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LA DÉTECTION DE LA MENACE CHEZ LES POLICIERS : UN PROCESSUS STRATÉGIQUE?

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Sommaire

La capacité à détecter les éléments menaçants de notre environnement est une habileté importante au quotidien, voire même essentielle dans certaines professions, spécifiquement chez les policiers. Ces derniers, sujets à rencontrer des situations menaçantes fréquentes, doivent détecter la menace rapidement afin d'ajuster leurs conduites le plus efficacement possible. Ainsi, l'orientation de l'attention peut s'effectuer sur différents types de cibles dans des contextes environnementaux variés. L'objectif de ce travail de thèse était double. D'une part, il visait à examiner l'effet de stratégie de traitement de l'information sur la détection de la menace chez des policiers et aspirants policiers en tenant compte de leur état affectif. D'autre part, nous voulions déterminer ces effets selon le type de tâche attentionnelle et le type de stimuli, à savoir la tâche d'indiçage spatial comprenant des mots et la tâche de recherche visuelle incluant des images. La thèse présente deux articles incluant au total quatre études en lien avec ces objectifs et un article avec deux études préliminaires. Les résultats indiquent une amélioration de la détection de la menace chez les policiers et aspirants policiers lorsqu'une stratégie émotionnelle de traitement de l'information est induite, et cela, pour les deux types de tâches attentionnelles. Ceci n'était pas modulé par l'état affectif. Cette thèse apporte donc un nouveau regard sur la modulation stratégique possible de la détection de la menace en milieu policier.

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« Die sonne scheint »

Introduction

Pendant longtemps, la question de la séparation entre émotion et cognition fut l'objet de nombreux débats. Les émotions ont beaucoup été considérées comme des éléments perturbateurs des pensées et du comportement. Descartes, dans son ouvrage « Le discours de la Méthode », stipule que tout choix authentique doit s'effectuer au moyen d'un entendement éclairé, capable de distinguer le vrai du faux, et capable de mettre les émotions à l'arrière-plan. En opposition, Damasio, suite à l'étude de cas du patient *Elliot* décrit dans « L'Erreur de Descartes » (1994), constate que des lésions cérébrales spécifiques empêchent ce patient d'avoir des réactions émotionnelles appropriées et le mène à prendre des décisions catastrophiques alors que la partie rationnelle de son esprit est préservée. Plusieurs travaux récents montrent à quel point les émotions affectent les processus cognitifs comme le raisonnement, la prise de décision, la mémoire ou encore l'attention. Le traitement des émotions est utile à la compréhension de notre environnement, à l'orientation de notre comportement et nous permet d'engendrer des réponses adaptatives. L'influence des émotions sur les processus cognitifs comme l'attention est aujourd'hui bien admise. Toutefois, la façon avec laquelle ces influences s'opèrent au sein d'un environnement complexe selon des attentes spécifiques reste à explorer, notamment chez les policiers. Le travail de cette thèse s'inscrit dans ce cadre.

Au sein de la partie introductive, nous verrons ce qu'est l'attention, plus spécifiquement l'attention visuelle sélective et la façon avec laquelle la sélection de

l'information peut s'opérer à partir des informations provenant de l'environnement ou par les objectifs de recherche de l'individu. Nous examinerons comment la valeur affective des stimuli de l'environnement visuel module le traitement attentionnel, et cela, en lien avec l'état affectif des individus. Nous verrons comment la priorisation du traitement des informations émotionnelles s'effectue en environnement complexe comprenant l'exécution de tâches subséquentes. Enfin, nous nous intéresserons au traitement des informations émotionnelles spécifiquement en lien avec la profession policière. À la lumière de ces sections, nous constaterons que les informations émotionnelles bénéficient d'un traitement efficace et que ce traitement peut être modulé par l'état affectif dans lequel les individus sont, ainsi que par les objectifs de ces derniers. Toutefois, l'ensemble de ces éléments et leur relation au sein d'un environnement complexe reste à déterminer, particulièrement au sein de la profession policière.

Dans la partie expérimentale, il sera présenté une série de six expériences de type comportemental présentées sous la forme de trois articles scientifiques rédigés en anglais et soumis ou en révision dans des revues internationales. En premier lieu, nous avons examiné l'impact de deux types de présentation de stimuli menaçants et neutres (horizontal et vertical) sur l'orientation de l'attention lors d'un paradigme d'indiçage. Cette étude préliminaire (article 1; soumis à la revue *Cognition, Brain, Behavior*) est présentée en premier lieu, car elle a orienté les choix méthodologiques effectués pour les études de l'article 2. En second lieu, nous avons étudié l'impact de stratégies de traitement de l'information lors de la réalisation d'une tâche d'indiçage comprenant la présentation

de stimuli neutres et menaçants chez des aspirants policiers et officiers de police (article 2; publié dans la revue *Acta Psychologica*). En troisième lieu, nous avons examiné l'impact de stratégies de traitement de l'information sur la détection de stimuli menaçants lors d'une tâche complexe de recherche visuelle chez des aspirants policiers et officiers de police (article 3; en révision à la revue *Applied Cognitive Psychology*).

Les travaux présentés dans cette thèse permettent d'obtenir des résultats novateurs et encourageants repris dans la discussion. Ce travail permet d'envisager de nouvelles perspectives sur la compréhension du fonctionnement de l'orientation de l'attention envers la menace en milieu complexe au sein d'une population policière.

Enfin, les travaux rapportés dans cette thèse ont fait l'objet de six communications orales et six communications affichées dont quatre ont reçu un prix, une communication affichée sur invitation lors du forum sur la formation policière et un article dans le journal de l'École Nationale de Police du Québec, une entrevue à radio Canada, un article paru dans le journal « Connexion » de l'Université du Québec à Trois-Rivières ainsi qu'une communication orale lors de la finale nationale 2015 de '*Ma Thèse en 180 secondes*'.

Contexte théorique

L'attention

Une multitude d'informations sont présentes dans notre environnement visuel et l'être humain ne peut pas traiter simultanément toutes ces informations. Il est alors important de prioriser les stimuli pertinents à des fins de survie ou pour atteindre des objectifs et donc, de négliger les autres stimuli. La fonction permettant de sélectionner les stimuli pertinents parmi les stimuli non pertinents est appelée l'attention visuelle sélective. Celle-ci implique deux phénomènes de base. Le premier est la *sélectivité,* soit l'habileté de filtrer les informations non pertinentes. Il est possible de traiter un stimulus en particulier et d'ignorer les autres. Le second phénomène concerne la *capacité limitée* pour traiter les informations de notre environnement. À n'importe quel moment, une quantité limitée d'information provenant de notre champ visuel peut être traitée et utilisée afin de réagir si besoin. Si une partie de notre attention est allouée à un stimulus, alors il y a moins de ressources disponibles pour les autres stimuli.

Un facteur important influençant la sélectivité concerne le traitement de type *ascendant* (*bottom-up*), soit le traitement déterminé par les caractéristiques sensorielles des stimuli. Cette forme de traitement implique une orientation attentionnelle, soit un alignement du focus attentionnel avec une source de l'environnement (Posner, 1980; voir Encadré 1) déterminée par des caractéristiques présentes au sein de l'environnement visuel indépendamment des buts de l'individu (Theeuwes, 2010). On observe aisément ce traitement lorsque l'on présente une matrice de stimuli contenant une cible « X » rouge parmi des distracteurs « O » bleus. L'attention visuelle va se porter rapidement vers l'emplacement de la cible sur la base des propriétés visuelles de celle-ci.

Posner, dans les années 70, a mis en place un paradigme permettant d'étudier la manière dont l'attention visuelle s'oriente dans l'espace. Dans la version classique de son paradigme d'indiçage, publié pour la première fois dans les années 1980, un point de fixation est présenté avec deux carrés de chaque côté (à droite et à gauche) (Posner, 1980). Suite à cela, un indice apparait (illumination d'un carré), puis une cible (un point) apparait au même emplacement où l'indice s'est illuminé (condition valide) ou de l'autre côté (condition non valide). La condition neutre étant l'illumination des deux carrés, ne fournissant aucun indice sur le futur emplacement de la cible que le participant doit détecter (voir Figure 1). Cette version du paradigme comprenant 50 % d'essais valides concerne l'étude de l'attention exogène, car l'orientation attentionnelle est guidée par les informations de l'environnement (traitement *ascendant*) contrairement à une autre version qui suscite l'orientation endogène en remplaçant les illuminations par des symboles

(flèches) au centre de l'écran guidant sur le futur emplacement de la cible ou non (traitement *descendant* ou *top-down*). Ce type de paradigme mettrait donc en avant trois mécanismes de l'attention visuelle. Le premier concerne l'engagement de l'attention faisant référence au fait de porter son attention à un emplacement particulier suscité par la saillance d'un objet environnant ou par la volonté. Le second mécanisme est le désengagement attentionnel qui s'opère une fois que l'information est traitée nous permettant d'être disposé au dernier mécanisme de réorientation de l'attention. Ce dernier mécanisme consiste en un déplacement de l'attention visuelle dans l'espace pour éventuellement s'engager vers une nouvelle stimulation d'intérêt.

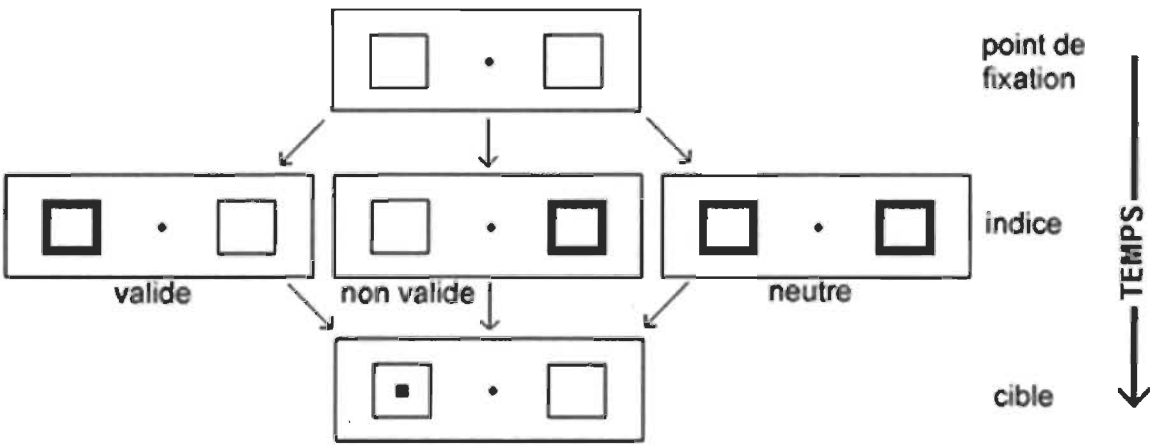

Figure 1. Illustration du paradigme de Posner (1980).

L'orientation de l'attention peut aussi être initiée sur une base volontaire selon les objectifs de l'individu. Ce traitement peut s'opérer lorsqu'une personne cherche ses clés de voiture sur son comptoir de cuisine. Les mécanismes impliqués sont alors de type

descendant, car une recherche visuelle volontaire est effectuée dans le but de retrouver les clés.

Bien que nous ayons identifié deux types de traitement distinct, *ascendant* et *descendant*, ces derniers peuvent fonctionner ensemble. En effet, le modèle de « compétition biaisée » de l'attention sélective de Desimone et Duncan (1995) stipule que les informations provenant d'un traitement *ascendant* peuvent faire l'objet d'un biais de traitement selon les objectifs de la personne. Ces influences de type *descendantes* peuvent alors favoriser le traitement des entrées sensorielles et ainsi sélectionner le stimulus désiré. De ce fait, une information sur un stimulus d'intérêt comme sa forme, sa couleur ou encore son emplacement peut être pertinente pour l'individu. Ce type d'information peut alors être utilisé pour biaiser le système visuel, de sorte que les entrées sensorielles en adéquation avec la description puissent être favorisées dans le cortex visuel (Bundesen, Habekost, & Kyllingsbæk, 2005; Duncan & Humphreys, 1989). En conséquence, la description du stimulus d'intérêt va susciter l'intervention de la mémoire de travail qui va ensuite influencer le fonctionnement du système perceptif.

Dans ce contexte, Bar (2009) propose que plutôt que de voir notre environnement ou un objet en lien avec la question « Qu'est-ce que c'est? » et de redécouvrir cette information à chaque fois, notre cerveau fait un lien étroit entre les entrées sensorielles et les représentations analogues stockées en mémoire pour plutôt répondre à la question « À quoi cela ressemble? ». De cette manière, cette reconnaissance par analogie ne nécessite

pas obligatoirement d'analyse exhaustive concernant les propriétés des objets de notre environnement et donc, ne se base pas uniquement sur les informations *ascendantes*. En effet, cette question sollicite des processus *ascendants* basés sur des entrées sensorielles rudimentaires (Bar et al., 2006). Une fois que l'analogie est trouvée, les représentations associées sont activées rapidement. Dans ce sens, il a été démontré que l'activité des aires cérébrales liées aux entrées sensorielles visuelles était associée à l'activité des aires cérébrales impliquées dans la mémoire (Wang et al., 2008). En conséquence, il ressort que la perception de l'environnement est en relation autant sur la mémoire que sur le système visuel. Ainsi, les processus *ascendants* et *descendants* sont en relation dans l'établissement de la signification de notre environnement.

Attention et émotion

L'orientation attentionnelle peut être modulée par la valeur affective des stimuli présents dans l'environnement. De nombreuses observations comportementales indiquent que les individus portent davantage attention aux stimuli émotionnels que neutres (Vuilleumier, 2005). Öhman, Flykt et Esteves (2001) utilisent une tâche de recherche visuelle et démontrent que les stimuli menaçants de serpents et d'araignées sont détectés plus rapidement que les stimuli neutres de fleurs et de champignons. Lipp et Waters (2007) démontrent que la détection de cibles neutres représentant des animaux était ralentie par la présence de distracteurs menaçants comme des serpents ou des araignées relativement à la présence de distracteurs non menaçants comme des cafards ou des lézards. Cette priorisation de traitement de l'information menaçante a également été mise en évidence

avec des visages. Des visages de colère sont détectés plus rapidement que des visages non menaçants (Fox et al., 2000).

L'influence des stimuli émotionnels sur les processus attentionnels semble être modulée par l'état affectif des participants. Bradley, Mogg, Falla et Hamilton (1998) utilisent une tâche « dot-probe » présentant simultanément un visage menaçant et neutre de part et d'autre d'un point de fixation central. Les participants doivent ensuite détecter une cible qui apparait à l'emplacement de l'un ou de l'autre visage. Les résultats montrent qu'un niveau élevé d'anxiété est associé à un engagement attentionnel plus marqué vers des stimuli menaçants que neutres. Ces résultats sont en lien avec d'autres travaux (Amir, Elias, Klumpp, & Przeworski, 2003; Fox, Russo, Bowles, & Dutton, 2001). Leleu, Douilliez et Rusinek (2014) utilisent également une tâche de type dot-probe dans laquelle des mots neutres et menaçants sont présentés au-dessus et en dessous d'un point de fixation central. Leurs résultats indiquent que les individus avec une anxiété élevée manifestent une difficulté de désengagement des stimuli menaçants par rapport aux stimuli neutres. D'autres travaux utilisant une version modifiée du paradigme dot-probe rapportent à la fois un engagement attentionnel ainsi qu'une difficulté de désengagement des informations menaçantes accrue avec l'anxiété (Grafton & MacLeod, 2014; Rudaizky, Basanovic, & MacLeod, 2014).

Ces deux composantes du biais attentionnel dans l'anxiété peuvent s'expliquer avec la théorie du contrôle attentionnel d'Eysenck, Deraksen, Santos et Calvo (2007). Cette

approche stipule que l'anxiété altère le fonctionnement du système attentionnel des buts dirigés (*descendant*) et augmente l'ampleur avec laquelle le traitement de l'information est influencé par le système attentionnel des stimuli externes (*ascendant*). En diminuant le contrôle attentionnel, l'anxiété augmente l'attention envers les stimuli menaçants.

Par ailleurs, l'influence de la dépression sur les processus attentionnels liés à l'anxiété est souvent négligée et pourrait contribuer à mieux rendre compte de la complexité du traitement de l'information selon l'état affectif (Peckham, McHugh, & Otto, 2010). C'est également le cas des expériences de vie potentiellement traumatisantes. Celles-ci ont des répercussions sur les processus attentionnels. Les résultats de plusieurs études suggèrent que les personnes souffrant de Trouble de Stress Post-Traumatique (TSPT) manifestent une orientation initiale de l'attention envers les stimuli négatifs (Felmingham, Rennie, Manor, & Bryant, 2011; Kimble, Fleming, Bandy, Kim, & Zambetti, 2010). Des symptômes de TSPT élevés chez des vétérans sont associés à une orientation initiale de l'attention envers des stimuli négatifs et pertinemment reliés au trauma vécu (Kimble et al., 2010). D'autres études montrent aussi que des personnes souffrant du TSPT manifestent une orientation initiale de l'attention envers des stimuli reliés au trauma (Felmingham et al., 2011; Olatunji, Armstrong, McHugo, & Zald, 2013). Ce type de résultats concorde avec l'idée de l'influence de la mémoire sur les processus attentionnels et renforce l'idée du modèle de Bar (2009). En effet, lorsque le cerveau traite les informations provenant des entrées sensorielles du moment présent, il interprète celles-ci à partir de souvenirs et utilise aussi bien les connaissances sémantiques que les

représentations affectives associées au passé. Ainsi, Barrett et Bar (2009a) développent l'hypothèse de la prédiction affective qui implique que les réponses émotionnelles signalant la pertinence d'un objet sont associées à son identification et non séparées. Les expériences vécues passées fournissent alors une source extrêmement riche d'informations pouvant être utilisées afin de guider notre comportement et optimiser notre perception de l'environnement (Stokes, Atherton, Patai, & Nobre, 2012). En somme, le fait que le cerveau traite les informations provenant du registre sensoriel en cherchant un lien avec la mémoire afin de favoriser la reconnaissance permet de comprendre que le vécu traumatisant des individus mène à un biais de traitement envers les stimuli reliés au trauma.

Attention et stratégie de traitement de l'information

Les expériences passées des individus, tout comme les objectifs qu'ils doivent atteindre lors de l'exécution d'une tâche, peuvent jouer un rôle capital dans le traitement de type *descendant* des informations menaçantes. Vromen, Lipp, Remington et Becker (2016) ont évalué l'orientation de l'attention envers la menace selon que cette dernière était pertinente dans les objectifs d'une tâche d'indiçage ou non pertinente. Dans leur première expérience, les participants devaient identifier si une cible, accompagnée par des distracteurs, représentait une araignée ou un chat. Dans la seconde expérience, les participants devaient identifier si la cible, accompagnée par des distracteurs neutres et menaçants, représentait un oiseau ou un poisson. Les résultats montrent que l'orientation et le désengagement attentionnel envers l'araignée (le stimulus menaçant) étaient plus

forts lorsque celle-ci était pertinente à la tâche (expérience 1) plutôt que non pertinente (expérience 2). L'orientation et la difficulté de désengagement attentionnel comparées entre les deux expériences soulignent que ces deux phénomènes sont modulés par les attentes liées aux instructions, donc par les processus de type *descendants*. Hahn et Gronlund (2007) montrent que l'orientation de l'attention vers des visages menaçants est modulée par des objectifs de recherche liés à la tâche. En effet, les visages menaçants bénéficiaient d'un traitement privilégié quand ils étaient la cible, mais pas lorsqu'ils étaient des distracteurs non pertinents pour la tâche. Les instructions en lien avec les stimuli sont intégrées dans une forme de mémoire liée à la mémoire de travail (Baddeley, 1986; Desimone & Duncan, 1995) pouvant intégrer les caractéristiques des informations à traiter selon les instructions. De cette manière, le traitement des stimuli menaçants peut donc être amélioré par des processus *descendants* selon que ces stimuli sont la cible des instructions.

Parmi les influences de type *descendantes* liées aux instructions sur l'orientation attentionnelle, on retrouve les intentions d'action sur les stimuli (Belardinelli, Herbort, & Butz, 2015; Belardinelli, Stepper, & Butz, 2016; Sartori, Straulino, & Castiello, 2011). Belardinelli et collaborateurs (2015, 2016) demandent à des participants d'examiner des objets selon s'ils peuvent contenir du liquide ou s'ils doivent réaliser une tâche motrice avec ces objets. Les résultats montrent que l'orientation de l'attention est influencée par les différentes consignes. Plus précisément, le pattern de fixation des premières saccades en vue d'une préparation à une tâche motrice correspond à l'emplacement ou devrait se

placer le pouce et l'index. Il est alors important de considérer le rôle des instructions sur les processus attentionnels. La création d'attentes via les stratégies de traitement de l'information influencerait les processus *descendants* pour biaiser la compétition attentionnelle et favoriser le traitement des éléments pertinents émotionnels ou non à la réalisation de la tâche demandée.

