	22.4	32.0	36.1
Any anxiety disorder		30.3	23.7	37.3	37.9	19.4	33.9	32.2
Any mental disorder	10.1	44.5	36.7	50.2	54.6	34.1	49.1	48.4
Mental Disorder Count								
0		58.2	65.9	52.7	48.4	67.7	52.9	55.7
1		15.1	13.8	14.8	16.7	13.2	19.4	13.9
2		8.7	8.0	8.1	10.9	8.7	7.4	12.4
3 or more		18.0	12.3	24.4	24.0	10.4	20.4	17.9

R. N. Carleton et al., "Mental Disorder Symptoms among Public Safety Personnel in Canada," The Canadian Journal of Psychiatry, vol. 63, pp. 54-64, 2018.

Prevalence Study – Results

- Mental Disorder Symptoms Among Public Safety Personnel in Canada

  - *All PSP* categories screened positively at substantial rates for several operational stress injuries

  - *Women* screened positively more than men

  - Persons with *more years of service* screened positively more

  - *Married persons* screened positively less than others

  - *ON* and *QC* persons screened positively less than others

  - *University educated persons* screened positively less than others

  - No differences based on age, ethnicity, or urban/rural location

Prevalence of Mental Disorder Symptoms Among Canadian PSP

- Suicidal Ideation, Plans, and Attempts Among Public Safety Personnel in Canada
  - Canadian Psychology
    - Freely available to all online (DOI: 10.1037/cap0000136); www.cipsrt-icrtsp.ca

- Questions aligned with Statistics Canada suicide items
  - Suicidal ideation
    - "Have you ever contemplated suicide?"
    - "Has this happened in the past 12 months?"
  - Suicide plans
    - "Have you ever made a serious plan to attempt suicide?"
    - "Has this happened in the past 12 months?"
  - Suicide attempts
    - "Have you ever attempted suicide?"
    - "Did this happen in the past 12 months?"

Suicidal Ideation, Plans, and Attempts Among Public Safety Personnel in Canada

Prevalence of Past-Year and Lifetime Self-Reported Suicidal Behaviour								
	General Pop.	Total Sample	Mun /Prov Police	RCMP	Correctional Workers	Fire	Paramedics	Call Centre
Past-Year								
Suicidal Ideation	~5.8	10.1	8.3	9.9	11.0	8.5	15.4	9.5
Suicidal Planning	~2.2	4.1	3.4	4.1	4.8	2.7	7.1	2.5
Suicidal Attempt	~<1.0*	0.3	0.2	0.2	0.4	0.3	0.9	0.4
Lifetime								
Suicidal Ideation	~11.5-14.1	27.8	20.5	25.7	35.2	25.2	41.1	28.7
Suicidal Planning	~4.1-5.1	13.3	8.9	11.2	20.1	8.8	23.8	13.6
Suicidal Attempt	~1.0-4.0*	4.6	2.1	2.4	8.1	3.3	9.8	8.6

R. N. Carleton et al., "Suicidal ideation, plans, and attempts among public safety personnel in Canada," *Canadian Psychology*, vol. 59, pp. 220-231, 2018.

Suicidal Ideation, Plans, and Attempts Among PSP in Canada

- All PSP categories reported substantial rates for suicidal ideation and planning

  - Municipal/ Provincial Police, RCMP, and Firefighters reported a history of suicidal attempts *less frequently* than rates among general population and PSP samples

  - Call Centre Operators/Dispatchers, Correctional Workers, and Paramedics reported a history of suicidal attempts *more frequently* than rates among general population and PSP samples

  - Women, younger persons, and persons with fewer years of service were *more likely* to report suicidal behaviours

  - Married persons were *less likely* to report suicidal planning an attempts

  - *No differences* based on provincial region, ethnicity, education, or urban/rural location

Prevalence Study – Stigma

- Playing the system: Structural factors potentiating mental health stigma, challenging awareness, and creating barriers to care for Canadian Public Safety Personnel.
  - Health
    - Freely available to all online (DOI: 10.1177/1363459318800167); www.cipsrt-icrtsp.ca