Attention et environnement complexe

Les activités quotidiennes peuvent solliciter notre capacité à porter attention à différentes informations simultanément. Cela peut être le cas lorsque nous conduisons, nous entendons notre téléphone sonner et que nous devons porter attention à la signalisation. Cela peut être particulièrement le cas des ambulanciers, des contrôleurs aériens ou encore des policiers en intervention qui doivent traiter une quantité d'informations importante dans un temps donné et être réceptifs à de nouvelles informations. Typiquement, les paradigmes expérimentaux utilisent des tâches assez simples afin d'examiner l'utilisation de nos ressources. Ceci peut sembler être en contraste avec les tâches quotidiennes ou plusieurs informations doivent être traitées dans un laps de temps très court. Toutefois, pour examiner au mieux certaines variables, il nous faut pouvoir les manipuler dans un environnement contrôlé. Une manière de respecter l'aspect de validité écologique est de mettre les individus en situation proche d'une situation de double tâche comme cela pourrait être le cas dans la vie réelle ou l'individu aurait deux tâches à réaliser simultanément. Il est possible que la réalisation d'une tâche puisse en influencer une autre. Plus précisément, une préparation mentale issue d'une tâche à

effectuer pourrait être un prédicteur de la réalisation de la seconde tâche à faire (Chun, Golomb, & Turk-Browne, 2011). Cela souligne l'influence d'une tâche sur une autre lorsque nous devons traiter plusieurs informations successivement et souvent dans un délai très court.

Les informations reliées à l'exécution d'une tâche encore présentes dans notre mémoire de travail peuvent influencer la réalisation d'une seconde tâche. Des travaux montrent que les mouvements oculaires liés à l'orientation initiale de l'attention peuvent être dirigés vers des stimuli présents dans l'environnement dont les caractéristiques sont liées aux informations gardées en mémoire (Hollingworth, Richard, & Luck, 2008; Soto, Heinke, Humphreys, & Blanco, 2005). Par exemple, Downing (2000) utilise une tâche dot-probe dans laquelle il présente un stimulus, avant la présentation de la paire de stimuli, que les participants doivent retenir en mémoire. Ce stimulus présenté à nouveau au sein de la paire de stimuli attirera plus rapidement l'attention. En conséquence, bien que l'attention soit généralement conçue pour permettre aux informations sélectionnées d'entrer en mémoire de travail, ces résultats indiquent que la mémoire de travail façonne aussi l'orientation attentionnelle (Awh & Jonides, 2001; Downing, 2000). D'autres travaux suggèrent qu'il y a un traitement précoce de type *descendant* dirigeant l'attention vers les stimuli activés en mémoire de travail (Soto et al., 2005). De ce fait, certaines stratégies de préparation mentale seraient en mesure d'influencer l'orientation initiale de l'attention. Une forme de préparation mentale comme des attentes ou une stratégie de traitement de l'information serait en mesure de biaiser le fonctionnement de la mémoire

de travail pour influencer ensuite le pattern d'exploration visuelle. Ce type de fonctionnement peut s'avérer important dans des environnements riches en informations, surtout lorsque nous sommes amenés à réaliser une action et que celle-ci peut influencer le traitement du prochain stimulus. Toutefois, peu d'études ont exploré l'influence des stratégies de type *descendantes* sur la détection de la menace. Or, cette possibilité est d'un intérêt central dans les professions exposées fréquemment à des événements dangereux (Skogstad et al., 2013).

Attention chez les premiers répondants

Les premiers répondants comme les pompiers, les ambulanciers, mais aussi les militaires et les policiers doivent régulièrement intervenir dans des contextes complexes. Cela autant au niveau des ressources attentionnelles à déployer sur le terrain que sur les réponses émotionnelles suscitées par les événements autour des interventions fréquemment potentiellement traumatiques. Les symptômes de TSPT seraient positivement associés au nombre d'années de service dans ces professions (Jonsson, Segesten, & Mattson, 2003; Meffert et al., 2008; Mitchell-Gibbs & Joseph, 1996; Sattler, Boyd, & Kirsch, 2014). Selon une étude épidémiologique de 2008 (Van Ameringen, Mancini, Patterson, & Boyle), le taux de prévalence du TSPT à vie dans la population générale serait de 9,2 % au Canada. Toujours selon cette étude, l'exposition à au moins un événement suffisamment traumatique pour causer un TSPT concerne 76,1 % des répondants. Nous retrouvons également un fort pourcentage de personnes exposées en France (72,7 %) pour 3,9 % de prévalence à vie de TSPT (Husky, Lépine, Gasquet, &

Kovess-Masfety, 2015). Aux États-Unis, on retrouve environ 50 à 60 % de la population exposée à un événement traumatique pour 5 à 10 % de TSPT (Ozer, Best, Lipsey, & Weiss, 2003). Dans ce même pays, la prévalence du TSPT chez les militaires serait de 28,5 % (Weiss et al., 1992). Chez les ambulanciers, on trouve une prévalence également élevé de 22 % (Bennett, Williams, Page, Hood, & Woollard, 2004), de 18,2 % chez les pompiers (Wagner, Heinrichs, & Ehlert, 1998) et de 13 % chez les policiers (Robinson, Sigman, & Wilson, 1997). En conséquence, au sein de la population, les militaires et les professionnels de la sécurité publique comme les policiers, les pompiers et les ambulanciers ont un risque élevé d'être exposés à des incidents critiques dus à leur travail quotidien (Skogstad et al., 2013) et donc de développer des symptômes de stress post-traumatique. D'une part, ces expériences vécues peuvent influencer l'orientation de l'attention envers la menace. D'autre part, il a été proposé que les symptômes de TSPT puissent être maintenus en partie à travers une orientation attentionnelle favorisant la détection de stimuli menaçants (Ehlers & Clark, 2000).

L'orientation initiale de l'attention peut être modulée par les expériences de terrain chez des militaires. Dans une expérience, des vétérans de la guerre en Irak de l'armée des États-Unis devaient librement regarder des images à contenu neutre et émotionnel, présentées simultanément. Les participants ayant des symptômes de TSPT élevés orientaient initialement leur attention davantage envers les images négatives et reliées au combat (Kimble et al., 2010). Une autre étude présentant une matrice d'image avec des expressions neutres, négatives et positives montre une relation positive entre les

symptômes de TSPT et la rapidité des fixations envers les stimuli négatifs (Beevers, Lee, Wells, Ellis, & Telch, 2011). Ces données soulignent la modulation de traitement des stimuli visuels par les symptômes de stress post-traumatique chez des militaires.

La capacité ou l'incapacité à détecter les éléments menaçants de l'environnement, peut mener à prendre des décisions erronées et de telles situations sont particulièrement cruciales pour des occupations comme le contrôle aérien et la surveillance de sécurité (Tremblay, Lafond, Chamberland, Hodgetts, & Vachon, 2018). Lors de ces activités professionnelles, les agents doivent fréquemment changer l'orientation de leur attention d'un écran à l'autre tout en restant réceptifs à de possibles messages radio ou téléphoniques. Ce contexte de gestion de l'attention peut créer un déficit de performance à travers une augmentation des erreurs ou un allongement des temps de réponse dans l'une ou l'autre de ces tâches (Monsell, 2003). Des travaux montrent qu'il est possible de moduler les stratégies d'exploration visuelle des agents à l'aide de technologie impliquant des alertes visuelles (Tremblay et al., 2018). Toutefois, dans ces études, les capacités de détection de la menace n'étaient pas prises en compte; les alertes visuelles étaient considérées comme une augmentation de la charge de travail perçue par les participants. De plus, les alertes visuelles étaient issues des technologies et pouvaient entrer en conflit avec la stratégie de recherche naturelle du participant qui pouvait avoir de bonne raison de ne pas suivre les alertes visuelles imposées afin de minimiser la non-détection. Il existe aussi des situations dans lesquelles des décisions sont prises à tort lorsqu'on pense avoir à faire face à une menace qui n'en est pas une. Des travaux soulignent des facteurs

situationnels ou l'usage de la force chez les policiers est plus fréquent lorsque le taux de criminalité est élevé (Smith, 2004). Le fait d'intervenir dans une zone à risque serait un prédicteur contextuel de comportement faisant usage de la force impliquant le tir. Bien que les aspects situationnels soient à prendre en considération, d'autres travaux s'intéressent aux aspects individuels spécifiques aux tireurs. Kleider, Parrott et King (2010), ont demandé à 24 officiers de police de passer une tâche de mémoire de travail avant d'effectuer une tâche de tir. Leurs résultats montrent qu'une faible capacité de mémoire de travail était associée à un taux d'erreur de tirs élevé (tirer une cible non armée ou ne pas tirer une cible armée). Le contexte de l'intervention autant que certains facteurs individuels ont un rôle dans la prise de décision précédée par l'orientation de l'attention.

Les policiers doivent faire face à toutes sortes de situations potentiellement dangereuses dans des environnements autant variés que complexes et leur habileté à détecter les stimuli menaçants est essentielle. Damjanovic, Pinkham, Clarke et Phillips (2014) ont examiné comment le niveau d'expertise des officiers de police dans la gestion de foule hostile influence la détection de la menace. Les auteurs ont utilisé une tâche de recherche visuelle incluant des visages joyeux, neutres et menaçants. Les policiers experts étaient plus rapides que les jeunes recrues et que les aspirants policiers dans la détection de visages menaçants parmi des distracteurs neutres relativement aux visages joyeux, et étaient aussi plus efficaces pour inhiber le traitement de distracteurs menaçants pour détecter une cible neutre. Les policiers novices prenaient plus de temps pour détecter les visages joyeux parmi des distracteurs menaçants. Une autre étude suggère que des

officiers de police tireurs d'élite ont une exploration visuelle plus efficace que des policiers novices contribuant à de meilleures performances dans la neutralisation de la menace (Vickers & Lewinski, 2012). Ces données mettent en avant le rôle de l'expertise des policiers sur l'orientation de l'attention envers les stimuli menaçants. En particulier, les aspirants policiers doivent apprendre à devenir efficaces dans le traitement de stimuli menaçants. Leur entrainement comprenant des exercices de tir, des exercices d'usage de la force, de la gestion d'incident domestique peut façonner la façon avec laquelle les stimuli menaçants sont traités. Les aspirants policiers sont possiblement déjà influencés par des stratégies induites dans une mesure plus ou moins grande. L'intérêt d'étudier l'attention chez des policiers et aspirants policiers est donc tout aussi important.

Actuellement, il y a encore peu d'études qui s'intéressent à l'orientation de l'attention envers les stimuli menaçants chez les policiers. Pourtant, une meilleure compréhension des processus impliqués dans la détection des stimuli menaçants peut avoir des implications importantes de sécurité. D'autre part, le travail policier implique régulièrement de pouvoir effectuer des tâches subséquentes dans un environnement complexe changeant rapidement. Ceci est rarement examiné dans la littérature auprès de la population policière. De plus, les différences individuelles liées à l'état affectif et l'implication des processus *descendants* sur l'attention visuelle sélective en milieu policier sont aussi peu étudiées.

Synthèse et objectifs

De nombreux travaux montrent que les informations de nature émotionnelle, plus particulièrement menaçante, font l'objet d'une sélection attentionnelle prioritaire. Les individus peuvent en conséquence traiter les informations pertinentes à leur survie. De plus, les caractéristiques individuelles, telles que l'état affectif (niveau d'anxiété et de dépression) ou encore les expériences potentiellement traumatiques, peuvent moduler les processus attentionnels tout comme les stratégies mises en place pour atteindre un objectif. Toutefois, l'impact simultané des stimuli menaçants, des affects individuels et des stratégies de traitement sur les processus attentionnels a été peu examiné. C'est ce que nous proposons de faire, au sein d'une population policière, un corps de métier exposé à des environnements complexes et pour qui la détection de la menace est capitale.

Dans ce contexte, ces travaux de recherche visent en premier lieu à étudier l'impact des stratégies de traitement de l'information sur la détection de la menace chez des aspirants policiers et des policiers. Plus spécifiquement, nous voulions étudier ces effets en termes de priorisation spatiale et de vigilance générale et voir l'implication des symptômes d'anxiété, de dépression et des symptômes de stress post-traumatique. En second lieu, nous avons voulu étudier les mêmes variables que précédemment, soit l'impact des stratégies de traitement de l'information sur la détection de la menace chez des policiers et aspirants policiers, lors d'une tâche de recherche visuelle, plus proche d'une situation d'environnement complexe que la tâche d'indiçage.

Article 1
Étude préliminaire

Dans le cadre de ce travail de thèse, une étude a été réalisée afin de vérifier l'impact de la méthodologie de deux modes de présentation visuelle sur les processus attentionnels lors de la tâche d'indiçage. En présentant les informations visuelles sur un axe horizontal puis vertical, le but était d'examiner l'orientation de l'attention dans la détection de cible précédée par des stimuli neutres et menaçants, et cela, sous l'influence de stratégies de traitement de l'information sémantique et émotionnelle chez des étudiants universitaires. Les résultats inciteront à utiliser la tâche d'indiçage comprenant la présentation des stimuli sur l'axe vertical dans la suite de cette thèse.

Attentional processing of neutral and threatening words in the cueing paradigm: horizontal or vertical presentation?[1]

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Abstract

In the cueing paradigm, a target is presented after a cue in the same location (valid condition) or in another location (invalid condition). There is privileged attentional processing for stimuli preceded by a spatial cue. This validity effect is more pronounced for emotional cues than neutral. Across two experiments, we studied differences in the cueing effect when emotional or neutral stimuli were presented on the horizontal (Experiment 1) or the vertical meridian line (Experiment 2). We were interested in examining the impact of emotional and semantic processing strategy on attention, using these two methods of stimulus presentation. The first experiment did not show a significant validity effect when the cue was threatening and the validity effect was reversed when the cue was neutral. There was also no effect of the processing strategies. In the second experiment, a three-way interaction showed a 0ovalidity effect when the cue was neutral and the processing strategy emotional, but not in the other condition. From these results, we conclude the validity effect in a cueing paradigm can be more effective with a vertical presentation of stimuli than with a horizontal presentation.

Keywords: *Cueing paradigm; visual attention; threatening stimuli; vertical presentation; horizontal presentation.*

Introduction

Visual attention enables people to filter relevant amongst irrelevant information in their environment. One way to study this process is to use the cueing paradigm, first created by Posner (1980). Many studies have used the cueing task to better understand the functioning of visual attention (Fox, Russo, & Dutton, 2002; Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007; Müller-Plath & Klöckner, 2014; Olk, Tsankova, Petca, & Wilhelm, 2014; Palmer & Mattler, 2013; Preciado, Munneke, & Theeuwes, 2017). Interest for the use of this paradigm to study visual attention is still growing. A PubMed search (keyword: 'visual attention' in the title or the abstract and 'cueing') yields approximately 261 articles from 1980 to 2005 and 544 from 2006 to 2017. More than half of these 544 articles were published in the last seven years. Many of these studies, though they are based on the same paradigm, have used different methods for presenting the stimuli and different instructions given to participants. These differences could be responsible for a certain amount of variability in the results. In this study, we were interested in examining the impact of processing strategies on attentional orientation toward emotional and neutral stimuli with a horizontal presentation (Experiment 1) and then with a vertical presentation (Experiment 2).

In the classic Posner task, two rectangles separated by a fixation point are presented simultaneously. Then a cue (in the form of highlighting one of the rectangles) appears, briefly followed by a target presented in one of the two rectangles. Participants are instructed to press a response key as soon as possible when they see the target. Reaction

times (RTs) are typically faster in the "valid" condition, when the target is presented in the cued location, and longer in the "invalid " condition, when the target and the cued rectangle are not presented in the same location. The shorter RTs in the valid condition can be explained by the fact that attention is spatially attracted by the cue, so attention is already deployed in this location when the target appears, allowing faster target detection. Conversely, the longest RT in the invalid condition can be explained by the fact that there needs to be a disengagement from the cued location and a redeployment to the other location, to detect the target appearing in the other location. Researchers can use the cueing paradigm to investigate attentional engagement by examining RTs in the valid condition, and attentional disengagement by focusing on RTs in the invalid condition. In general, when the interval between the onset of the cue and the onset of the target (stimulus-onset asynchrony; SOA) is short, RTs are faster to targets at the cued location compared to the uncued location. When SOAs are longer however, RTs can be slower to the cued location (Klein, 2000), an effect called the inhibition of return (IOR). This can encourage orientation toward a new location. The crossover point – where facilitation changes to inhibition – is typically about 250ms following cue onset (Klein & Ivanoff, 2008). However this can depend on task demands (Pérez-Dueñas, Acosta, & Lupiáñez, 2014). In the classic version of the cueing paradigm, exogenous orientation of attention is studied because attention is driven by external cues, environmental stimuli unrelated to the participant's goal. Because there are as many invalid as valid trials, there is no strategic task advantage in allocating attention to the cue, which does not help perform the task.

Variants of the cueing paradigm have been used to investigate whether emotional cues attract attention more efficiently than neutral cues, and whether this is related to engagement or disengagement processes. In this context, the logic is to compare RTs for the valid condition when cues are emotional relative to neutral. Studies have shown RTs faster in the valid condition when cues are emotional compared to neutral (Stormark, Nordby, & Hugdahl, 1995). Some studies have found longer RTs in the invalid condition when cues are emotional compared to neutral, suggesting a difficulty in disengaging attention from threatening stimuli in anxiety (Amir, Elias, Klumpp, & Przeworski, 2003). Others have found slower responses for stimuli presented at previously cued location (IOR) for non-emotional and positive stimuli (Pérez-Dueñas, Acosta, & Lupiáñez, 2009). For negative stimuli, an IOR effect may be found but depends on the level of individual trait anxiety. Thus, attentional engagement, disengagement and IOR may be dependent on affective state.

The processing of cues can be influenced by their properties but also by their location. Indeed, presenting stimuli in the left visual field may lead to a better identification of them relatively to a presentation in the right visual field (Asanowicz, Śmigasiewicz, & Verleger, 2013; Verleger, Dittmer, & Śmigasiewicz, 2013). This may be explained because of different abilities of the two hemispheres in attentional processing of relevant information in the contralateral hemifield (Śmigasiewicz, Asanowicz, Westphal, & Verleger, 2014). Others results have shown that the left visual field advantage reflects right hemisphere predominance in stimulus-driven orienting of spatial attention (Asanowicz, Kruseb,

Śmigasiewicz, & Verleger, 2017; Asanowicz et al., 2013; Śmigasiewicz et al., 2014). Furthermore, upper and lower visual field differences have been observed in various tasks, with a lower visual field advantage occurring for motion and global processing. An upper visual field advantage occurs for visual search, local processing and categorical judgements (Thomas & Elias, 2011). Thus, presenting peripheral cues to the right or the left of a fixation point and above or below it could lead to different results, irrespective of cue-target congruence. Further, cues such as words, presented to the right or the left of a central fixation point could create a '*reading*' effect (Jainta, Blythe, Nikolova, Jones, & Liversedge, 2015). Words presented on the horizontal line could benefit from the habitual reading process, with an advantage for stimuli presented to the left of the central fixation point, in languages where reading occurs from left to right. The reading process may lead to an advantage in detecting targets presented to the right of central fixation point, following the presentation of cues to the left of the fixation point. This would not occur with cues presented above or below a central fixation point.

The mode of presentation for stimuli may explain some of the discrepancies in the findings concerning the effect of threatening stimuli in the cueing paradigm. Indeed, Stormark and colleagues (1995, 1996) showed that attentional disengagement was faster for aversively conditioned cues, compared to neutral cues. These findings run contrary to theoretical predictions concerning attention to threat (Koster et al., 2007). However, other studies found facilitated attentional engagement and difficulties in disengaging from aversively conditioned cues (Koster, Crombez, Van Damme, Verschuere, & De

Houwer, 2004; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2005; Van Damme et al., 2004). These mixed results could be explained by the different visual angles in cue presentation. Studies have presented cues at different distances from the central fixation point ranging from 1.6° (Stormark et al., 1995), 4° (Fox, Russo, Bowles, & Dutton, 2001) to 7.2° (Koster et al., 2007). This methodological difference may account for some of the discrepancies in findings. Participants may be able to deploy attentional resources through an area large enough to process all the stimuli with equal ease (Ducrot & Grainger, 2007). This 'large' area processing could explain why Stormark and colleagues found participants fast to disengage attention from negative cues because of the proximity between stimuli and central fixation point (1.6°). Participants didn't need to reorient their attention as for the work of Koster and colleagues were the distance between cues and central fixation point was longer (7.2°). More generally, the finding that spatial cueing effects vary as a function of eccentricity suggests that reallocation of attention away from a central fixation point is necessary only above a certain level of eccentricity (Ducrot & Grainger, 2007). Furthermore, visual acuity is not uniform in different regions of the visual field and decreases with eccentricity. Some investigations have shown that there is an asymmetry in acuity between the lower visual field and the upper one and also between the left visual field and the right one (Loughnane, Shanley, Lalor, & O'Connell, 2015; Szelest & Elias, 2014; Thomas, Castine, Loetscher, & Nicholls, 2015; Thomas & Elias, 2011; Zito, Cazzoli, Müri, Mosimann, & Nef, 2016). However, little research has explored whether emotional information detection in cueing paradigms can be modulated by the location of cues.

While many studies have used spatial cues such as the highlighting of the rectangle to attract attention to one location, other studies have instead used symbolic cues. This kind of paradigm involves 'endogenous' attention because participants have to decode the symbol and orient their attention voluntarily as a consequence. For instance, Renner, Grofer Klinger, and Klinger (2006) presented an arrow as a cue. This arrow replaced the central point and indicated the right or the left direction. The target appeared just after the location cued or uncued by the arrow. Results show that this central, symbolic cue allowed participants to anticipate where the target would appear, as evidenced through faster RTs for the cued location. Different kinds of endogenous cues can create a cueing effect, for instance colored dots or numbers, although less strongly than an arrow, which is an over-learned symbol, possibly involving a combination of voluntary and involuntary orienting (Olk, Cameron, & Kingstone, 2008; Olk et al., 2014; Ristic, Wright, & Kingstone, 2006).

Another feature that has varied from one experiment to another in the study of the effect of emotion on attention is the instructions given to participants. For example, providing information about the nature of the stimulus before its presentation can improve its detection (Hodsoll & Humphreys, 2001). Vromen, Lipp, Remington, and Becker (2016) assessed attentional orientation to threat according to its relevance by manipulating instructions in cueing task. Attentional orientation and disengagement were modulated by participants' expectations. In their first experimentation, participants had to identify if a target, among distractors, represented a spider or a cat. In the second experimentation, participants had to identify if a target, among neutral and threatening distractors,

represented a bird or a fish. The results showed that attentional orientation towards and disengagement from spiders (the threatening stimuli) were stronger when it was relevant to the task (Experiment 1) rather than irrelevant (Experiment 2). A number of results support the important role of expectations and information processing strategies in attentional orientation (Downing, 2000; Soto, Heinke, Humphreys, & Blanco, 2005). However, little research has explored whether emotional information detection in a cueing paradigm can be modulated by inducing voluntary information processing strategies. In the following studies of this article, processing strategies were induced by asking a question about the cue. The question was known from the start of a block and repeated throughout the block, which could orient processing towards the emotional or semantic dimension of the stimuli.

Attentional orientation can also be modulated by the emotional state of individuals (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendororn., 2007; Fox, 2002; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Hankin, Gibb, Abela, & Flory, 2010; Mogg & Bradley, 2002; Mogg, Millar, & Bradley, 2000). Individuals with high or low levels of anxiety may both initially direct their attention towards threat, while only high anxious individuals show greater difficulty disengaging their attention from a threat (Frewen, Dozois, Joanisse, & Neufeld, 2008). The ability to detect threatening information can be modulated by psychological factors such as emotional traits or emotional state (Bar-Haim et al., 2007; Bradley et al., 1998; Fox, 2002; Mogg & Bradley, 2002). Attention towards threat can be modulated by past experiences. Individuals exposed to intense

stressful events such as sexual assault or earthquakes exhibit increased vigilance towards stimuli specifically related to the events (Caparos & Blanchette, 2014; Latack, Moyer, Simon, & Davila, 2017; Zhang, Kong, Han, Najam Ul Hasan, & Chen, 2014) or more generally to threatening stimuli (Pollak & Tolley-Schell, 2003).

In short, there is privileged attentional processing for stimuli preceded by a spatial cue, and this validity effect may be more marked with threatening cues, but there have been conflicting results. Various methodological variations, including stimulus presentation, instructions given to participants or processing strategies induced could be the origin of some mixed results concerning threatening cues. In the present study, we were interested in examining the impact of processing strategies on attentional orientation toward emotional and neutral stimuli with a horizontal (Experiment 1) or vertical presentation (Experiment 2). We expected validity effect for both experiments with a possible different magnitude between them. We also expected faster reaction times when cues are threatening than neutral. This threat superiority effect should be greater with emotional processing strategy and should be greater with participants' affective state as anxiety.

Experiment 1

Method

Participants. Participants were 50 students from the Université du Québec à Trois-Rivières (38 women; $M_{age} = 24.3$, $SD = 7.1$). Participants who did not have normal or corrected to normal vision were excluded.

Procedure. Students participated individually in the experiment which was conducted at the Université du Québec à Trois-Rivières in a dark room. Participants first answered questions concerning the inclusion and exclusion criteria. They then performed the attention task, followed by an evaluation of the emotional value of the cues, and finally completed the questionnaires. The experiment was presented on a standard screen (34.0 cm X 27.2 cm) in a 640 X 480 resolution (60Hz). Participants had to place their head on a chin rest located 60 cm from the screen.

During the attention task participants were instructed to keep their gaze on a fixation point (a dot) in the center of the screen throughout the attention task. A trial started with a fixation point for 500ms, followed by a cue word displayed for 280ms (see Figure 2). These cues were written in white font, size 12, on black background in 'Times New Roman'. They appeared to the right or on the left of the fixation point. Distance between the central fixation point and the center of the first letter of the word presented on the right, or the last letter of the word presented to the left was 3.3° visual angle. This means that the closest letter from the central fixation was about 1.8°. This distance seems

reasonable between 1.6° of Stormark and collaborators (1995) and 7.2° of Koster and collaborators (2007). Following the cue, a target ('+' or 'x') was presented for 180ms. The center of the target was located just slightly over 3.3 ° of visual angle from the central fixation point. Participants' first task was to determine whether the target was a '+' or 'x' (by pressing 'l' or 'a' key). Response keys were counterbalanced across participants to prevent the possibility of motor response effects. Valid trials included cues and targets appearing in the same location (right or left as presented in Figure 2), while invalid trials included cues and targets appearing in different locations. There were the same number of valid and invalid trials.

After participants determined the target, they answered a question related to the previously presented cue. This question could be semantic (Is it an object?) or emotional (Is it dangerous?). Participants answered 'yes' by pressing the 'a' key or 'no' by pressing the 'l' key. The question was the same for all trials within a block and was thus known to participants beforehand. The aim of asking participants to answer this question was to encourage processing the target based on a more emotional dimension or on a more semantic dimension. Indeed, participants knew before the start of a block the type of question that would be asked, and this question was repeated for all trials in the block. The advanced knowledge of the question should create a tendency to process the stimuli in line with this question, even if the answer is provided after the target. The order was counterbalanced across participants. Each experimental block consisted of 48 trials

with 12 neutral words and 12 threatening words which were each presented twice (see section cues evaluation for details about words used as cues in Experiment 1).

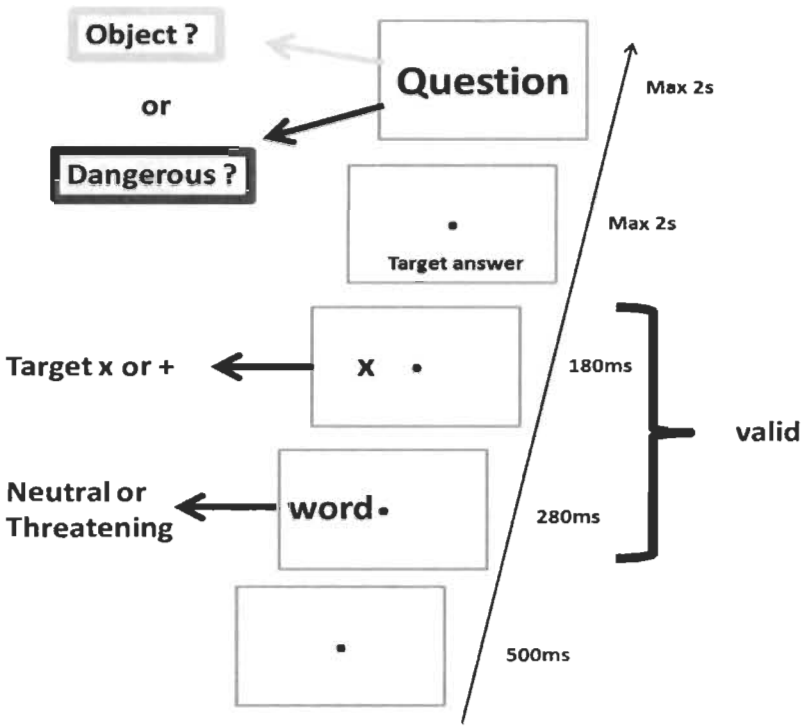

Figure 2. Trial structure. A trial started with a fixation point presented for 500ms. The cue (threatening or neutral word) then appeared for 280ms, followed by the target to be detected, which was presented for 180ms. The cues were presented on the right or on the left relatively to the fixation point. The target was an 'x' or a '+'. After detecting the target, a question about the cue-word presented previously was asked. The question was either semantic (Is it an object?) or emotional (Is it dangerous?), constant within a block and known by the participant before to start a block.

Once the attention task was finished, participants evaluated the stimuli and completed questionnaires.

Stimuli. The two experimental blocks presented different sets of words. These included words selected from an existing database (Syssau & Font, 2005), as well as other

words taken from others studies of visual attention (Ashley, Honzel, Larsen, Justus, & Swick, 2013; Felmingham, Rennie, Manor, & Bryant, 2011). We ensured that neutral and threatening words within a block differed on emotional value ($p < .05$) and did not differ on the number of letters ($p > .05$). We also ensured that neutral words across blocks were not different in terms of emotional valence and number of letters ($p > .05$). We finally ensured that threatening words across blocks did not differ in terms of emotional valence and number of letters ($p > .05$).

Cue evaluation. We asked participants to evaluate the threatening and neutral cues used in the cueing paradigm in order to verify that our two categories of words were different on emotional valence for our participants (see appendix A). A fixation point was presented for 1 second and words were presented individually for 1 second, in a random order. Participants assessed emotional valence using a scale from 1 (absolutely neutral) to 7 (highly emotional).

The corpus of 24 neutral words and 24 threatening words differed in terms of emotional valence, as evaluated by participants ($M_{\text{eval neutral}} = 1.32$, $SD = 0.17$; $M_{\text{eval threatening}} = 4.51$, $SD = 0.78$; t (25.244) = -19.56, $p < .001$). The average number of letters in neutral words ($M = 5.91$, $SD = 1.41$) and threatening words ($M = 5.87$, $SD = 1.73$) did not significantly differ, ($t(46) = 0.09$, $p > .9$).

Questionnaires. Participants answered three self-report questionnaires which would allow us to take into account their emotional state and its influence on the task. Those questionnaires were used in others attention studies and have shown influence process of negative stimuli (Ashley et al., 2013; Calvo & Avero, 2002; Koster, De Raedt, Verschuere, Tibboel, & De Jong, 2009).

- *Post-Traumatic Stress Disorder scale* (PTSD Cheklist; Weathers, Litz, Herman, Huska, & Keane, 1993): This scale assesses symptoms of post-traumatic stress after a highly emotional experience. This questionnaire is based on categories of DSM-IV symptoms (reliving, avoidance, autonomic hyperactivity) and has good psychometric properties (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996).
- *Trait Anxiety Inventory* (IASTA-Y; Gauthier & Bouchard, 1993; Spielberger, Gorsuch, & Lusthene, 1983): This scale measures anxiety levels that are relatively stable in time. It has good psychometric properties and is well known.
- *Beck Depression Inventory* (BDI-II; Beck, Steer, & Brown, 1996): This inventory was created based on the DSM-IV and assesses depression. This scale has good psychometric properties (Beck et al., 1996) and is widely used.

Data analysis. The analyses included 42 participants (34 women; $M_{age} = 24.3$, $SD = 7.7$). Two participants were excluded from analyses because they failed to reach a minimum accuracy of 75% in target discrimination and six failed to reach the same level of accuracy in their answers to the question about the cue. We consider this level of

accuracy (75%) for target discrimination and answer to the question because we wanted to ensure that the participants performed both tasks adequately, and not one better than the other. The main behavioral dependent measure was participants' RTs to determine target type. We considered mean per condition, including only correct answers (95%). Reaction times lower than 250ms were excluded as well as those greater than two standard deviations above the participant's individual mean, to reduce the influence of outliers (Mogg, Holmes, Garner, & Bradley, 2008). We performed an analysis of variance on the average RT to determine the impact of cue type (threatening, neutral) and processing strategy (emotional, semantic) as well as validity condition (valid, invalid). We then conducted correlational analyses to investigate the impact of participants' emotional state on RTs.

Results

Questionnaires

'Table 1 presents descriptive statistics of self-report questionnaires and Table 2 presents correlations between self-report questionnaires for 42 students.

Table 1

Descriptive statistics of questionnaires for 42 students

Questionnaire	Mean	Median	Standard deviation	Minimum	Maximum
STAI-B (trait anxiety)	46.1	43.5	10.45	24	67
BDI-II (depression)	10.1	7.5	9.20	0	39†
PCL (post-traumatic stress symptoms)	31.9	28.0	12.10	18	67

Notes. † One participant had a score of 39 on the depression scale (2nd and 3rd highest score being respectively 32 and 29).

Table 2

Pearson correlations between questionnaires for 42 students

Questionnaire	BDI-II	PCL
STAI-B	.77**	.63**
BDI-II		.82**

Notes. *$p < .05$; **$p < .01$

Behavioural results. An analysis of variance conducted on RTs revealed no significant three-way interaction between validity condition (valid vs. invalid), cue type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1,41) = .07$[1], $p = .79$, $\eta^2_p = 0.002$[2] but a significant two-way interaction between cue type and validity $F(1,41) = 8.08$, $p = .007$, $\eta^2_p = 0.16$ (see Figure 3), and a main effect of cue type $F(1,41) = 7.03$, $p = .01$, $\eta^2_p = 0.15$ showing RTs faster when neutral cues were presented compared to threatening cues. For the two-way interaction, post-hoc analyses showed that when the cue was neutral, RTs were faster in the invalid condition compared to the valid condition $t(41) = -2.36$, $p = .02$, $\eta^2 = 0.12$, $M_{diff} = -54.46$, $SD = 149.38$. When the cue was threatening, there was no significant difference between the valid and the invalid condition ($p > .05$, $M_{diff} = 24.1$, $SD = 120.5$). Additional analyses show that in the invalid condition, RTs were faster when the cue was neutral compared to threatening $t(41) = 3.48$, $p = .001$, $\eta^2 = 0.23$, $M_{diff} = 91.42$, $SD = 170.03$. In the valid condition, there was no significant difference between neutral and threatening cue ($p > .05$, $M_{diff} = 12.86$, $SD = 136.7$).

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[1] Use a Greenhouse-Geisser or Huynh-Feldt correction does not change the results.

[2] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

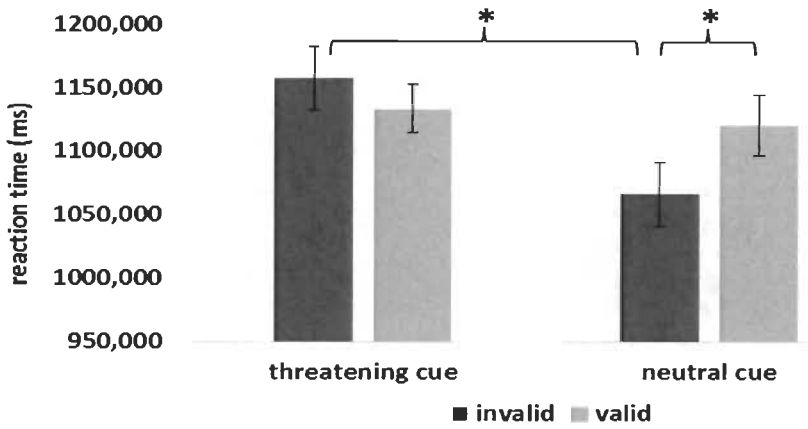

Figure 3. Reaction time to determine target type according to the different experimental conditions for students. Error bars cannot represent the standard error or confidence intervals because there is no inter-subject variability here (Cousineau, 2005). Consequently we applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014). *$p < .05$.

Additional analysis of variance conducted on RTs revealed no significant four-way interaction between target position (right vs. left), cue position (right vs. left), cue type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1,41) = .42$, $p = .52$, $\eta^2_p = 0.01$[1] but a significant three way interaction between cue type, target position and cue position $F(1,41) = 6.95$, $p = .012$, $\eta^2_p = 0.15$ (see Figure 4), and a main effect of cue type $F(1,41) = 6.75$, $p = .01$, $\eta^2_p = 0.14$ showing faster RTs when neutral cues were presented compared to threatening cues. There was also an effect of cue position $F(1,41) = 3.62$, $p = .06$, $\eta^2_p = 0.08$ showing RTs faster when cues were presented on the right compared to the left.

[1] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

For the three-way interaction, post-hoc analyses showed no significant effect (all $p > .05$).

Link between questionnaires and performance on the attention task. We computed a validity score by calculating the difference between RT in the invalid and the valid conditions (RT invalid - RT valid). Higher validity scores indicate that participants were faster in the valid condition than in the invalid condition, suggesting attentional capture by the cue. The reverse would reflect attentional avoidance of the cue. Validity scores were calculated for each type of cue. We then examined whether validity scores were correlated with questionnaire scores (see Table 3).

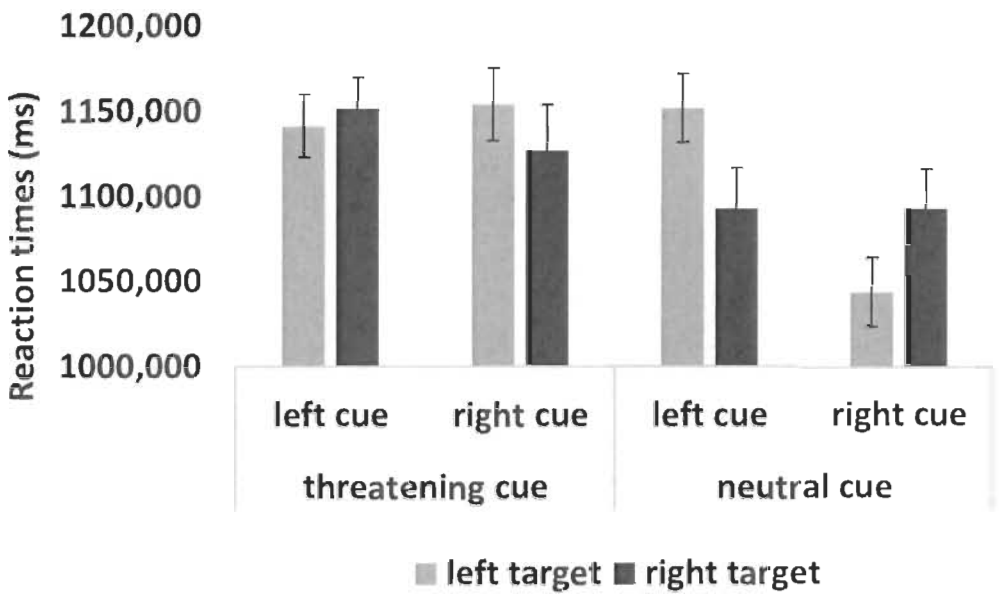

Figure 4. Reaction time to determine target type according to the different spatial experimental conditions and cue type for students. Error bars cannot represent the standard error or confidence intervals because there is no inter-subject variability here (Cousineau, 2005). Consequently, we applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014).

Table 3

Pearson correlations between validity scores and questionnaires on 42 students

	STAI-B	BDI-II	PCL
Validity score : threatening cue	-.12	-.16	-.01
Validity score : neutral cue	-.06	-.14	.08

We did not observe any correlation between validity scores on the cueing task and questionnaires scores. It seems that performance on the attention task was not modulated by trait anxiety, depression or post-traumatic stress symptoms in this sample of students.

Discussion

This first experiment showed no significant validity effect when the cue was threatening and a reversed validity effect when the cue was neutral. This reversed validity effect could be an IOR but the presentation delay between the cue and the target seems to be a little shorter to appear (Klein, 2000). There was no effect of the processing strategies on the validity effect, and this factor also did not interact with cue type or the emotional state of participants. These results reinforce the inconsistency observed from previous studies, as different studies have found faster or slower attentional disengagement from threatening stimuli, compared to neutral stimuli (Koster, Crombez, Verschuere, & De Houwer, 2004; Koster et al., 2007; Stormark & Hugdahl, 1996; Stormark et al., 1995). It is possible that the visual properties related to the horizontal presentation of stimuli may influence the results, in line with possible reading effect. It also possible that the different

abilities of the hemisphere to process relevant information in their contralateral hemifield (Śmigasiewicz et al., 2014) add some variability that we didn't consider in this experiment. However additional analysis in this experiment did not confirm either of these two hypotheses. Maybe, in the Experiment 1 the manipulations produce the IOR effect with neutral stimuli and disappear this effect when the participants pay attention to the emotional cue because are relevant for the task. There are other studies where the emotional valence of the target is manipulated and the IOR is override for threatening stimuli (e.g.: Pérez-Dueñas et al., 2014). What happens when cues and target are presented on the vertical meridian line.

Experiment 2

Method

Participants. Participants were 35 students from the Université du Québec à Trois-Rivières (27 women; M_{age} = 21.9, SD = 1.7). Exclusion criterion was not to have normal or corrected to normal vision.

Procedure. We used the same procedure as in Experiment 1, except that the cues and targets appeared above or below the fixation point (see Figure 5). Distance between the central fixation point and center of the cue word was 1.6 ° visual angle. This distance allows to have equivalent distance between stimuli and central fixation point in Experiment 1. The center of the target was also located 1.6 ° of visual angle from the central fixation point. Participants' tasks were the same as in Experiment 1 except that the

attention task was presented in three blocks. The first consisted of a practice block with 72 trials intended to familiarize participants with the task. It included only neutral cues (chosen randomly in the database: http://www.lexique.org/) that were not used in the experimental blocks. In this block, the processing strategy induced was semantic only (question related to the previously presented cue was: Is it an object?).

The two experimental blocks followed. Each experimental block consisted of 72 trials with 12 neutral words and 12 threatening words. Each was presented three times (see section cues evaluation for details about words used as cues in Experiment 2).

Stimuli. We used different words than in Experiment 1. The two experimental blocks also presented different words. We ensured that neutral and threatening words within a block differed on emotional value ($p < .05$) and did not differ on the number of letters ($p > .05$). We also ensured that neutral words across blocks were not different in terms of emotional valence and number of letters ($p > .05$). We finally ensured that threatening words across blocks did not differ in terms of emotional valence and number of letters ($p > .05$).