- System-level processes shape care-seeking decisions and views of care-seekers
  - Structural stigma shape how persons who express mental injuries are perceived
    - E.g., Reinforces the notion that some PSP "play the system"
  - Yet, the stigma is less tied to mental illness and more toward outcomes of treatment seeking

Prevalence Study – Stigma

- Mental injuries are recognized as real
  - System-level processes exist
  - Individual factors contribute

- Thus, stigma remains

- In consequence:
  - PSP are hesitant about being forthcoming about their mental health needs

  - Self-responsibilzation was apparent and largely embedded in the belief that PSP should be prepared for what the job entails
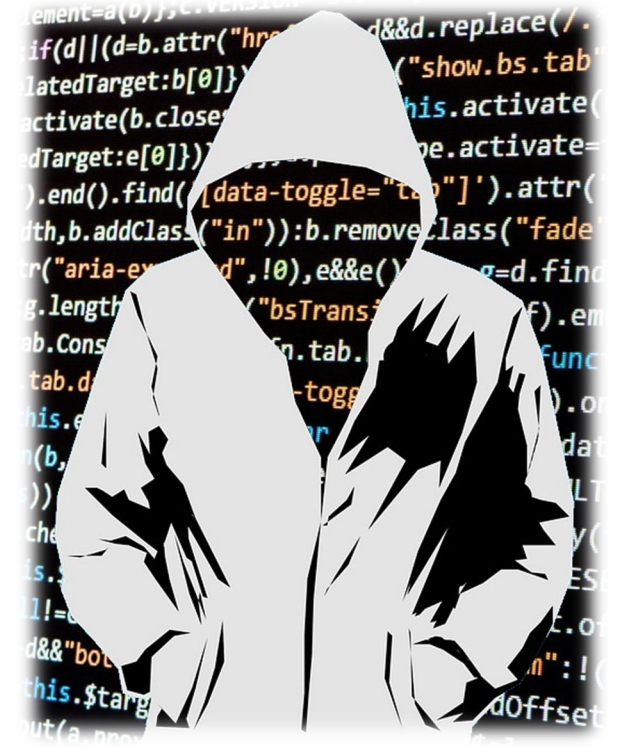
Prevalence, Stigma, and NG911

What's next for public safety communicators?

The Horizon of NG911

- We know that communicators, like other PSP are much more likely to be exposed to potentially traumatic events;
  - An event is considered potentially traumatic when exposure includes *direct or indirect experiences* of actual or threatened death, serious injury, or sexual violence (American Psychiatric Association, 2013).
  - Most of the North American general population are exposed to one or more potentially traumatic events during their lifetime (i.e., 50–90%)

- PSP experience significantly higher rates of mental disorders compared to the general public
  - Also, higher rates than other "first responders" and PSP in some categories and overall
  - struggle with the long-term effects of exposures much more than the general public and overall statistics for PSP;
    - i.e., suicidal ideation, planning, and attempts

Prevalence of Potentially Traumatic Exposure Types Across PSP

	Total	Mun/Prov Police	RCMP	Correctional Workers	Firefighters	Paramedics	Call centre operators/ dispatchers
	% (n)	%	%	%	%	%	%
Life threatening natural disaster	66.4 (2832)	61.2	70.2	51	71.4	74.9	73.1
Fire or explosion	86 (3727)	85.8	88.4	61.8	98	89.2	86.8
Serious transportation accident	93.2 (4084)	94.7	95.9	74.1	98.3	97.2	92.3
Serious accident at work, home, or during recreational activity	81.6 (3430)	81	79.2	75	87	88.4	77.9
Exposure to toxic substance	67.4 (2664)	61.7	67.3	49.6	89.6	73.1	52.1
Physical assault	90.6 (3931)	95.3	95.4	88.7	75.7	93.7	80.5
Assault with a weapon	83.9 (3639)	90.2	91.7	78.8	64.6	83.2	82.3
Sexual assault	71.2 (3035)	75.6	80.7	65.9	44.5	75.4	78.1
Other unwanted or uncomfortable sexual experience	67.3 (2803)	69.5	75	69.3	39.2	73.6	76.5
Combat	18.8 (791)	19	20.6	19.8	13.1	21.8	15.4
Captivity	30.5 (1279)	33.8	36.5	42.2	8.9	20.6	46.7
Life threatening illness or injury	76.7 (3301)	73.9	75.5	77.9	74	83.8	84
Severe human suffering	79.1 (3234)	79.7	79.4	71.2	80.5	85.5	70.7
Sudden violent death	93.8 (4101)	95.2	95.7	85.6	93.2	95.7	93.8
Sudden accidental death	93.7 (4063)	95	95.1	80.6	96.7	97	92.3
Serious injury, harm, or death you caused to someone else	36.2 (1485)	48.1	43.1	29	20.1	30.3	21.7
Total number of different types of PTEs, M (SD)	11.08 (3.23)	11.36 (3.16)	11.64 (3.04)	9.88 (3.88)	10.22 (2.84)	11.59 (2.86)	10.96 (3.56)