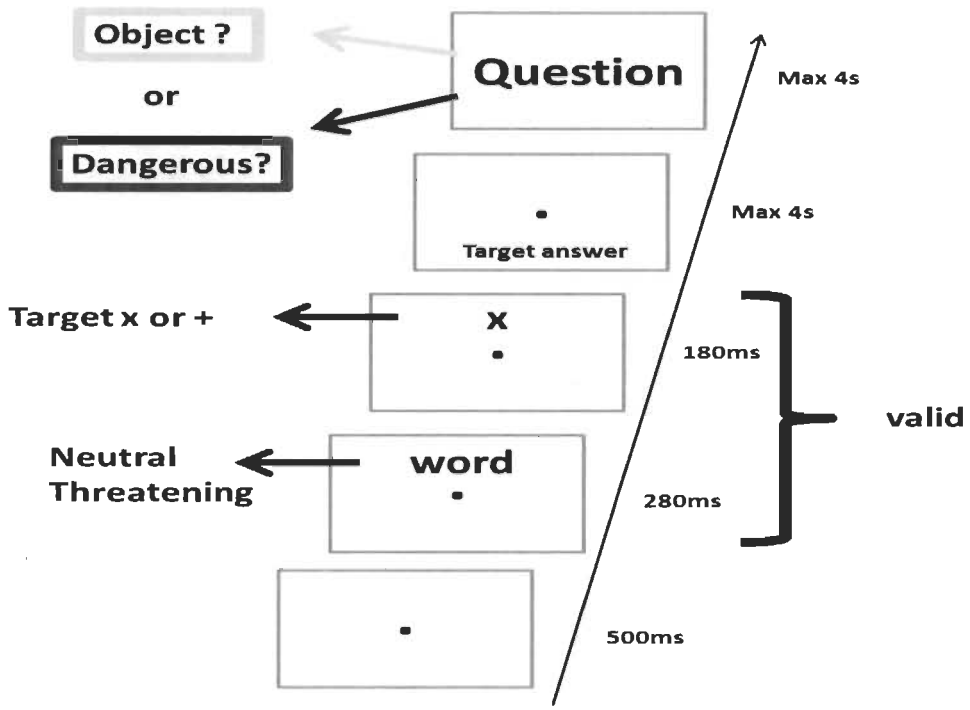

Figure 5. Trial structure. A trial started with a fixation point presented for 500ms. The cue (threatening or neutral word) then appeared for 280ms, followed by the target to be detected, which was presented for 180ms. The cues were presented above or below the fixation point. The target was an 'x' or a '+'. After detecting the target, a question about the cue-word presented previously was asked. The question was either semantic (Is it an object?) or emotional (Is it dangerous?), constant within a block and known by the participant before to start a block.

Cue evaluation. We used exactly the same cue evaluation procedure as in Experiment 1 to verify that the 35 students who took part in the attention task judged the two categories of words (neutral vs. threatening) to be different on emotional valence (see appendix B). Participants indeed evaluated the neutral and threatening words as different in terms of emotional value ($M_{\text{eval neutral}} = 1.23$, $SD = 0.17$; $M_{\text{eval threatening}} = 4.79$, $SD = 0.59$; $t\ (26.952) = 28.54$, $p < .001$). The average number of letters in neutral words ($M = 5.92$, $SD = 1.41$) and threatening words ($M = 6.62$, $SD = 1.93$) did not significantly differ, ($t\ (46) = 1.45$, $p > .15$).

Questionnaires. We used exactly the same questionnaires as in Experiment 1.

Data analysis. The analyses included 33 participants (25 women; $M_{age} = 21.9$, $SD = 1.8$). Two participants were excluded from analyses because they failed to reach a minimum accuracy of 75% in target discrimination. The main behavioral dependent measure was participants' RTs to determine target type. We again considered average mean per condition, including only correct answers (92%). Then we executed the same data analysis as in Experiment 1.

Results

Questionnaires

Table 4 presents descriptive statistics of self-report questionnaires and Table 5 presents correlations between self-report questionnaires for 33 students.

Table 4

Descriptive statistics of questionnaires for 33 students

Questionnaire	Mean	Median	Standard deviation	Minimum	Maximum
STAI-B (trait anxiety)	44.1	42	10.3	26	61
BDI-II (depression)	7.7	6	5.6	0	21
PCL (post-traumatic stress symptoms)	28.4	27	6.9	19	46

Table 5

Pearson correlations between questionnaires for 33 students

Questionnaire	BDI-II	PCL
STAI-B	.57**	.23
BDI-II		.41**

Notes. $*p < .05$; $**p < .01$

Behavioural results. An analysis of variance conducted on RTs revealed a significant three way interaction between validity (valid vs. invalid), cue type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1, 32) = 4.19$, $p = .049$, $\eta^2_p = 0.12$[1] (see Figure 6); a marginal significant two-way interaction between cue type and

[1] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

processing strategy $F(1,32) = 3.54$, $p = .069$, $\eta^2_p = 0.1$ and a significant two-way interaction between validity condition and cue type $F(1,32) = 4.24$, $p = .043$, $\eta^2_p = 0.12$. There were no other significant effects. We conducted a second stage of analysis examining the data separately for the blocks inducing emotional and semantic processing strategies.

When participants answered the emotional question, there was a significant interaction between cue type and validity $F(1, 32) = 5.54$, $p = .025$, $\eta^2_p = 0.15$. Post-hoc analyses showed that when cues were neutral, RTs were faster in the valid compared to the invalid condition $t(32) = 2.27$, $p = .03$, $\eta^2 = 0.14$. When the cues were threatening, there was no statistically significant difference between the valid and the invalid condition ($p = .17$).

When participants answered the semantic question, there was no interaction between cue type and validity ($p > .05$, $\eta^2_p = .07$), and a marginally significant main effect of validity $t(32) = 3.68$, $p = .06$, $\eta^2 = 0.30$ where RTs were faster in valid compared to invalid condition.

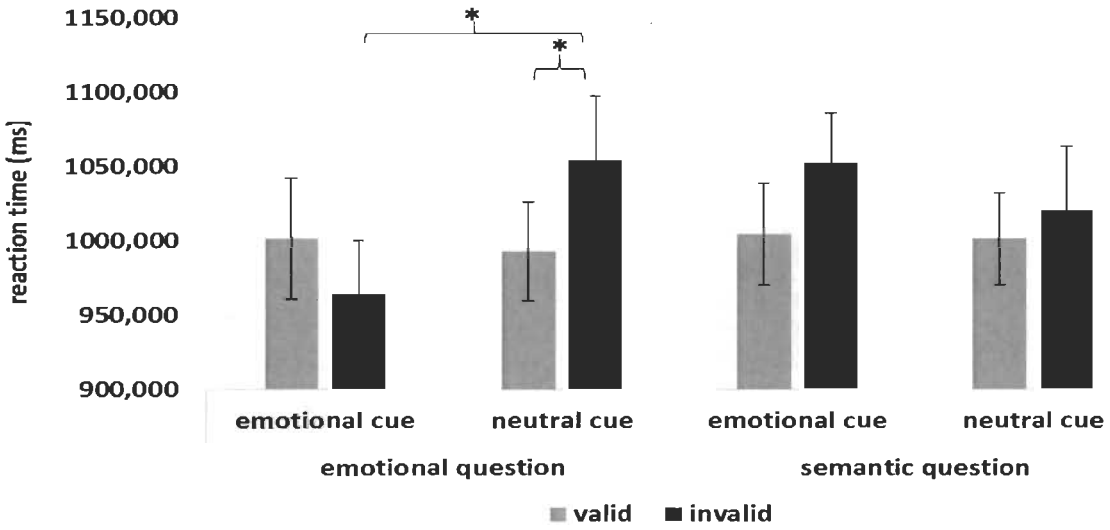

Figure 6. Reaction time to determine target type according to the different experimental conditions for students. We applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014). *$p < .05$.

Link between questionnaires and performance on the attention task. We computed a validity score as in Experiment 1 and examined whether attentional capture by the cues in the different conditions was correlated with questionnaire scores (see Table 6).

Table 6

Pearson correlations between validity score and questionnaires on 33 students

	STAI-B	BDI-II	PCL
Validity score : threatening cue and emotional question	.14	-.03	.27
Validity score : neutral cue and emotional question	.10	.22	.16
Validity score : threatening cue and semantic question	.32	.38*†	-.03
Validity score : neutral cue and semantic question	.13	.19	-.10

Notes. *$p < .05$.

†The correlation between BDI-II and validity score when the question was semantic and cue threatening disappeared ($r(32) = .29$, $p = .11$) when we removed the highest participants on BDI-II score (21, second and third highest were 18).

Table 6 presents all correlations. There were no significant correlations between RTs and questionnaire scores. In this study as in the previous one, performance in the attention task was not modulated by trait anxiety, depression or post-traumatic stress symptoms with students.

Cross-study comparison on attentional task. An analysis of variance conducted on RTs revealed a non significant four-way interaction between experiment (Experiment 1 vs. Experiment 2), validity condition (valid vs. invalid), target type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1,73) = 2.15$, $p > .05$, $\eta^2_p = 0.03$. There was significant three-way interaction between validity condition, cue

type and experiment $F(1,73) = 10.42$, $p < .05$, $\eta^2_p = 0.12$. We also have two-way interaction between cue type and experiment $F(1,73) = 6.32$, $p < .05$, $\eta^2_p = 0,08$, and between validity condition and experiment $F(1,73) = 3,32$, $p = .07$, $\eta^2_p = 0,04$. Post-hoc analyses showed for this last two-way interaction that reaction time did not differ significantly between invalid ($M = 1111,77$) and valid condition ($M = 1127,12$) in Experiment 1 $t(41) = -0,97$, $p = .34$, neither in Experiment 2, ($M_{invalid} = 1018,80$) ($M_{valid} = 997,94$) $t(32) = 1,57$, $p = .13$. Additional analyses showed that reaction times in invalid condition in Experiment 1 were not significantly superior ($M = 1111,77$) from Experiment 2 ($M = 1018,80$) $t(73) = 1,32$, $p = .19$, and reaction times in valid condition in Experiment 1 were marginally superior ($M = 1127,12$) from Experiment 2 ($M = 997,94$) $t'(71,97) = 1,92$, $p = .06$.

Discussion

The purpose of this research was to examine the impact of processing strategies on attentional orientation toward emotional and neutral stimuli with a horizontal presentation (Experiment 1) and then with a vertical presentation (Experiment 2). The findings show that overall, there was a validity effect in Experiment 2, where stimuli were presented vertically, while there was no validity effect in Experiment 1, where stimuli were presented horizontally. This experiment also showed no effect of processing strategies. From these results, we conclude the validity effect in a cueing paradigm can be more effectively detected with a vertical presentation of stimuli.

Our results show that methodological features may be important in explaining some variability in previous results using the cueing paradigm. An explanation could be that there are differences in processing between left and right visual field. This is supported by the existence of hemisphere specialisation, as well as a possible reading effect; though we didn't observe direct evidence for this in the first experiment. It has, however, been shown that the left visual field may be better able to detect stimuli efficiently (Asanowicz et al., 2017). Some studies provide evidence that this left visual field advantage reflects right hemisphere predominance in stimulus-driven orienting of spatial attention (Asanowicz et al., 2017). It is important to note that the left visual field advantage in others research is not related to handedness (Śmigasiewicz, Liebrand, Landmesser, & Verleger, 2017). The left visual advantage could be explained by the localisation of the ventral system specialized in bottom-up processing in the right hemisphere (Corbetta & Shulman, 2002). We also used words as cues in our experimentations and this property of stimuli could favour the left hemisphere, specialized for processing of verbal stimuli including reading (Asanowicz et al., 2013). It is possible that our results could be explained by those factors, as we found an interaction between cue and target position. However follow-up tests were equivocal and thus more studies are needed to investigate hypotheses concerning lateralisation and its possible effect on threat detection.

We used processing strategies that could endogenously drive attention and facilitate bottom-up processing and this kind of process is more controlled by the right hemisphere (Śmigasiewicz, Hasan, & Verleger, 2017). It is therefore possible that stimulus driven

orienting interacted with processing strategies involving hemispheric specialisation to result in the pattern observed in Experiment 1. In any case our results show that the way stimuli are presented in a cueing paradigm needs to be considered. Indeed, Chaumillon and collaborators (2017) showed that participants with a strong eye dominance exhibited differences in reaction times to detect stimuli between the two visual hemifields with respect to the dominant eye. Others studies have considered the possible influence of right/left or lower/upper visual field (Asanowicz et al., 2017; Loughnane et al., 2015; Śmigasiewicz et al., 2014; Thomas & Elias, 2011; Zito et al., 2016) but the contribution of each hemisphere is still unclear and future studies need to be conducted to elucidate this.

Studies of attentional orientation towards threatening stimuli have revealed mixed results. Leleu, Douilliez, and Rusinek (2014) found that participants were longer to disengage attention from threat with a vertical presentation with no facilitation for attentional capture. On the other hand, Stormark and collaborators (1995) found that there were faster reaction times to detect targets after cues on the same location with an horizontal presentation. Meier and Robinson (2004) found that negative words are faster evaluate when they are presented down than the up position. Those mixed results could partially be explained by two different kinds of stimuli presentation.

Our results show that there is no modulation of attentional processing by affective state as anxiety, depression or PTSD symptoms in our two experiments. One possibility

is that we did not have enough variability in the scores to observe correlations. It is also possible that the use of processing strategies changed the way participants performed the task, and attenuated differences between participants as a function of individual differences. Anxious participants may naturally have some expectations about the presentation of visual stimuli and this could influence the processing of neutral and threatening stimuli. The use of processing strategies induced by the question about the cues could alter the natural expectations and homogenize reactions.

This study has some limitations that could be important to consider for future research. First, there was not the same number of trials per condition in both experiments. In the first experiment, there were 48 trials per block/question leading to 12 trials per condition and there were 72 trials per block/condition in experiment 2 leading to 24 trials per condition. In next experiment, it will be important to keep the number of trials on the same number. Second, some words were changed from experiment 1 to experiment 2 because of some words as '*cigarette*' or '*seringue*' that could be confusing for some participants about the emotionality in regards to their personal life or mind context. In the next experiment, we should better consider the choice of words in regards to their meaning in general context. Third, we tried to induce processing strategies with a question about cues that participants had to answer after detecting the target. This puts participants in a near dual task situation. It is difficult to be sure about the strategy used by participants to do the task trial by trial and the impact this may have on working memory and attentional processing. Indeed, to keep in mind an instruction to realize the task could influence

attentional processing. Next experiment should consider a way to discriminate which strategy participants use.

In sum, we found that the validity effect in a cueing paradigm can be more effective with a vertical presentation rather than a horizontal one. We also found that the attentional cueing by neutral and threatening cues were modulated by processing strategies, but not by the affective state of participants, when the presentation was vertical. Our results suggest that visual parameters of stimulus presentation are important in attentional processing of emotional stimuli.

Conflict of Interest

We declared to have no conflict of interest for this research.

Appendix A. Words list from experiment 1

Neutral words	Emotionality score	Threatening words	Emotionality score
ballon	1.44	*bombe*	5.34
castor	1.46	*fusil*	5.00
chaise	1.14	*grenade*	4.88
chameau	1.34	*haine*	4.96
chapeau	1.20	*obus*	4.06
feuille	1.14	*pistolet*	4.82
manteau	1.20	*rage*	4.46
noix	1.18	*sang*	4.06
pied	1.26	*seringue*	4.00
table	1.06	*serpent*	3.48
tapis	1.26	*sida*	5.12
verre	1.52	*stress*	4.58
assiette	1.30	arme	4.78
carotte	1.20	brutalité	4.90
classeur	1.20	cancer	5.68
fromage	1.58	canon	4.22
gomme	1.24	cigarette	3.36
kangourou	1.56	colère	4.54
lapin	1.60	couteau	4.16
pelle	1.68	crime	5.26
poule	1.42	hache	3.92
seau	1.16	matraque	4.66
tomate	1.40	meurtre	5.72
vase	1.22	rat	2.28

Words in italic were presented in the emotional processing strategy bloc.

Appendix B. Words list from experiment 2

Neutral words	Emotionality score	Threatening words	Emotionality score
assiette	1.09	*agression*	5.03
ballon	1.31	*attaque*	4.51
carotte	1.09	*attentat*	4.71
chameau	1.40	*brutalité*	4.57
fromage	1.37	*cancer*	5.20
kangourou	1.77	*explosion*	4.40
noix	1.23	*grenade*	3.69
pelle	1.29	*meurtre*	5.46
poule	1.17	*otage*	4.46
seau	1.06	*sida*	4.37
tomate	1.17	*suicide*	5.63
verre	1.14	*viol*	5.71
castor	1.31	arme	3.94
chaise	1.23	assassin	4.86
chapeau	1.11	bombe	4.43
classeur	1.14	braquage	3.77
feuille	1.14	deuil	5.29
gomme	1.14	fusillade	5.00
lapin	1.40	homicide	5.17
manteau	1.17	menace	4.17
pied	1.51	mort	5.37
table	1.06	terrorisme	4.71
tapis	1.03	tuer	5.71
vase	1.09	tumeur	4.80

Words in italic were presented in the emotional processing strategy bloc.

Appendix C. Words changed from experiment 1 to experiment 2

Words from experiment 1	Emotionality score	Words from experiment 2	Emotionality score
agression	5.03	canon	4.22
assassin	4.86	cigarette	3.36
attaque	4.51	colère	4.54
attentat	4.71	couteau	4.16
braquage	3.77	crime	5.26
fusillade	5.00	*fusil*	5.00
deuil	5.29	hache	3.92
explosion	4.40	*haine*	4.96
homicide	5.17	matraque	4.66
menace	4.17	*obus*	4.06
mort	5.37	*pistolet*	4.82
otage	4.46	*rage*	4.46
suicide	5.63	rat	2.28
terrorisme	4.71	*sang*	4.06
tuer	5.71	*seringue*	4.00
tumeur	4.80	*serpent*	3.48
viol	5.71	*stress*	4.58

Words in italic were presented in the emotional processing strategy bloc.

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Article 2

Can threat detection be enhanced using processing strategies by police trainees and officers?

Can threat detection be enhanced using processing strategies by police trainees and officers?[1]

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Abstract

The ability to detect threatening stimuli is an important skill for police officers. No research has yet examined whether implementing different information processing strategies can improve threat detection in police officers and police trainees. The first aim of our study was to compare the effect of strategies accentuating the processing of the emotional or the semantic dimension of stimuli on attention towards threatening and neutral information. The second aim was to consider the impact of PTSD symptoms on threat detection, as a function of processing strategies, in police officers and trainees. In a cueing paradigm, participants had to respond to a target that was presented following a threatening or neutral cue. Participants then answered a question, known beforehand, concerning the cue. The question was used to induce a more emotional or semantic processing strategy. Results showed that when the processing strategy was emotional, police trainees and officers were faster to detect the target when it followed a threatening cue, compared to a neutral cue, independently of its spatial location. This was not the case when the processing strategy was semantic. This study shows that induced processing strategies can influence attentional mechanisms related to threat detection in police trainees and police officers.

Keywords: *Visual attention; Threat detection; Processing strategies; Police; Cueing paradigm.*

Introduction

The ability to detect threatening stimuli is an important skill for police officers, in order for them to be able to adjust their behavior efficiently. Indeed, police work involves arresting suspects, managing domestic situations or monitoring crowd behavior. Police officers are often in potentially dangerous situations. They need to be able to rapidly detect threatening information in complex and rapidly changing environments. Research shows that threatening stimuli generally receive privileged attentional processing (Blanchette, 2006). In this paper, we explore the possibility that such attentional mechanisms may be influenced by the use of voluntary processing strategies, which may favor the processing of the emotional or the semantic dimension of stimuli. More specifically, the aim of our study was to examine whether emotional or semantic processing strategies can improve the detection of threatening stimuli in police trainees and police officers.

The impact of emotion on visual attentional processes can be studied using different paradigms. Stormark, Nordby, and Hugdahl (1995) adapted the cueing paradigm of Posner (1980) by manipulating the emotional valence of words used as cues. In this paradigm, a cue is presented, followed by a target that appears in the same location (valid condition) or in another location (invalid condition). The logic is that if attention is attracted by a cue, then participants should be faster to detect the target in valid condition, because attention is already focused in that location. This validity effect should be even more pronounced when the cue is threatening, if these attract attention more than neutral stimuli. Indeed, participants are generally faster to detect the target in the valid condition when the

cues are emotional relative to neutral (Stormark et al., 1995). This prioritized processing of emotional stimuli, spatially localized, has also been found with emotional faces (Fox, 2002) and aversively-conditioned color cues (Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004).

The attentional prioritization of emotional stimuli has also been demonstrated with other paradigms, including the dot-probe task (Calvo & Lang, 2004; Frewen, Dozois, Joanisse, & Neufeld, 2008) and the visual search task (Blanchette, 2006; Öhman, Flykt, & Esteves, 2001). In the latter, a target must be detected amongst distractors. Threatening stimuli are detected faster (Öhman et al., 2001) and benefit from the first fixation, even when instructions ask participants not to pay attention to them (Nummenmaa, Hyönä, & Calvo, 2006). In this way, many studies establish that the detection of negative, particularly threatening stimuli is more efficient than that of neutral stimuli. One explanation of this effect is that attentional resources are limited and allocated in priority to the location of threatening stimuli. More specifically, in the cueing paradigm, attentional resources are distributed across the visual space and the threatening cues cause an increase of attentional resources on the location of threatening stimuli, allowing a better detection of a target following in this same location relative to other locations. This effect can be considered as a threat-related spatial vigilance.