R. N. Carleton *et al.*, "*Exposures to potentially traumatic events among public safety personnel in Canada,*" *Canadian Journal of Behavioural Science, vol. 51, pp. 37-52, 2019.*

The Horizon of NG911

- We do not have direct data on stigma in communications
  - The data presented earlier included all respondents together
  - *Communicators* were a very small part of that sample

- We do not know the impact that new modalities of information will have on communicators
  - Text messages
    - Reduce contextual information, change data entry, etc.
  - Image data
    - Immediate presentation of visual imagery, significantly limited context, etc.
  - Video data
    - Immediate presentation of audible and visual information, reduced contextual information, etc.
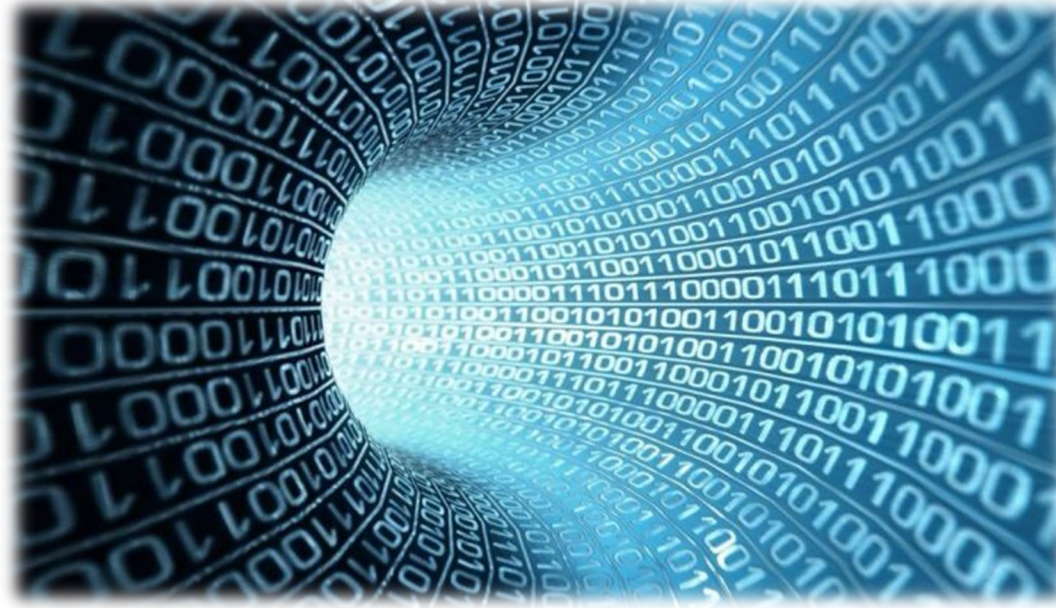
NG911

Lessening the impact through advanced artificial intelligence research

What is Artificial Intelligence?