Threatening stimuli benefit from attentional priority and this kind of prioritization can occur spatially, as seen previously, but can also occur independently of the spatial

dimension. Indeed, the presentation of threatening stimuli may induce a specific emotional state, temporarily increasing anxiety, which could lead to a general over-activation of attentional processes (Dennis & Chen, 2007; Fernández-Castillo & Caurcel, 2015). This increased vigilance would create a general advantage in processing targets presented after threatening cues, no matter where these targets occur. This would result from the anxious state leading to an increased spread of attention across the visual field, which would lead to more efficient target detection. In this way, the presentation of threatening cues may also lead to a general, non-spatial increased alertness for all targets.

The ability to detect threatening information can be modulated by psychological factors such as emotional traits or emotional state (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Bradley, Mogg, Falla, & Hamilton, 1998; Fox, 2002; Mogg & Bradley, 2002). Individuals with high or low levels of anxiety may both initially direct their attention towards threat, while only high anxious individuals show greater difficulty disengaging their attention from a threat (Frewen et al., 2008). Attentional processes can also be modulated by the emotional state of individuals (Bar-Haim et al., 2007; Fox, 2002; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Hankin, Gibb, Abela, & Flory, 2010; Mogg & Bradley, 2002; Mogg, Millar, & Bradley, 2000).

Attentional mechanisms may also be influenced by exposure to threatening events (Frewen et al., 2008). Individuals exposed to intense stressful events such as sexual assault or earthquakes exhibit increased vigilance towards stimuli specifically related to the

events (Caparos & Blanchette, 2014; Latack, Moyer, Simon, & Davila, 2017; Zhang, Kong, Han, Najam Ul Hasan, & Chen, 2014) or more generally to threatening stimuli (Pollak & Tolley-Schell, 2003). These studies show that attention towards threat can be modulated by past experiences and that these effects are closely bound with the emotional response triggered by these events (Coyle, Karatzias, Summers, & Power, 2014; Infurna, Rivers, Reich, & Zautra, 2015). Therefore, it is necessary to take into account prior emotional experiences related to potentially traumatic events when studying attention towards threatening stimuli. This is particularly important with police officers who are particularly at risk of being exposed to violent, critical incidents in the course of their work (Hodgins, Creamer, & Bell, 2001). Even trainee police officers often have prior professional experiences, in the army or as security agents for example, before integrating police training that may be associated with increased risk of exposure to stressful events (Buchanan, Stephens, & Long, 2001).

The allocation of attentional resources can thus be modulated by internal control system which includes past experiences but also current goals (Folk, Remington, & Johnston, 1992). This internal control system represents a balance between a rigid network necessary to ensure the processing of important stimuli and a flexible network allowing adaptation to change in current goals and circumstances. Stimuli that are relevant for the task, for instance because they share attributes with the target, are more likely to attract attention (for example, a red shirt will attract attention more when we are looking for someone wearing a red hat) (Folk et al., 1992, cited by Corbetta & Shulman, 2002).

Anticipated knowledge of the target characteristics to be detected (such as size) improves target detection (Hodsoll & Humphreys, 2001). Providing information about the nature of the stimulus before it is presentation can activate internal control mechanisms (Hodsoll & Humphreys, 2001). These predispose participants to detect information consistent with their expectations, or relevant for their goals. A number of results support the important role of expectations and information processing strategies in attentional orientation. However, most of this research has been conducted with neutral information. Little research has explored whether emotional information detection can be modulated by inducing voluntary information processing strategies.

In this study, we examined whether threat detection can be influenced by encouraging participants to process the emotional or the semantic dimension of stimuli. This could be particularly relevant for police officers in their everyday work and with police trainees who must learn to become effective at processing threatening stimuli. To this end, we examined threat detection using a cueing paradigm including threatening or neutral cues. After detecting the target, participants answered one of two questions concerning the cue: "Is it dangerous?" or "Is it an object?". These questions were known by participants beforehand and should preferentially induce more emotional or semantic processing of the stimuli. Such a protocol allows for a direct comparison of the influence of affective and semantic processing strategies on attention to threatening cues.

Our hypothesis was that inducing an emotional processing strategy would lead to more efficient threat detection, compared to a semantic processing strategy, in police officers and future police officers. We wanted to examine this both in terms of spatial prioritization and general vigilance. A secondary objective was to investigate whether the influence of processing strategies on threat detection was modulated by self-report PTSD symptoms related to prior emotional experiences.

Experiment 1

Method

Participants. Participants were 68 police trainees from the École National de Police du Québec (14 women; $M_{age} = 22.8$, $SD = 2.9$). They followed three years of police techniques and they were recruited during the last stage of their training, which involved 15 weeks at the École National de Police du Québec. During this period, they are trained in shooting and driving in high speed.

Participants were recruited in school, following a brief explanation of the project provided in class. The only exclusion criterion was not to have normal or corrected to normal vision. We took into account participants' field experience prior to starting police training, as this could influence levels of post-traumatic stress symptoms. Fifteen of the participants reported having at least six months of experience in security activities or military experiences.

Apparatus. The presentation of the attentional task and data collection were conducted with a PC laptop with standard screen (34.0 cm X 27.2 cm) of resolution 640 X 480 and a refresh rate of 60 Hz. Participants had to place their head on a chin rest located 60 cm from the screen. E-prime software was used to deliver stimuli and record responses and reaction times. Manual responses to the task were collected from designated responses keys on the computer's keyboard.

Material

Pilot study: Stimuli selection and validation. A pilot study was conducted in order to determine which words to include in the cueing paradigm. A total of 71 police trainees (a separate group from those taking part in the main experiment) evaluated 98 threatening and neutral French words on a scale from 1 (absolutely neutral) to 7 (highly emotional). Some of these words were taken from an existing database (Syssau & Font, 2005) and others inspired by studies of post-traumatic stress. The mean ($M = 2.89$, $SD = 1.75$) and the median ($Mdn = 3$) were determined for all words. We considered words to be emotional if 80% (at least 57) of participants evaluated them as equal or superior to the median. Conversely, if 80% of participants evaluated a word below the median, it was considered neutral. Following this process, we kept 52 words (26 neutral, 26 emotional) from the original 98. To simplify, we removed two words per group, selected randomly, to keep 24 words per group (see appendix A). The final corpus of 24 neutral words and 24 threatening words differed in terms of the assessment made by participants ($M_{\text{eval neutral}} = 1.12$, $SD = 0.07$; $M_{\text{eval threatening}} = 4.65$, $SD = 0.60$; $F(1, 46) = 821.75$,

$p < 0.001$). The average number of letters in neutral words ($M = 5.92$, $SD = 1.41$) and threatening words ($M = 6.63$, $SD = 1.93$) did not significantly differ, ($F(1, 46) = 2.11$, $p = .15$). Furthermore, the frequency of words did not differ significantly between the two emotional categories based on the ''Lexique'' database (New, Pallier, Ferrand, & Matos, 2001), for movies ($F(1, 46) = 1.03$, $p = .31$) and books ($F(1, 46) = 1.39$, $p = .24$). It is important to control for frequency because it was demonstrated that unfrequently used word need more resources to be processed (Just & Carpenter, 1980).

Questionnaires. Participants answered three self-report questionnaires that would allow us to take into account their emotional state and its possible influence on the task.

- *Post-Traumatic Stress Disorder scale* (PTSD Checklist; Weathers, Litz, Herman, Huska, & Keane, 1993): This scale consists of 17 questions (e.g. How much have you been bothered by repeated, disturbing dreams of a stressful experience from the past?) that assess symptoms of post-traumatic stress after a highly emotional experience. The presence of each symptom is assessed on a scale ranging from 1 (not at all) to 5 (extremely). This self-report questionnaire is based on categories of DSM-IV symptoms (reliving, avoidance, autonomic hyperactivity) with an alpha of Cronbach for the total scale was 0.94 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996). The alpha of Cronbach was 0.85 in the present sample. Diagnosis of post-traumatic disorder can be determined when the total score is above 50 (with a minimum of 17 and a possible maximum of 85).

- *Trait Anxiety Inventory* (IASTA-Y; Gauthier & Bouchard, 1993; Spielberger, Gorsuch, & Lusthene, 1983): This scale measures anxiety levels that are stable in time, has an alpha of Cronbach of 0.91 and is well known. The alpha of Cronbach was 0.97 in the present sample.
- *Beck Depression Inventory* (BDI-II; Beck, Steer, & Brown, 1996): This inventory was created based on the DSM-IV and assesses depression. This scale has good psychometric properties with an alpha of Cronbach of 0.91 (Beck et al., 1996; Dozois, Dobson, & Ahnberg, 1998) and is well known too. The alpha of Cronbach was 0.84 in the present sample.

Procedure. Police trainees participated individually in the experiment which was conducted at École National de Police du Québec in an isolated room. Participants first answered questions concerning the exclusion criteria. They then performed the attention task, followed by an evaluation of the emotional value of the cues, and finally answered the questionnaires.

The attention task was presented in three blocks. The first consisted of 72 practice trials intended to familiarize participants with the task. It included only neutral cues (from a pilot study) that were not used in the experimental blocks, and the processing strategy induced was semantic only (i.e., the question related to the previously presented cue was: Is it an object?).

The two experimental blocks followed. One induced a semantic processing strategy and the other induced an emotional processing strategy. The order was counterbalanced across participants. Each experimental block consisted of 72 trials with 12 neutral words and 12 threatening words that were each presented three times. The two experimental blocks presented different words. We ensured that neutral and threatening words within a block differed on emotional value ($p < .05$) and did not differ on the number of letters ($p > .05$). We also ensured that neutral words across blocks were not different in terms of emotional valence and number of letters ($p > .05$). We finally ensured that threatening words across blocks did not differ in terms of emotional valence and number of letters ($p > .05$).

Participants were instructed to keep gaze on a fixation point (a dot) in the centre of the screen throughout the attention task. A trial started with a fixation point for 500ms, followed by a cue word displayed for 280ms (see Figure 7). These cues were written in white font, size 12, on black background in 'Times New Roman'. They appeared above or below the fixation point. The cues were either threatening or neutral. Distance between the central fixation point and centre of the cue word was 1.6 ° visual angle. Following the cue, a target ('+' or 'x') was presented for 180ms. The centre of the target was also located 1.6 ° of visual angle from the central fixation point. Participants' first task was to detect whether the target was a '+' or 'x' (by pressing 'l' or 'a' key with a classic keyboard). Key responses were counterbalanced across participants to prevent the possibility of motor response effects. Valid trials included cues and targets appearing in the same location (top

or bottom as in Figure 7), while invalid trials included cues and targets appearing in different locations. There was the same number of valid and invalid trials.

Once the target detection was done, participants answered a question related to the previously presented cue. This question could be semantic (Is it an object?) or emotional (Is it dangerous?). Participants answered 'yes' by pressing the 'a' key or 'no' by pressing the 'l' key. The question was the same for all trials within a block and was thus known to participants beforehand.

Once the attention task was finished, participants were asked to rate the emotional value of the 48 words presented as cues during the task on a seven-point scale ranging from 1 (absolutely neutral) to 7 (highly emotional). A fixation point was displayed at the centre of the screen for one second, then words were presented in a random order at the centre of the screen for one second each, after which participants provided their evaluation. Following this, participants completed the questionnaires.

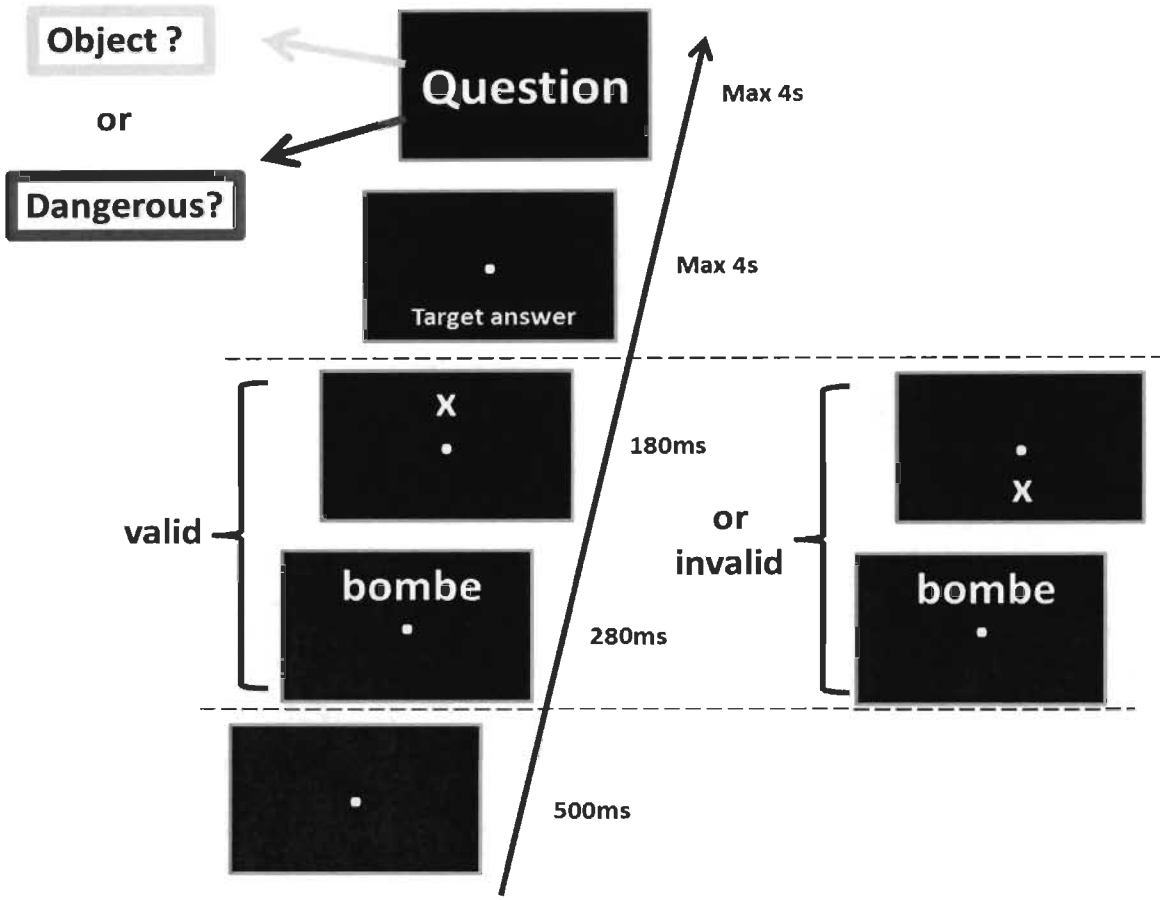

Figure 7. Trial structure. A trial started with a fixation point presented for 500ms. The cue (threatening or neutral word) then appeared for 280ms, followed by the target to be detected, which was presented for 180ms. The target was an 'x' or a '+'. After detecting the target type, a question about the cue-word presented previously was asked. The question was either semantic (Is it an object?) or emotional (Is it dangerous?), constant within a block and known by the participant before to start a block.

Data analysis. The analyses included 64 participants (12 women; $M_{age} = 22.7$, $SD = 2.9$). One participant left the testing session before the end and was excluded. One participant was excluded from analyses because he failed to reach a minimum accuracy of 75% in target detection and two failed to reach the same level of accuracy in the answer to the question about the cue. The same level of accuracy was required (75%) in answering the questions about the cues. We used this level of accuracy for the target detection and

in answer to the question because we wanted to be sure that the participants had performed both tasks adequately, and not focused on one to the detriment of the other. This level of accuracy has been used in other similar studies (Busse & Whiteside, 2012; D'Angiulli, Herdman, Stapells, & Hertzman, 2008; Dufor, Serniclaes, Sprenger-Charolles, & Démonet, 2007). The main behavioral dependent measure was participants' reaction times to determine target type. We considered average mean per condition, including only correct answers (96%). Reaction times lower than 250ms were excluded as well as those greater than two standard deviations above the individual mean of each participant to reduce the influence of outliers (Mogg, Holmes, Garner, & Bradley, 2008). We performed an analysis of variance on the average reaction time to determine the impact of cue type (threatening, neutral) and processing strategy (emotional, semantic) as well as validity condition (valid, invalid). We then conducted correlational analyses to investigate the impact of participants' emotional state on reaction times.

Results

Questionnaires

Table 7 presents descriptive statistics of self-report questionnaires for 64 police officers. Table 8 presents correlations between self-report questionnaires in the police trainees sample. There were strong correlations between the scales. Results suggest that there is a high comorbidity between anxiety, depression and PTSD symptoms as reported in others studies (Ginzburg, Ein-Dor, & Solomon, 2010; Kar & Bastia, 2006).

Table 7

Descriptive statistics of questionnaires for 64 police trainees

Questionnaire	Mean	Median	Standard deviation	Minimum	Maximum
STAI-B (trait anxiety)	37.2	37.0	8.0	21	60†
BDI-II (depression)	6.3	5.0	4.7	0	25†
PCL (post-traumatic stress symptoms)	26.5	25.5	6.9	17	54†

Notes. † Only one participant had a score of 60 on the trait anxiety scale (2nd highest score being 51) and the same participant had a high score of 25 on the depression scale (2nd highest score is 15) and still the same one had a high score of 54 on the post-traumatic stress symptoms scale (2nd highest score is 45). Exclusion of this participant did not change the results, the three-way interaction did not remain significant $F(1, 62) = 1.65$, $p = .2$, $\eta^2_p = 0.026$ and the significant two-way interaction was still present $F(1, 62) = 11.1$, $p = .001$, $\eta^2_p = 0.15$.

Table 8

Pearson correlations between questionnaires for 64 police trainees

Questionnaire	BDI-II	PCL
STAI-B	0.51**	0.46**
BDI-II		0.62**

Notes. $*p < .05$; $**p < .01$

Behavioural results. An analysis of variance conducted on reaction times revealed a non significant three-way interaction between validity condition (valid vs. invalid), cue type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1,63) = 1.99, p = .16, \eta^2_p = 0.03$[1] but a significant two-way interaction between cue type and processing strategy $F(1,63) = 11.63$, $p = .001$, $\eta^2_p = 0.16$, and no other significant effect (see Figure 8). For the two-way interaction, post-hoc analyses showed that when the processing strategy was emotional, reaction times were statistically faster when the cue was threatening compared to neutral $t(63) = 2.37$, $p = .02$, $d = 0.59$. When the processing strategy was semantic, reaction times were faster when the cue was neutral compared to when it was threatening $t(63) = 2.64$, $p = .01$, $d = 0.67$. Additional analyses showed that in the threatening cue condition, reaction times were faster when the processing strategy was emotional compared to semantic, $t(63) = 2.58$, $p = .01$, $d = 0.63$. To sum up, when the processing strategy was emotional, participants were faster to detect

[1] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

the target when it was preceded by a threatening cue, regardless of its spatial location. When the processing strategy was semantic, the threatening cue slowed down target detection, regardless of its spatial location.

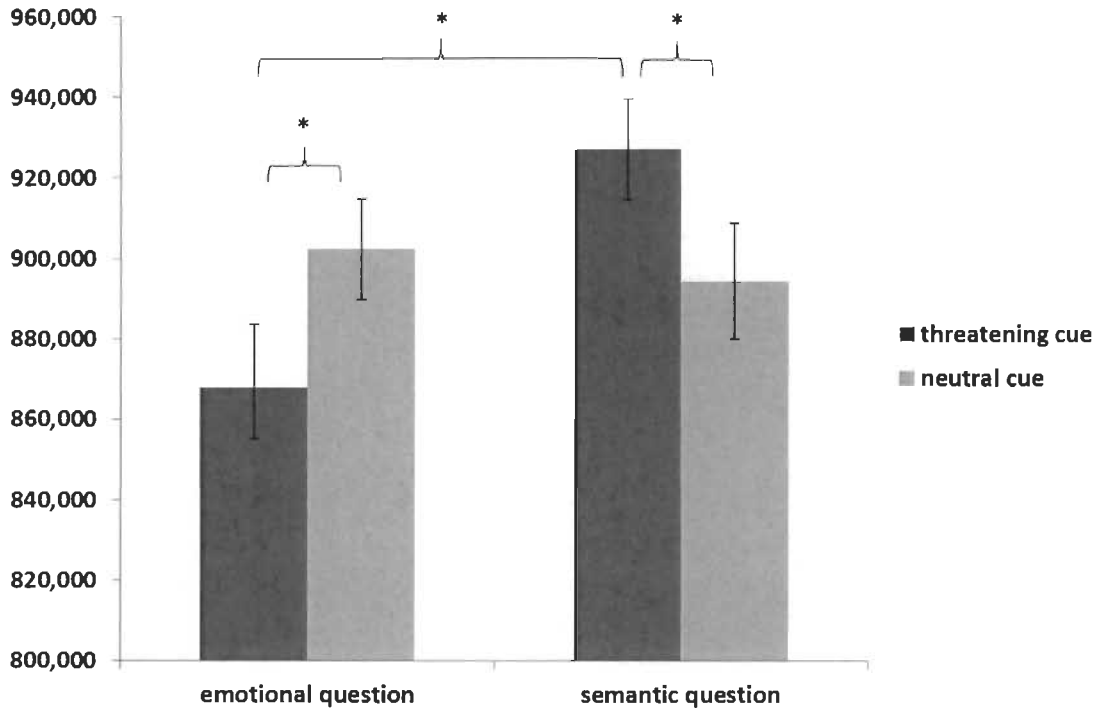

Figure 8. Reaction time to detect the target according to the different experimental conditions for police trainees. Error bars can not represent the standard error or confidence intervals because there is no inter-subject variability here (Cousineau, 2005). Consequently we applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014). *$p < .05$.

Link between questionnaires and performance on the attention task. In the correlational analyses, we considered reaction times averaged for valid and invalid conditions, separately for the different cue types and processing strategy conditions. We examined whether these were correlated with questionnaire scores.

Table 9

Pearson correlations between reaction times averaged for valid and invalid conditions and questionnaires on 64 police trainees

	STAI-B	BDI-II	PCL
Reaction times averaged: threatening cue and emotional question	0.26*†	0.28*†	0.16
Reaction times averaged: neutral cue and emotional question	0.22	0.19	0.15
Reaction times averaged: threatening cue and semantic question	0.24	0.18	0.26*†
Reaction times averaged: neutral cue and semantic question	0.21	0.16	0.23

Notes. *$p < .05$.

† If we remove the one participant with the highest score on PCL, anxiety and depression scales, all correlations did not exceed .19 and all $p > .1$.

Table 9 presents all correlations. It is important to note that we removed one participant (the one with the highest score on anxiety, depression and PCL scales). We did not observe any correlation between reaction times in the cueing task and questionnaires scores. It seems that performance in the attention task was not modulated by trait anxiety, depression or post-traumatic stress symptoms in this sample of police trainees.

Results of cue evaluations. The threatening words used as cues were evaluated as more emotional than the neutral cues ($M_{\text{eval neutral}} = 1.12$, $SD = 0.05$; $M_{\text{eval threatening}} = 5.27$,

SD = 0.53; $F(1, 46) = 1452.62$, $p < .001$). We examined whether these evaluations were linked to post-traumatic stress symptoms, as indexed by the PCL scores. This showed no statistically significant relationship between PTSD symptoms and the evaluation of neutral, $p > .05$, or threatening words, $p > .05$.

Discussion

This first experiment showed that police trainees detected targets presented after threatening stimuli more efficiently when the question was emotional regardless of its spatial location. It was the contrary when the processing strategy was semantic: police trainees were faster to detect the target after neutral stimuli, regardless of its spatial location. It is possible that processing strategies influence the way that attentional resources will be deployed. A strategy focused on emotional or semantic dimension of stimuli could recruit specific attentional network in order to process preferentially stimuli in congruence with the expectations induced by processing strategy. This allocation of attentional resources was not modulated by affective state of police trainees. It seems important to see if we can replicate these results with police officers who have more field experience. This is the aim of Experiment 2.

Experiment 2

Method

Participants. Participants were 53 police officers from the Service de Police de la Ville de Québec (17 women; M_{age} = 38.1, SD = 7.7). The finale sample of 46 participants

(see data analysis) was composed of 12 patrollers (4 women; M_{age} = 32, SD = 5.36), 15 investigators (6 women; M_{age} = 42.33, SD = 4.42), 7 with others functions as team supervisor (4 women; M_{age} = 41, SD = 7.68) and 12 did not answer this question. Patrollers had on average 9.41 years of service (SD = 4.25, MIN = 4, MAX = 17), investigators had 20.33 years of service on average (SD = 4.3, MIN = 14, MAX = 27) and others had 17.36 years of service (SD = 7.65, MIN = 9, MAX = 29). Exclusion criterion was not to have normal or corrected to normal vision. We took into account their length of service because more field experience means increased exposure to potentially traumatic events and post-traumatic stress symptoms, which may alter the processing of emotional information.

Material

Stimuli, questionnaires and procedure. We used exactly the same stimuli, apparatus, questionnaires and procedure as those used in Experiment 1. The coefficients of alpha of Cronbach in the present sample were 0.92, 0.83 and 0.83 for the PCL, BDI-II and STAI-B respectively.

Data analysis. The analyses included 46 participants (16 women; M_{age} = 38.3, SD = 7.2). Two participants were excluded from analyses because they failed to reach a minimum accuracy of 75% in target detection and five participants failed to reach the same level of accuracy in the answer to the question. We determined the 75% level of accuracy as a threshold for both the target detection and the answer of the question because

we wanted to be sure that participants were performing both tasks equally well. The main behavioral dependent measure was participants' reaction times to determine target type. We considered average mean per condition, including only correct answers (95%). Reaction times lower than 250ms were excluded as well as those greater than two standard deviations above the individual mean of participants to reduce the influence of outliers (Mogg et al., 2008). We performed an analysis of variance on the average reaction time to determine the impact of cue type (threatening, neutral) and processing strategy (emotional, semantic) as well as validity condition (valid, invalid). We then conducted correlational analyses to investigate the impact of participants' emotional state on reaction times.

Results

Questionnaires. Among the 46 police officers who participated in the study, 11 participants did not have time to complete questionnaires but were included in the other analyses.

Table 10 presents descriptive statistics of self-report questionnaires and Table 11 presents correlations between self-report questionnaires for 35 police officers.

Table 10

Descriptive statistics of questionnaires for 35 police officers

Questionnaire	Mean	Median	Standard deviation	Minimum	Maximum
STAI-B (trait anxiety)	34.9	35	6.7	25	52†
BDI-II (depression)	5.1	4	4.0	0	19†
PCL (post-traumatic stress symptoms)	26.6	25	8.8	17	65††

Notes. † Only one participant had a score of 52 on the trait anxiety scale (2nd highest score being 48) and the same participant had a high score of 19 on the depression scale (2nd highest score is 11) and another participant had a high score of 65 on the post-traumatic stress symptoms scale (2nd highest score is 38). Exclusion of participants (11 without questionnaires scores and 2 with high scores from 46 participants in analysis) change a little bit the results, the three way interaction remained not significant $F(1, 32) = .11$, $p = .75$, $\eta^2_p = 0.003$ and the significant two way interaction was still present $F(1, 32) = 3.77$, $p = .06$, $\eta^2_p = 0.11$.

Table 11

Pearson correlations between questionnaires for 35 police officers

Questionnaire	BDI-II	PCL
STAI-B	0.72**	0.63**
BDI-II		0.52**

Notes. It is important to note that 11 participants were not included because they did not have time to complete questionnaires so we had miss data. *$p < .05$; **$p < .01$.

Behavioural results. An analysis of variance conducted on reaction times revealed a non significant three-way interaction between validity condition (valid vs. invalid), cue

type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1, 45) = 1.71$, $p = .20$, $\eta^2_p = 0.04$[1], but a significant two-way interaction between cue type and processing strategy $F(1,45) = 5.83$, $p = .02$, $\eta^2_p = 0.11$ (see Figure 9). There was also a significant main effect of validity ($M_{valid} = 953.4$ ms, $SD = 34.63$; $M_{invalid} = 976.53$, $SD = 35.03$; $F(1,45) = 6.27$, $p = .02$, $\eta^2_p = 0.12$) and a marginally significant effect of cue type, $F(1,45) = 3.5$, $p = .068$, $\eta^2_p = 0.07$. For the two-way interaction, post-hoc analyses showed that when the processing strategy was emotional, reaction times were faster when the cue was threatening compared to neutral $t(45) = 3.07$, $p = .004$, $d = 0.91$. When the processing strategy was semantic, reaction times were not significantly different in the neutral cue and threatening cue conditions, $t(45) = .21$, $p = .83$, $d = 0.06$. Additional analyses showed that when the cue was threatening, reaction times were faster when the processing strategy was emotional compared to semantic, $t(45) = 2.04$, $p = .047$, $d = 0.59$. To sum up, when the processing strategy was emotional, participants were faster to detect the target when it was preceded by a threatening cue, regardless of its spatial location. This was not the case when participants answered the semantic question.

[1] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

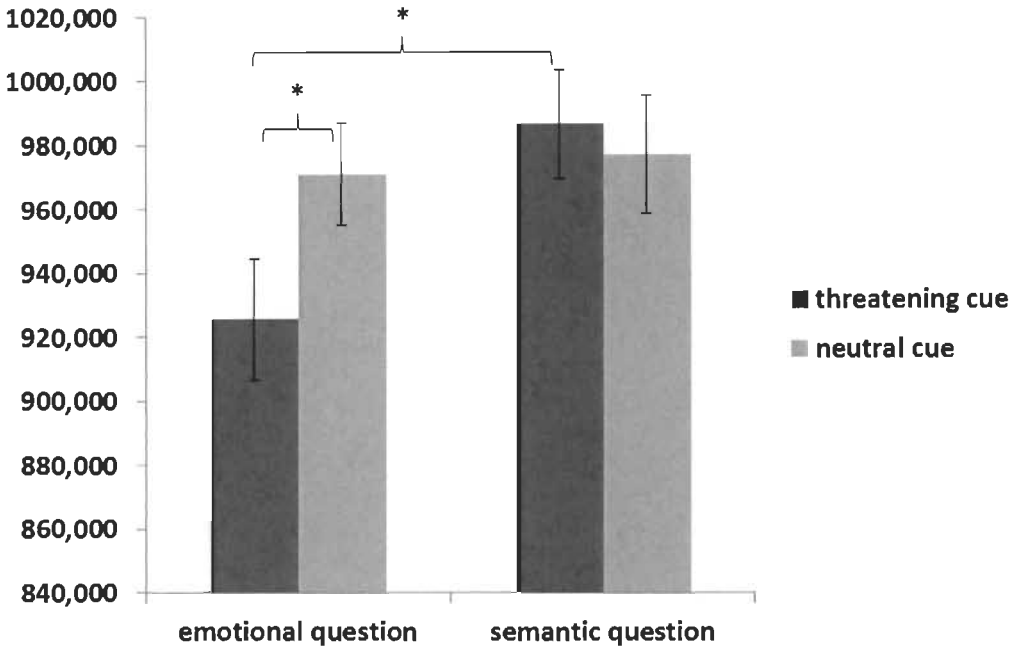

Figure 9. Reaction time to detect the target according to the different experimental conditions for police officers. We applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014). *$p < .05$.

Link between questionnaires and performance on the attention task. In the correlational analyses, we considered reaction times averaged for valid and invalid conditions, separately for the different cue types and processing strategy conditions. We examined whether these were correlated with questionnaire scores.

Table 12

Pearson correlations between reaction times averaged for valid and invalid condition and questionnaires on 35 police officers

	STAI-B	BDI-II	PCL
Reaction times averaged : threatening cue and emotional question	-0.06	-0.07	-0.05
Reaction times averaged : neutral cue and emotional question	-0.12	-0.13	0.08
Reaction times averaged : threatening cue and semantic question	-0.01	-0.04	0.09
Reaction times averaged : neutral cue and semantic question	-0.10	-0.14	-0.06

Notes. $*p < .05$.

Table 12 presents all correlations. There were no significant correlations between reaction times and questionnaire scores. In this study as in the previous one, performance in the attention task was not modulated by trait anxiety, depression or post-traumatic stress symptoms with police officers.

Discussion. This second experiment showed that police officers detected targets presented after threatening stimuli more efficiently when the question was emotional, regardless of the spatial location of the threatening stimuli. When the processing strategy was semantic, there was no significant difference between neutral and threatening cues presented before the target. Results were the same with police officers and trainees when

the question was emotional. Slowing down of threat after semantic question seems specific to trainees.

General Discussion

This study showed a general, non-spatial, vigilance effect following threatening stimuli which occurred only when the processing strategy focused on the emotional dimension of stimuli. This was evident in faster RTs among police trainees and officers to detect targets that followed threatening cues, regardless of their location. The way in which attentional resources are preferentially activated by threatening cues, allowing faster target detection, seems to depend on internal strategic processes generated here by the type of question asked about the cues. This suggests that police trainees and officers' goals while doing the task modulates the activation of attentional resources generated by threatening information. Moreover, this allocation of attentional resources activated by threatening cues observed with emotional questions was not modulated by PTSD symptoms. In other words, emotional reactions related to potentially traumatic events did not appear to play an important role in modulating the allocation of attentional resources activated by threatening stimuli with an emotional or semantic processing strategy, with police trainees and officers too.

This study shows, for the first time, that processing strategies induced during a cueing paradigm influence the deployment of attentional resources in relation to threatening stimuli. There is a debate in the literature concerning the automatic nature of threat

detection (Pessoa, 2010). Automatic processing is conceptualized as being involuntary, requiring few cognitive resources and to operate in parallel and without consciousness (Matthews & Wells, 2000). Attentional deployment in relation to threatening stimuli could be considered automatic if it was not modulated by induced strategies. However, our results do not support the automatic nature of threat processing because attentional vigilance activated by threatening stimuli did not occur when the processing strategy was focused on the semantic dimension of the stimuli, in police officers. Moreover, with police trainees we even observed a privileged attentional deployment for target detection preceded by neutral cues, compared to threatening cues, when a semantic processing strategy was induced. A congruence effect on emotional component between processing strategy and cue type possibly induced an attentional deployment allowing an efficient target detection for future police officers with less field experience. However, we need to see if this effect could be replicated in other studies. For police officers with field experience, attentional resources can be activated by threatening cues only with emotional processing strategy for a better target detection. So, there is a modulation of attentional resources by processing strategy.

In addition to processing strategy, level of expertise of participants may also influence attentional orientation. A recent study examined how police officers' level of expertise in the management of a hostile crowd improved threat detection abilities (Damjanovic, Pinkham, Clarke, & Phillips, 2014) . This skill is important for police officers to react as quickly and appropriately as possible, should a dangerous person enter the visual

environment. In a visual search paradigm involving the detection of faces, experienced police officers were better at detecting threatening faces, and were also better at inhibiting the processing of threatening distractors to detect neutral targets. Police trainees took longer to detect happy faces among threatening distractors than to detect threatening faces among happy distractors. By contrast, experienced police officers were not slowed down by threatening distractors. This data could be interpreted as suggesting that experienced officers rely on a different information processing strategy from trainee officers. Our work is consistent with this view as trainee officers relied on both contextual strategies to perform the task, whereas the experienced officers selectively engaged their attentional resources more with the emotional strategy whilst ignoring the semantic one.

In this study, we did not observe that the effect of threat was spatially based. There was no advantage for targets to be spatially cued, no matter the processing strategy and cue type. This result is in contradiction with space-based theories of attention, which suggest that location cues improve the allocation of attentional resources (Posner, Snyder, & Davidson, 1980). It also conflicts with a number of empirical results showing attentional prioritization of locations spatially cued by threatening stimuli. One possible explanation for our lack of spatial validity effect rests with zoom lens theories (Theeuwes, 1989). It is possible that processing strategy may lead to a broadening of the attentional spotlight, allowing participants to be alert and detect a target more efficiently, even if it has not been spatially cued (by a threatening or neutral cue). The fact that a main effect of validity was observed in the police officers group but not in the trainees could suggest

differences between these groups in the ability to manage the broadening of the attentional spotlight under the influence of processing strategies. It is also possible that spatial cueing effects may only be present under specific visual conditions. Ducrot and Grainger (2007) suggest that validity effects should be less present in central vision (which is what was involved in our task), compared to peripheral vision. This means that in central vision, participants should be equally able to deploy their attentional resources across a visual area and as easily process all targets of interest.

Our results are also consistent with a number of studies showing that inducing processing strategies can modify neurobehavioral responses related to emotion (Bekkering & Neggers, 2013; Belardinelli, Herbort, & Butz, 2015; Critchley et al., 2000; Gorno-Tempini et al., 2001; Gur et al., 2002; Hodsoll & Humphreys, 2001; Ochsner & Gross, 2005; Taylor, Phan, Decker, & Liberzon, 2003). Specifically, our findings show that promoting an affective processing strategy can act as a cognitive filter impacting attentional resources towards a target preceded by threat with future police officers without field experience and with police officers with field experience.

We observed that the general vigilance effect in future police officers and police officers was not modulated by PTSD symptoms and other affective traits including anxiety and depressive symptoms. This contrasts with results of other studies suggesting that individuals exposed to certain forms of trauma, including sexual abuse, show increased vigilance towards generally threatening stimuli (Pollak & Tolley-Schell, 2003) and stimuli

specifically related to trauma (Caparos & Blanchette, 2014; Latack et al., 2017) and this may be related to PTSD symptoms. Other studies show that the allocation of attentional resources toward negative information is modulated by trait anxiety (Fox, Russo, Bowles, & Dutton, 2001; Yiend & Mathews, 2001) or depression (Peckham, McHugh, & Otto, 2010). The discrepancy between ours and these other findings could be explained by processing strategies. It is possible that inducing the use of a processing strategy masks any modulation of attention towards threat by emotional state. For instance, affective state like PTSD symptoms might pre-activate rigid networks (internal control system) priming the processing of threatening stimuli. This rigid network may be overridden by the one imposed by behavioral goals (flexible network) when processing strategy is used. Furthermore, the affective state of people could generate expectations about threatening stimuli, which would determine the emotional reaction to that stimulus and prioritize specific stimuli. Processing strategies could change the initial appraisal of stimuli and suppressed the attentional priority created by emotional state.

Our data have potential implications for the training of police officers. Induced processing strategies could be used within simulators or on the ground training to enhance the efficiency of trainees and officers at detecting threat. The training of future police officers often consists of repeated practice at a particular task, for example with shooting simulators, to improve precision and automaticity. This is often done without necessarily having a clear processing strategy. Inducing specific processing strategies could make the training more efficient possibly by minimizing the impact of individual differences in

expertise or emotional state, and make threat detection more homogeneous. For instance, police trainees could be trained to use the emotional processing strategy during a hostage situation as well as patrols with occurrence of threatening stimuli. This is in order that police trainees be more prepared to react with a concrete way of thinking, instead of being always in screening without knowing what to search exactly. The use of processing strategy could help police to have a way of thinking during their duty. More investigations are needed to determine if the use of processing strategies can be used at every time or if the repeated use of specific strategy becomes less effective over a long time.

It is, however, important to mention that in our paradigm, participants had to detect a target and then answered a question concerning the cue that had been presented previously. It is difficult to know exactly how the person proceeded to complete the task. Participants may have kept the cue in memory during the target detection phase, or they may have tried to remember the cue after detecting the target. The first strategy could explain the fact that average target detection was relatively long (995ms) compared to other studies using a similar paradigm without the induced processing strategy (e.g. in the study by (Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007) (400ms). If participants were indeed maintaining items in working memory, this would require attentional resources and could lead to increased reaction times. There is a possible alternative explanation for the faster reaction times to detect target after the presentation of a threatening cue. Indeed, emotion elicited by the threatening nature of stimuli could increase the processing of the next stimuli, so the target, relatively to when the cue was

neutral. Also the use of these different procedures may explain why there was relatively high variability in RTs to detect the target (SD=334 ms) compared to Koster et al. (2007) (50 ms). It must be noted, however, that this dual task situation, where participants had to detect a target while also answering a question about the cues, is probably representative of many real-world situations that police officers face. Indeed, threat detection in real environments must often be done in parallel with other tasks. The effects we have observed may or may not be specific to police officers. We decided to study police officers because threat detection is particularly relevant to this type of work and that their training may be enhanced by modulation strategies. It is possible that similar effects may be observed for civilians, possibly under conditions when vigilance is required, or effects may be specific. Future studies will be necessary to determine this.

In conclusion, we found a general vigilance effect resulting in the faster detection of targets that were preceded by threatening stimuli, regardless of spatial location, when an emotional processing strategy was induced among police trainees and officers. This effect was not observed when a semantic processing strategy was induced. The effect was also not modulated by individual differences in affective traits or states. Our results suggest that the involvement of internal control mechanisms generated by processing strategies can influence attentional mechanisms and may minimize the impact of expertise, emotional experiences and spatial prioritization of threatening stimuli. Our study provides new insights into the mechanisms underlying threat detection.

Acknowledgments

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Conflict of Interest

We declared to have no conflict of interest for this research.

Appendix A. Words list

Neutral words	Emotional valence score	Threatening words	Emotional valence score
assiette	1.10	agression	4.27
ballon	1.11	**arme**	4.31
carotte	1.07	**assassin**	4.75
castor	1.08	attaque	3.81
chaise	1.04	attentat	5.18
chameau	1.15	**bombe**	5.10
chapeau	1.07	**braquage**	3.89
classeur	1.11	brutalité	4.03
feuille	1.07	cancer	4.54
fromage	1.30	**deuil**	4.41
gomme	1.11	**explosion**	4.56
kangourou	1.24	fusillade	5.69
lapin	1.18	**grenade**	4.34
manteau	1.14	homicide	4.51
noix	1.13	menace	3.46
pelle	1.23	**meurtre**	5.38
pied	1.13	mort	5.03
poule	1.07	**otage**	5.14
seau	1.10	**sida**	3.97
table	1.06	**suicide**	5.04
tapis	1.04	terroriste	5.17
tomate	1.08	tuer	5.45
vase	1.13	tumeur	4.25
verre	1.20	**viol**	5.41

Words in bold were presented in the semantic processing strategy bloc.