- Vision and Sensing
  - Allowing computers to *see*

- Machine Learning
  - Searching for *patterns* and *understanding*

- Speech Recognition
  - Teaching computers to *hear*

- Decision Making
  - Helping computers *think* and *choose*

Introduction: Artificial Intelligence and NG911

- New modalities of information (i.e., text, images and video) offer a unique opportunity to use ***artificial intelligence*** (AI) within call centres.
  - AI techniques process raw digital data
  - Perhaps AI can help
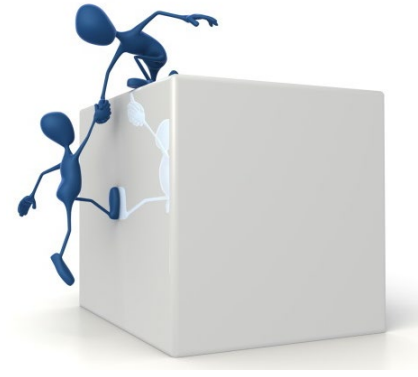
- We present our preliminary work toward applying AI to NG911 media
  - Reduce the effects of traumatic exposures within Canadian call centres.
    - preprocess information, flagging the type and severity of content

Methods

- We visited call centres in three Canadian provinces in 2019, job-shadowing communicators through call-taking and dispatching.

- We documented procedural observations:
  - interactions with callers, existing systems and technologies;
  - we focused particularly on communicator-caller interactions during initial contact.

- Conceptualizing how NG911 data will impact communicators, we then decomposed interactions into information exchange transactions
  - e.g., communication of type of emergency.

- From these transactions, we identified potential ways AI could process NG911 and existing call centre data

Results: Overall

- Our preliminary results show that there are many opportunities to use AI to support communicators, reducing the impact NG911 data will have on communicators' mental health
  - e.g., by pre-processing these data, communicators can be notified and prepare for an incoming call.
  - can be applied to both existing systems and with NG911 upgrades

Results: Procedural Observations

- Communicators engage in human-to-human dialog with callers:
    1. by following protocols
        - i.e., scripted questions
    2. non-protocol exchanges
        - dynamic and unstructured conversations
        - manually inputting data into downstream systems

- Both protocol and non-protocol exchanges include significant open-ended, unstructured data

Procedural Observations

- Protocols ensure all necessary information is gathered through sequential questions, but
  - information is rarely presented in sequential order by the caller
  - communicators must remember large amounts of information
    - the information can be entered into structured fields (e.g., location of emergency) when required
    - communicators try to avoid asking the caller questions they have already answered

- Non-protocol exchanges require communicators to enter unstructured data into systems

Procedural Observations

- The integrity of data inputs can significantly alter the priority and associated response for the event.
  - This applies to both structured and unstructured data

- Protocols restrict communicators to sequences of questions
  - This ensures all questions are asked
  - Conditions can be created where critical issues can take longer to identify
    - e.g., agonal breathing?

Results: Procedural Observations Summary

- NG 911 media will dramatically change the presentation of data to communicators
  - in many cases, NG911 data may remove a communicator's ability to understand the context around calls.

- Data entry will also change:
  - communicators will be impacted almost immediately with considerable amounts of information
    - e.g., via graphic images or videos
  - new sources of potentially traumatic events will be created!
    - This may lead to further increases in mental disorders in an already heavily impacted population.

- "No one really knows [how NG911 will affect communicators] yet"

Artificial Intelligence and NG911

- From our procedural observations and information exchange transaction decompositions, we identified many ways that AI could be used in call centres:

  1. pre-processing NG911 text, images and video

  2. dynamically processing audio while operators execute existing protocols

  3. dynamically processing audio and NG911 data
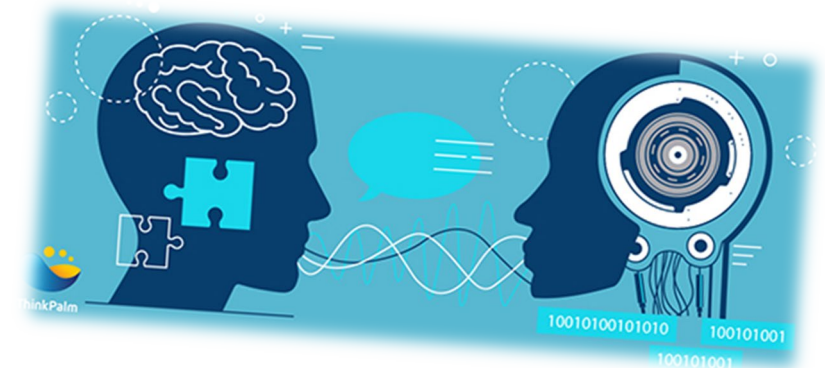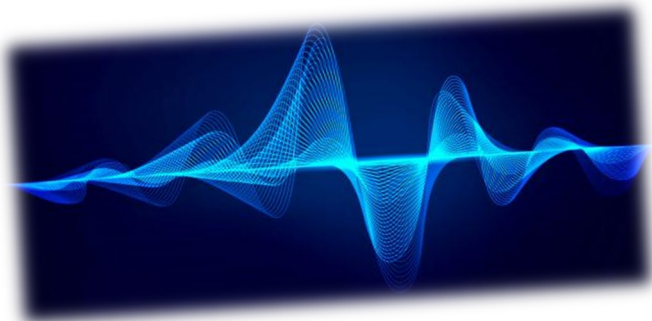
Pre-processing NG911 text, images and video
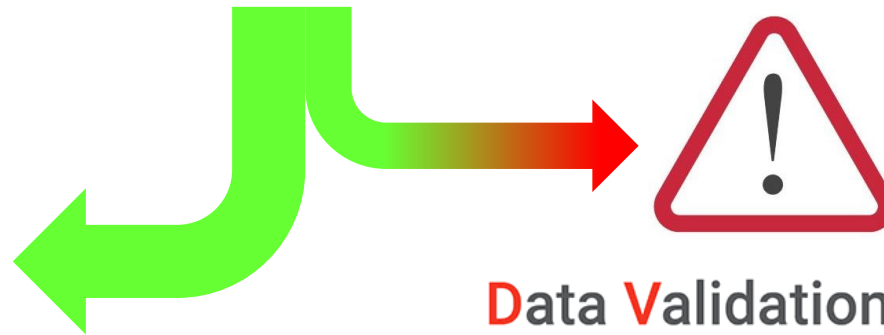
Identify the type of content and severity of call

Dynamically process audio through existing protocols

Real-time data entry validation

Rapidly identify critical conditions

Data Validation Testing

Dynamically process audio and NG911 data

Automatically pre-populate operator data entry fields

Results: Artificial Intelligence and NG911

- Modern AI techniques have been considered for many related applications including
  - data integrity;
  - text processing; and
  - thematic video processing.

- None of these approaches have never been applied to communicators or call-centre data.

Conclusions

- Our results suggest that artificial intelligence may play a functional role in supporting communicators,
  - with existing systems and procedures; and
  - through changes brought forward by NG911.

- In particular, the impact new modalities of information (e.g., images) may have on the mental health of communicators may be reduced.
  - E.g., by pre-processing these data, communicators can be notified ahead of time to be prepared for what is about to be seen or heard.

Thank you!

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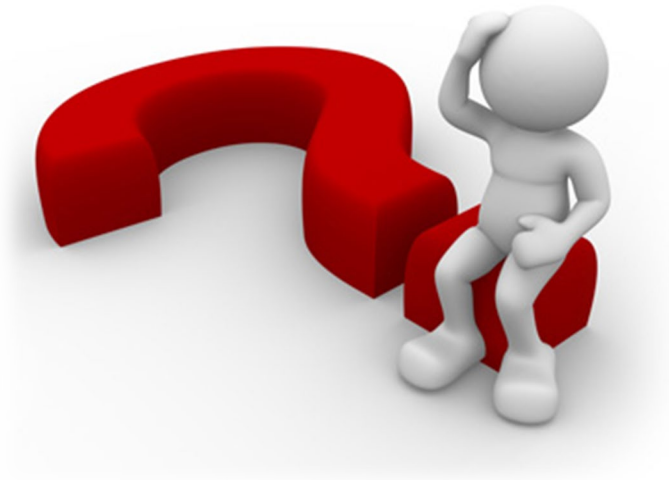
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