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Article 3

The influence of an emotional processing strategy on visual threat detection by police trainees and officers

The influence of an emotional processing strategy on visual threat detection by police trainees and officers [1]

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Abstract

Threat detection is an important skill for police officers but few studies have examined the impact of processing strategies on this ability. The first aim of our study was to compare the visual detection of threatening and neutral targets in 38 police trainees (Experiment 1) and 53 police officers (Experiment 2). The second aim was to examine the effect of strategies encouraging more emotional or semantic processing on this process. In a visual search task, participants had to quickly detect a threatening or neutral target among neutral distractors. Participants answered a question used to induce a more emotional or semantic processing strategy. Results revealed that threatening targets were detected faster than neutral ones, and this effect was enhanced with an emotional processing strategy. This study shows that inducing processing strategies can influence attentional mechanisms related to threat detection in police trainees and officers.

Keywords: *Visual attention; Threat superiority effect; Top-down processing strategies; Visual search task; Police.*

Introduction

In order to survive, people must be able to detect threatening information quickly and adjust their behavior adequately. This ability is very important for everybody in daily life but may be especially important for police officers who face many potential dangers and situations in which their lives or other people's lives are at risk. Until now, little research has examined the possibility of modulating attentional mechanisms to alter police officers' ability to detect threatening stimuli. The first aim of our study was to compare the orientation of attention towards threatening and neutral targets in police trainees (Experiment 1) and police officers (Experiment 2). The second aim was to examine the effect of strategies encouraging more emotional or semantic processing on this process. The third aim was to determine if the influence of processing strategies on threat detection is modulated by anxiety, depression or PTSD symptoms.

Studies have shown that emotional visual information receives privileged attentional processing. This phenomenon has been demonstrated with different paradigms. In the Rapid Serial Visual Presentation (RSVP) paradigm, two targets are presented separated by distractors in a continuous and rapid presentation. The second target can be more difficult to identify than the first, if it follows in close temporal proximity, an effect termed the attentional blink phenomenon (Shapiro, 1994). Anderson (2005) manipulated the emotional valence of the second target, presented after a neutral target. Participants identified the second target better when it was emotional compared to neutral. Furthermore, this attenuated attentional blink effect was greater when the interval between

the two targets was shorter. This benefit in processing emotional information in the RSVP paradigm has also been found with faces (Luo, Feng, He, Wang, & Luo, 2010).

The privileged attentional processing of emotional stimuli has also been examined with other paradigms such as the cueing paradigm (Stormark, Nordby, & Hugdahl, 1995) and the emotional Stroop task (Thomas, Johnstone, & Gonsalvez, 2007). In the first task, a cue is presented, followed by a target that appears in the same location (valid condition) or in another location (invalid condition). Fox, Russo, Bowles, and Dutton (2001) presented words as cues on the left or right side of a central fixation cross. Participants had to identify a target that appeared following the cue-word. If attention is attracted by the cue, participants should be faster to detect the target in the valid condition, because attention is already oriented to that location. This validity effect is even more pronounced when the cue is threatening relative to neutral (Stormark et al., 1995). In the emotional Stroop task, words are presented in different colours. Participants have to name the colour in which emotional or neutral words are written as quickly as possible (Yiend, 2010). Results show that reaction times (RTs) are longer for emotional words relative to neutral words (Ray, 1979), which is interpreted as indicating that greater attention is paid to the content of these emotional words (Yiend, 2010), even if emotion is irrelevant to the task. This suggests that it is difficult for people to ignore emotional meaning, leading to attentional interference (D'Hondt et al., 2013; Schmidt, Belopolsky, & Theeuwes, 2014; Vuilleumier, 2005). In this way, a number of studies have established that the allocation of attentional resources towards threatening stimuli is prioritized; this can be considered

as an attentional bias towards threat, a concept also termed the threat superiority effect (Blanchette, 2006).

The fact that threatening stimuli attract attentional resources more efficiently than neutral stimuli has been examined with another task called the visual search task. This task allows the examination of the ability to detect stimuli in visual space, in contrast with the others tasks presented before that do not include an important spatial component. In the visual search task, a target has to be detected amongst distractors. Participants are faster to detect threatening targets amongst neutral or emotional distractors and slower to detect neutral targets amongst threatening distractors (Öhman, Flykt, & Esteves, 2001; Öhman, Lundqvist, & Esteves, 2001). Hansen and Hansen (1988) considered this effect to be automatic, in the sense that the process is not affected by intentions or strategies and not dependent of the availability of resources (Pessoa, Pereira, & Oliveira, 2010). However, other researchers questioned these conclusions, suggesting that the results could not be interpreted as supporting automaticity, because the emotional targets were clearly different in terms of visual features, for instance colour or size (Vuilleumier, 2005). Despite this, other studies have shown that even when perceptual differences between neutral and emotional stimuli are controlled for, emotional stimuli still capture attention (Calvo & Lang, 2004). One suggestion is that a coarse impression of emotional scenes, an emotional gist (Calvo, Nummenmaa, & Hyona, 2008), can be extracted amongst others stimuli in competition and the more distractors there are, the longer the detection should take. So, the question of whether emotional stimuli are processed automatically or not is

still an open question. If the processing of emotional stimuli is not entirely automatic, it could be modulated by intentions or strategies.

The orientation of attentional resources is driven by salience, the quality by which an aspect of the environment stands out relative to its surroundings (Todd, Cunningham, Anderson, & Thompson, 2012). Bottom-up processing reflects sensory stimulation, such as stimulus salience (Hsu & Pessoa, 2007). In bottom-up processing, the orientation of attentional resources is mainly determined by the properties present in the environment, independently of the goals of the individual (Theeuwes, 2010). Attentional capture is stimulus-driven and occurs even if the individual tries to select another information. However, basic bottom-up effects can be inhibited in some situations, depending on momentary intentions or strategies. For instance, if a person has to detect a red target among blue distractors, general instructions provided for the tasks, which induce strategic goals, can modulate bottom-up effects resulting from target salience. Henderson, Malcolm, and Schandl (2009) presented visual scenes containing non-salient target objects and salient regions. Participants had to detect the target, cued by a picture or a word. Search was fast and efficient, with participants much more likely to look at the targets than the salient regions. Egner, Monti, and Summerfielkd (2010) presented faces or houses while participants had different levels of expectation for faces. Their results show that under high face expectation, brain responses (fusiform face area) were indistinguishable whether a house or a face was presented. These top-down effects illustrate how the attentional system can be influenced by task goals, as well as general

knowledge, and that these strategic considerations can help individuals to differentiate between targets and distractors (Hodsoll & Humphreys, 2001; Wolfe, Butcher, Lee, & Hyle, 2003).

There are two kinds of top-down strategies: implicit and explicit ones (Wolfe et al., 2003). Implicit top-down processing occurs in situations where, for example, a central cue indicates the spatial location of an upcoming target (Posner, 1980). The term implicit refers to the fact that participants are not told explicitly (for instance verbally) where the target will be presented, but that expectations set by the general context alter target processing without effortful processing (Wolfe et al., 2003). Explicit top-down processing refers to circumstances where participants have to perform a task and are informed, a priori, about the nature of the target. Results show a clear beneficial effect of explicit top-down guidance, as well as implicit top-down influences, on target detection (Egner et al., 2010; Wolfe et al., 2003). These types of studies suggest that attentional resources can be modulated by the goal of the person, which helps extract the relevant information for the task (Belardinelli, Herbort, & Butz, 2015; Belardinelli, Stepper, & Butz, 2016).

Huang, Baddeley, and Young (2008) showed that processing strategies can modulate attentional capture by emotional stimuli. In a modified RSVP task, participants were asked to detect a specific word target. Participants had to process information based on a semantic (report a fruit word), perceptual (identify a word in uppercase), or phonological (report a word that rhymes with 'pear') feature. When semantic processing was induced,

target detection was reduced if the target was preceded by an emotional distractor relative to a neutral distractor. This was not the case when phonological or perceptual processing was induced. These results suggest that emotional distractors caused more interference with the identification of the target but only when a semantic processing strategy was used. In this way, this study shows a modulation of the allocation of attentional resources towards emotional stimuli by top-down processing strategy (Frewen, Dozois, Joanisse, & Neufeld, 2008). Specific mechanisms related to processing strategy may serve to modulate responses to emotional stimuli (Vuilleumier & Huang, 2009). Here we examine the impact of an emotional processing strategy, relative to a semantic one. Research shows that modulating the activity of the amygdala by priming emotional concepts can alter subsequent visual processing (Pichon, Rieger, & Vuilleumier, 2012). An emotional processing strategy would directly engage the amygdala, which is activated to a greater extent when participants aim to determine the emotional significance of a stimulus. Stein, Zwickel, Ritter, Kitzmantel, and Schneider (2009) also showed that when participants had to determine the emotional expression of a face, fearful faces induced a stronger attentional blink (in a RSVP paradigm) compared to neutral faces; but this enhancement disappeared when participants had to judge the gender of faces. Voluntary emotional processing strategies might thus increase the impact of emotion on attention (Vuilleumier & Huang, 2009). Here we investigate how this applies in the reality of police work, specifically for threat detection. We compare the use of a strategy that promotes emotional information processing to a strategy that is less likely to promote such focus on emotion, focusing instead on semantics.

In the context of police work, it is important to consider another factor that can affect attention towards threat. Affective state can also modulate attentional processes, more specifically, attentional deployment towards emotional stimuli. Quigley, Nelson, Carriere, Smilek, and Purdon (2012) presented two pictures simultaneously. One was neutral and the other was positive or threatening. Their results show that in individuals experiencing high state anxiety, the duration of the first fixation toward threatening pictures was longer than in those with low state anxiety. In a dot-probe task where the spatial location of a target (a dot) should be detected after the presentation of two stimuli (one neutral and one emotional), high anxious participants showed an attentional orientation toward threatening stimuli, as evidenced by faster RTs when the target appeared in the same location as the threatening image. This effect has been observed with pictures, faces and words (Frewen et al., 2008). According to the Attentional Control Theory of Eysenck, Derakshan, Santos, and Calvo (2007), anxiety depletes the goal-directed attentional system and increases the ability of any external stimuli to attract attention. As a consequence, anxiety increases the processing of task-irrelevant threatening information (Eysenck et al., 2007). Other studies suggest that depression also influences attentional processes (Peckham, McHugh, & Otto, 2010). Altogether there is strong evidence in the literature that the allocation of attentional resources can be dependent on affective state and, more specifically, that the threat superiority effect could be modulated by anxiety and depression.

Symptoms related to PTSD can also influence attention. For instance, in one study using an emotional Stroop task, veterans with PTSD symptoms were longer to name the colour of words related to combat than neutral words (Khanna et al., 2017). Veterans without PTSD symptoms showed no difference in color-naming latency between words related to combat and neutral words. In a visual search task where words were used as stimuli, PTSD symptoms were associated with interference by threat-relevant distractors; however there was no evidence of facilitated detection of threatening words (Pineles, Shipherd, Welch, & Yovel, 2007). However other studies have found evidence of an attentional bias towards threat and no evidence of avoidance of threatening stimuli in PTSD (Felmingham, Rennie, Manor, & Bryant, 2011). Yet another study showed increased attentional capture by threatening cues and difficulty in disengaging from threat (Olatunji, Armstrong, McHugo, & Zald, 2013). All these studies show the importance of considering the impact of PTSD symptoms on attentional threat processing. One explanation for the heterogeneity of the results is the possibility that different levels of PTSD are associated with different processing strategies. To our knowledge, this hypothesis has not yet been considered in the literature. Furthermore, PTSD symptom severity is positively associated with heightened amygdala activity (Shin, Rauch, & Pitman, 2006) and exposure to anxiogenic contexts produce intense responses of the amygdala to negative stimuli (van Marle, Hermans, Qin, & Fernández, 2009; Williams et al., 2006). The modulation of the activity of the amygdala by the affective state of participants, combined with the use of a processing strategy that largely involves the amygdala could produce a sensitization to detect threatening stimuli.

To study attention to threatening stimuli in police workers, it is important to consider their level of expertise. Indeed, research shows that riot police officers exhibit a larger threat superiority effect than unspecialized trainee police officers and control participants (Damjanovic, Pinkham, Clarke, & Phillips, 2014). Furthermore, these experienced officers showed greater inhibitory control over threatening distractors in visual search relative to the other two groups. This indicates that experienced officers may rely on a different information processing strategy than trainee officers and controls. Police trainees must learn to become effective at processing threatening stimuli. Their training relative to shooting, the use of force, and management of domestic conflict can shape the way they process threatening stimuli. Yet they may be affected by induced strategies to a greater or lesser extent. Therefore, it is relevant to study attention to threat both with police trainees and police officers.

In short, there is privileged attentional processing of threatening information compared to neutral information. This threat superiority effect could be modulated by top-down processing strategies, although this has rarely been studied. Affective states or traits also influence attention to threat. These two types of effects have not been studied together nor have they been examined in police officers and police trainees. In the current study, our first aim was to see if police trainees and officers detect threatening targets faster than neutral ones, in a visual search task. Our second aim was to examine if this threat superiority effect is modulated by the use of an emotional or semantic processing strategy. This was induced by asking participants to answer a question concerning the target to be

detected. Our third aim was to determine if the influence of processing strategies on the threat superiority effect is modulated by anxiety, depression, or PTSD symptoms. These questions are examined in two experiments, one focusing on police trainees and another on police officers. We predicted that more negative affective states (PTSD, depression, anxiety) and a more emotional processing strategy would increase the threat superiority effect.

Experiment 1

Method

Design. The main dependent variable was RT to detect the target on target-present trials. This was measured from the onset of matrix presentation (Damjanovic et al., 2014; Fox et al., 2000). This dependent variable was analyzed using a 2 (target type: threatening vs. neutral) × 2 (processing strategy: semantic vs. emotional) analysis of variance (ANOVA). We also report descriptive statistics for the questionnaires (anxiety, depression and symptoms of post-traumatic stress scale) and Pearson correlations to examine the link between them. Furthermore, correlational analyses were used to assess the relationship between questionnaires scores and threat detection.

Participants. Participants were 38 police trainees from the École National de Police du Québec (7 women; $M_{age} = 23.4$, $SD = 3.5$). Participants were recruited in school, following a brief explanation of the project provided in class. Participants who did not have normal or corrected to normal vision were excluded.

Stimuli. We used 102 different matrices of nine images (three lines * three columns). A matrix could contain nine different images of the same category (distractors) or eight different distractors of the same category and one image of a target taken from a different category. The distractors were always neutral (watering guns, pens) and targets could be threatening (guns, knives) or neutral (shelf brackets, spoons). We kept distractors constant across the different targets because we wanted to be able to see the impact of the type of target (threatening VS neutral) exclusively, not the impact of distractors type (see Figure 10). We used four exemplars of targets in nine different positions presented twice (4*9*2), so there were 72 target-present trials per block and 30 trials without a target. We did not have the same number of trials with and without a target because we wanted to save a little time and we were only interested in trials with targets. All targets (guns, knives, shelf brackets, spoons) were presented twice at the same location, randomly in one of the nine possible locations, but always with different distractors. All images were presented in black and white and were controlled for luminosity and contrast with the SHINE Toolbox with Matlab (Willenbockel et al., 2010). All stimuli had the same orientation in each matrix because we didn't want participants to be faster to detect a target due to a possible affordance (Belardinelli et al., 2015; Sartori, Straulino, & Castiello, 2011).

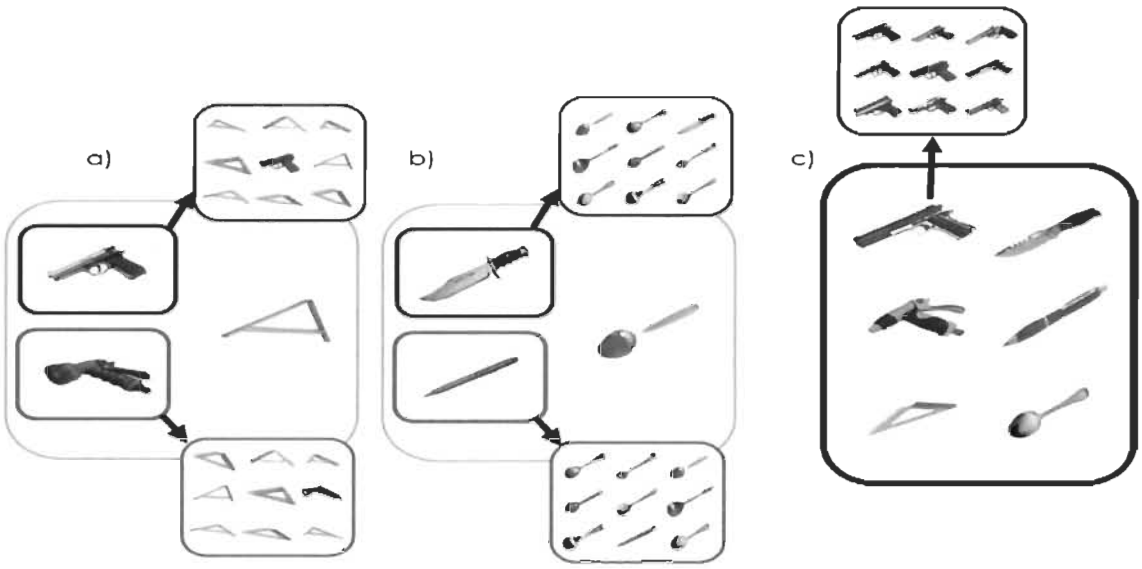

Figure 10. Presentation of stimuli in matrix. a) and b) A threatening target (gun, knife) or a neutral target (watering gun, pen) could be presented as a target with the same kind of distractors (shelf brackets or spoons) in a matrix. c) All the stimuli could be presented as one kind of distractors without target.

Questionnaires. Participants answered three self-report questionnaires that would allow us to take into account their emotional state and its influence on the task.

- *Post-Traumatic Stress Disorder scale* (PTSD Cheklist; Weathers, Litz, Herman, Huska, & Keane, 1993): This scale consists in 17 questions (e.g. How much have you been bothered by repeated, disturbing dreams of a stressful experience from the past?) that assess symptoms of post-traumatic stress. The presence of each symptom is rated on a scale ranging from 1 (not at all) to 5 (extremely). This self-report questionnaire is based on categories of DSM-IV symptoms (reliving, avoidance, autonomic hyperactivity). The alpha of Cronbach for the complete scale was 0.94 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996).

Diagnosis of post-traumatic disorder is likely when the total score is above 50 (with a minimum of 17 and a possible maximum of 85).

- *Trait Anxiety Inventory* (IASTA-Y; Gauthier & Bouchard, 1993; Spielberger, Gorsuch, & Lusthene, 1983): This scale is widely used to measure anxiety levels that are stable in time. It has an alpha of Cronbach of 0.91.
- *Beck Depression Inventory* (BDI-II; Beck, Steer, & Brown, 1996): This 21-item inventory was created based on the depression symptoms of the DSM-IV. This scale has good psychometric properties with an alpha of Cronbach of 0.91 (Beck et al., 1996; Dozois, Dobson, & Ahnberg, 1998).

Procedure. This study was approved by the Ethics Committee at the Université du Québec à Trois-Rivières, Québec, Canada and conducted with the accord and collaboration of the École Nationale de Police du Québec. Participants gave written informed consent and were compensated 10$ for their participation.

Police trainees participated individually in the experiment which was conducted at the École National de Police du Québec in an isolated room. Participants first answered questions concerning the inclusion and exclusion criteria. They then performed the visual search task after which they answered the self-report questionnaires. The experiment was presented on a standard screen (34.0 cm X 27.2 cm) of resolution 640 X 480. Participants had to place their head on a chin rest located 60 cm from the screen.

The visual search task was presented in two blocks of 102 trials in a random order. One block induced a semantic processing strategy and the other induced an emotion processing strategy. The order was counterbalanced across participants and preceded by a practice block of ten trials with stimuli not included in experimental blocks, using the semantic processing strategy. We choose to present only the semantic processing strategy during the practice block because it represented our ''control'' condition, the baseline against which we wanted to compare the more emotional processing strategy.

For one trial, participants were instructed to look at the fixation point (a dot) in the center of the screen at the beginning of each trial (see Figure 11). The fixation point disappeared after 500ms, and was followed by a matrix. Participants' task was to quickly detect if the nine pictures belonged to the same category (by pressing 'a' key) or if there was one picture (the target) belonging to a different category (by pressing 'l' key). The matrix disappeared when participants made a response. A question was then presented in relation to the target. This question could be semantic (Is it an object?) or emotional (Is it dangerous?). Participants answered 'yes' by pressing the 'a' key or 'no' by pressing the 'l' key. Responses keys were counterbalanced across participants to prevent the possibility of motor response effects. The question was the same for all trials within a block. Participants did not have to answer the question when the matrix did not include a target, they simply skipped the question.

The aim of asking participants to answer a question concerning the target was to encourage processing of the target based on a more emotional dimension or on a semantic dimension. Indeed, participants knew beforehand the type of question, before the start of a block, and this question was repeated for all trials in the block. The knowledge of the question in advance should create expectations to process the matrix in line with this question, even if the answer is provided after the target. Participants were asked to maintain high accuracy on both the attention-target detection task and to the question answer.

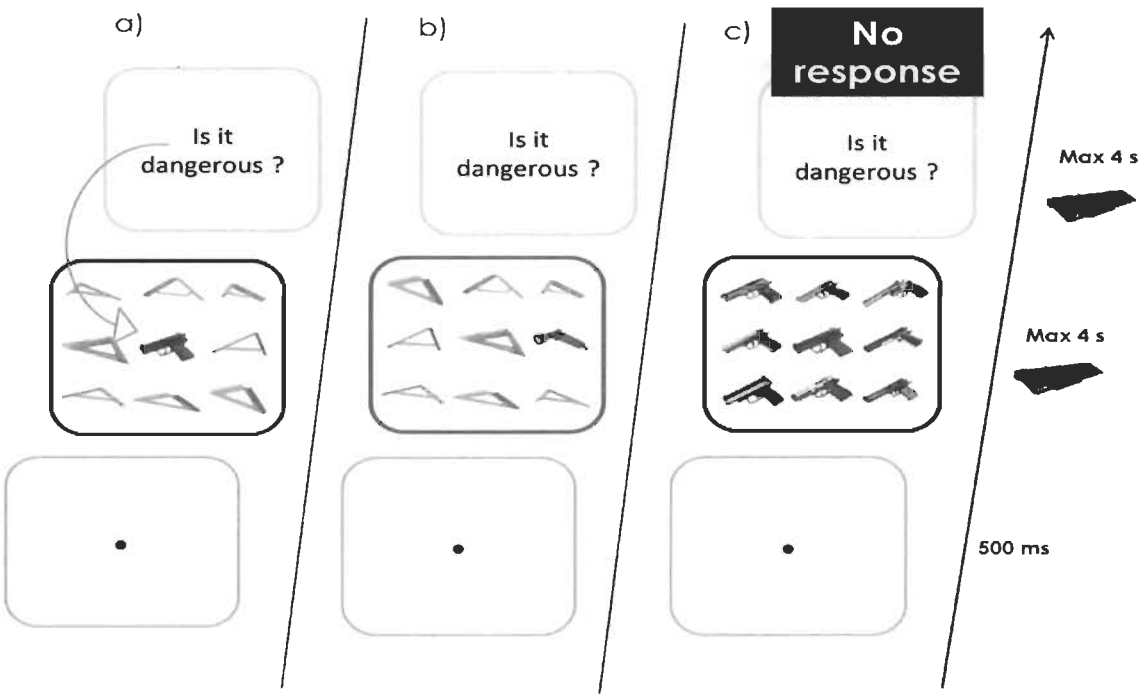

Figure 11. Trial structure. A trial started with a fixation point presented for 500ms. The matrix of nine images (with threatening target as in a), neutral target as in b) or no target as in c)) then appeared until the participant answered about the presence of a target or for a maximum of 4 seconds. Thereafter, the question about the target appeared until the participant answer or for a maximum of 4 seconds. The question was either semantic (Is it an object?) or emotional (Is it dangerous?) as in the example here and was constant within a block and known by the participant before to start a block.

Data analysis. All participants were included in the analyses. They all reached a minimum accuracy of 75% in target detection and in response to the questions. We used this threshold to ensure that participants were performing both tasks sufficiently well. The main behavioral dependent measure was participants' RTs in target detection. We wanted to see if threatening targets were detected faster than neutral targets when both were presented among neutral distractors. We considered average means per condition, including only correct answers (98%). RTs lower than 250ms were excluded as well as those greater than two standard deviations above the participant's individual mean, to reduce the influence of outliers (Mogg, Holmes, Garner, & Bradley, 2008). We performed an analysis of variance to determine the impact of target type (threatening, neutral) and processing strategy (emotional, semantic). We also conducted correlational analyses to investigate the link between participants' emotional state and RTs.

Results

Questionnaires. Descriptive statistics for 38 police trainees of the scales of trait anxiety (STAI-B), depression symptoms (BDI-II) and post-traumatic stress symptoms (PCL) are reported here. The means (and standard deviation) observed on the three scales were respectively 37.9 (8.2), 6.5 (4.6) and 28 (6.6). The medians were 38, 5.5 and 27. The maximum scores observed on the three scales were respectively 54 out of 80, 22 out of 63 and 45 out of 85. One participant had a score of 54 on the trait anxiety scale (2^{nd} and 3^{rd} highest score being 51) and the same participant had a high score of 22 on the depression scale (2^{nd} highest score is 14). One participant had a high score of 45 on the post-traumatic

stress symptoms scale (2nd and 3rd highest score is 42). The minimum scores observed on scales were 21, 0 and 18.

Pearson correlations were conducted between questionnaires for 38 police trainees. Anxiety significantly correlated with depression, $r = .57$, $p < .01$, and post-traumatic symptoms, $r = .55$, $p < .01$, the former was also significantly correlated with depression, $r = .66$, $p < .01$.

Behavioral results. The analysis of variance[1] conducted on RTs revealed a significant two-way interaction between target type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1,37) = 29.01$, $p < .001$, $\eta^2_p = 0.44$[2]. The analysis also showed a main effect of target type $F(1,37) = 114.74$, $p < .001$, $\eta^2_p = 0.76$, and a main effect of processing strategy $F(1,37) = 13.32$, $p < .001$, $\eta^2_p = 0.26$. For the two-way interaction, post-hoc analyses showed that when the processing strategy was emotional, RTs were faster when the target was threatening compared to neutral $t(37) = -11.417$, $p < .001$, $\eta^2 = 0.78$. When the processing strategy was semantic, RTs

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[1] We did not conduct an ANCOVA because the logic of this analysis is to equate two groups that have different means on the covariable; the ANCOVA serves to make them equal on the covariable, to see if there are differences over and above those related to the influence of this covariable. We only have one group in each of our studies. Also, to run an ANCOVA separately with anxiety, then depression and finally PTSD can lead to an inflation of type 1 error if we consider all interactions. If we keep the three variables as covariables, we exaggeratedly reduce the error variance. Furthermore, the correlations between anxiety, depression and PTSD are too high to consider them good covariables ($r > .5$). For all these reasons, we prefer to retain the current analyses (ANOVA + correlations).

[2] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

were also faster when the target was threatening compared to when it was neutral $t(37) = -6.97, p < .001, \eta^2 = 0.57$ (see Figure 12).

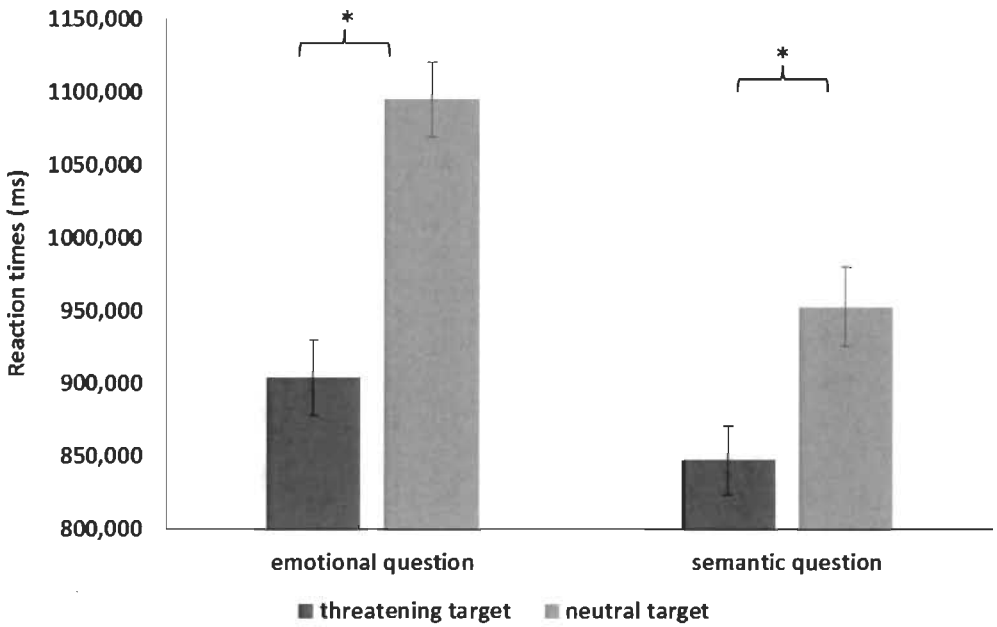

Figure 12. Reaction time to detect the target according to the different experimental conditions for police trainees. We applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014). *$p < .05$.

To further investigate the two-way interaction, we probed the difference in the detection of threatening and neutral targets, as a function of processing strategy. A threat superiority score was established by subtracting RTs to threatening targets from RTs to neutral targets. A positive score represents faster detection of threatening targets while a negative score represents longer RTs to detect threatening, compared to neutral targets. Threat superiority scores were calculated separately for each type of question. We then examined whether the threat superiority score was significantly different between the two questions. The analysis showed that threat superiority score was greater when the

processing strategy was emotional (M = 190.93 ms; SE = 15.87) compared to semantic (M = 105.43 ms; SE = 15.87) $t(37) = -5.39$, $p < .001$, $\eta^2 = 0.44$. To summarize, police trainees were faster to detect the threatening targets than neutral targets and this threat superiority effect was greater when the question induced an emotional processing strategy, compared to semantic.

Link between questionnaires and performance on the visual search task. We considered threat superiority score for emotional and semantic processing strategy. We then examined whether those scores were correlated with questionnaire scores. Table 13 presents all correlations. We did not observe any correlation between threat superiority scores on the visual search task and questionnaires scores. It seems that performance on the attention task was not modulated by trait anxiety, depression or post-traumatic stress symptoms in this sample of police trainees.

Table 13

Pearson correlations between threat superiority score for emotional and semantic processing strategy and questionnaires on 38 police trainees

	STAI-B	BDI-II	PCL
Threat superiority effect for emotional processing strategy	0.04	-0.19	-0.21
Threat superiority effect for semantic processing strategy	-0.15	-0.05	-0.15

Notes. All $p > .2$

Experiment 2

Method

Design. We used the same design as in Experiment 1.

Participants. Participants were 53 police officers from the Service de Police de la Ville de Québec (17 women; $M_{age} = 38.1$, $SD = 7.6$). Volunteers were recruited at the police station after the study was approved by the management of the service. We used the same exclusion criteria as in Experiment 1. The final sample (see data analysis) was composed of 49 participants (16 women; $M_{age} = 38.3$, $SD = 7.7$) including 13 patrollers (4 women; $M_{age} = 32.15$, $SD = 5.16$), 16 investigators (6 women; $M_{age} = 43$, $SD = 5.03$), 8 with others functions as team supervisor (4 women; $M_{age} = 41.25$, $SD = 7.15$) and 12 did not answer this question[1]. Patrollers had on average 9.69 years of service ($SD = 4.19$, $MIN = 4$, $MAX = 17$), investigators had 20.69 years of service on average ($SD = 4.39$,

[1] We performed complementary analyses in order to see if there was an impact of different levels of expertise in our results and nothing was significant, possibly because of the small number of participants in each group.

MIN = 14, *MAX* = 27) and others had 17.69 years of service (*SD* = 7.15, *MIN* = 9, *MAX* = 29).

Stimuli, Questionnaires & Procedure. This study was approved by the Ethics Committee at the Université du Québec à Trois-Rivières, Québec, Canada and conducted with the accord and collaboration of the Service de Police de la Ville de Québec. Participants gave written informed consent after reading an exhaustive information sheet. They were volunteers and performed the experiment without monetary compensation.

We used the same stimuli, questionnaires and procedure as in Experiment 1. The only difference was that participants completed questionnaires online when they were available, shortly after completing the task. The task was performed in a silent and dark room in the police station.

Data analysis. Of the 49 participants, four were excluded from analyses because they failed to reach a minimum accuracy of 75% in their answers to the questions. We used the 75% accuracy threshold for the same reasons as in Experiment 1. The main behavioral dependent measure was participants' RTs to detect a target amongst distracters. We considered mean RT per condition, including only correct answers (98%). RTs lower than 250ms were excluded as well as those greater than two standard deviations above the participant's individual mean, to reduce the influence of outliers (Mogg et al., 2008). We performed the same analyses as in Experiment 1.

Results

Questionnaires. Among the 49 police officers who participated in the study, 10 did not have time to complete the questionnaires. They were included in the other analyses. Descriptive statistics for 39 police officers of the scales of trait anxiety (STAI-B), depression symptoms (BDI-II) and post-traumatic stress symptoms (PCL) are reported here. The means (and standard deviation) observed on the three scales were respectively 34.3 (6.56), 4.8 (3.98) and 26.23 (8.6). The medians were 34, 4 and 25. The maximum score observed on the three scales was respectively 52 out of 80, 19 out of 63 and 65 out of 85. One participant had a score of 52 on the trait anxiety scale (2nd highest score being 48) and the same participant had a high score of 19 on the depression scale (2nd highest score is 11). One participant had a high score of 65 on the post-traumatic stress symptoms scale (2nd highest score is 38). The minimum scores observed on scales were 25, 0, 17. Those scores are close to the scores of police trainees (in Experiment 1) except that we have a higher maximum score on the PCL scale for police officers, maybe because they had more field experience and lived more potentially traumatic situations.

Pearson correlations were conducted between questionnaires for 39 police officers. Anxiety was significantly correlated with depression, $r = .71$, $p < .01$, and post-traumatic stress symptoms, $r = .63$, $p < .01$, the former was also significantly correlated with depression, $r = .51$, $p < .01$.

Behavioral results. An analysis of variance conducted on RTs revealed a significant two-way interaction between target type (threatening vs. neutral) and processing strategy (semantic vs. emotional) $F(1,48) = 28.73, p < .001, \eta^2_p = 0.37$[1]. The analysis also showed a main effect of target type $F(1,48) = 134.44, p < .001, \eta^2_p = 0.74$, and a main effect of processing strategy $F(1,48) = 58.93, p < .001, \eta^2_p = 0.55$. For the two-way interaction, post-hoc analyses showed that when the processing strategy was emotional, RTs were statistically faster when the target was threatening compared to neutral $t(48) = -10.65$, $p < .001$, $\eta^2 = 0.70$. When the processing strategy was semantic, RTs were also faster when the target was threatening compared to when it was neutral $t(37) = -4.77, p < .001$, $\eta^2 = 0.32$ (see Figure 13).

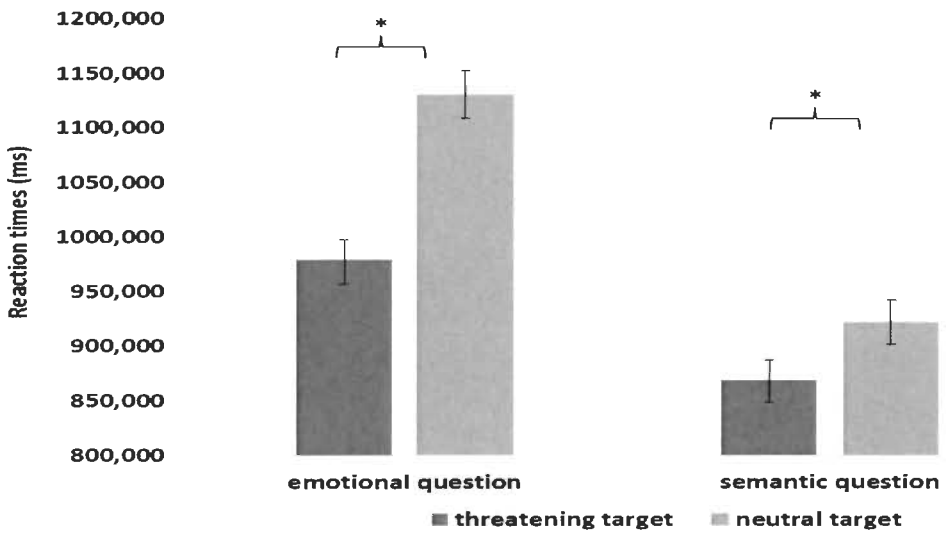

Figure 13. Reaction times to detect the target according to the different experimental conditions for police officers. We applied a correction based on the standard error (+/- 1 SE) to properly represent the intra-subject variability (O'Brien & Cousineau, 2014). $*p < .05$.

[1] It is necessary to take into consideration the fact that the experimental design of the study has an effect on effect size calculation (Olejnik & Algina, 2003). Accordingly, here, effects sizes like partial eta squared given by SPSS can be compared only with the same kind of design.

A threat superiority score was established as in Experiment 1, separately for each type of question. The comparison of the two showed that threat superiority score was greater when the processing strategy was emotional ($M = 261.4$ ms; $SE = 17.15$) compared to semantic ($M = 52.86$ ms; $SE = 17.15$) $t(48) = -8.59$, $p < .001$, $\eta^2 = 0.61$. As with police trainees in Experiment 1, the police officers in this experiment were thus faster to detect threatening targets than neutral targets and this threat superiority effect was greater when the question was emotional compared to semantic.

Link between questionnaires and performance on the visual search task. We considered threat superiority score for emotional and semantic processing strategy. We then examined whether those scores were correlated with questionnaire scores. Table 14 presents all correlations. We did not observe any correlation between threat superiority scores on the visual search task and questionnaires scores. It seems that performance on the attention task was not modulated by trait anxiety, depression or post-traumatic stress symptoms in this sample of police officers.

Table 14

Pearson correlations between threat superiority score for emotional and semantic processing strategy and questionnaires on 39 police officers

	STAI-B	BDI-II	PCL
Threat superiority effect for emotional processing strategy	-0.11	-0.14	0.18
Threat superiority effect for semantic processing strategy	-0.02	-0.09	0.06

Notes. All $p > .2$

Link between years of services and performance on the visual search task. Table 15 presents correlations between the number of years of services and threat superiority scores for each processing strategies. We observed that the more police officers spent time on service, the greater was the threat superiority effect when the processing strategy was emotional, but not when it was semantic. Therefore, we also conducted partial correlations controlling for age (see Table 16).

Table 15

Pearson correlations between threat superiority score for emotional and semantic processing strategy and years of services on 38 police officers

	Years of services
Threat superiority effect for emotional processing strategy	0.35*
Threat superiority effect for semantic processing strategy	-0.11

Notes. $*p < .05$

Table 16

Pearson correlations between threat superiority score for emotional and semantic processing strategy and years of services on 38 police officers controlling for age

	Years of services
Threat superiority effect for emotional processing strategy	0.30
Threat superiority effect for semantic processing strategy	-0.07

Cross-study comparison on attentional task. An analysis of variance conducted on threat superiority scores for each type of question and each group (police trainees vs police officers) revealed a significant two-way interaction $F(1,85) = 15.84$, $p < .001$, $\eta^2_p = 0.16$. There was no significant main effect. Post-hoc analyses showed that when the processing strategy was emotional, threat superiority score were statistically greater with police officers compared to police trainees $t(82.599) = -2.50$, $p = .01$. When the processing

strategy was semantic, threat superiority score were statistically greater with police trainees compared to police officers $t(85) = 2.87$, $p = .005$ (see Figure 14).

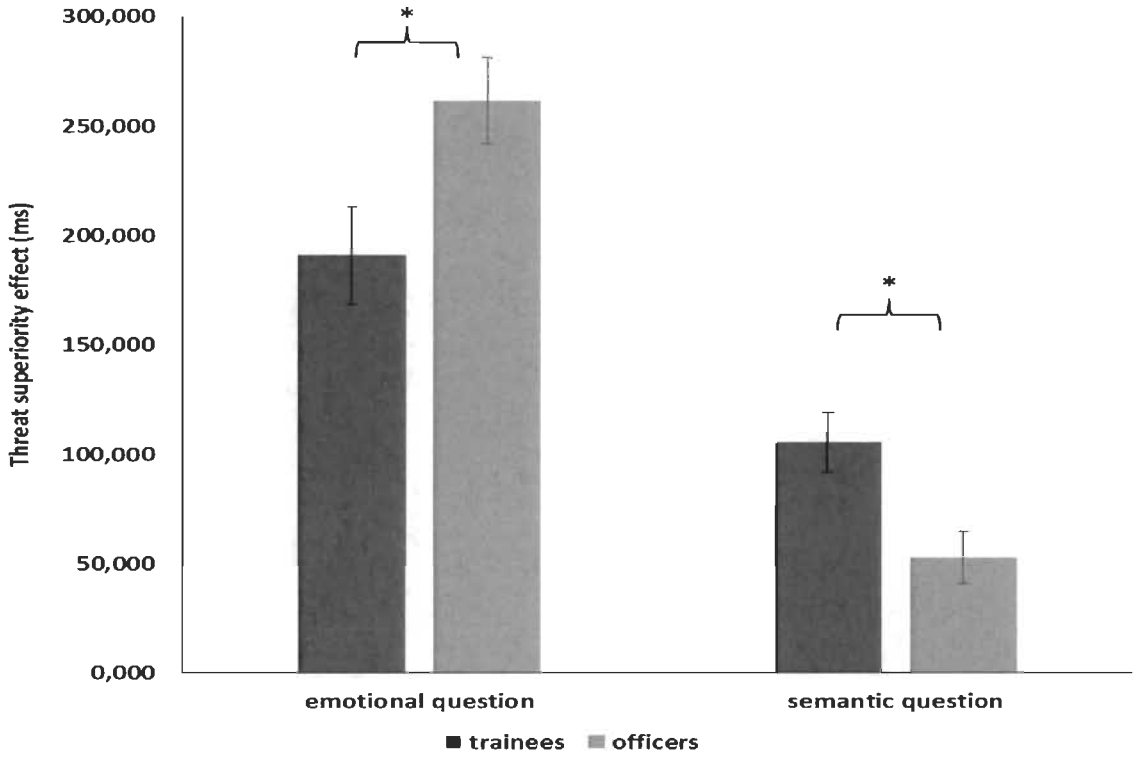

Figure 14. Threat superiority scores for each type of question for police officers and trainees.

Cross-study comparison on questionnaires. T-tests were performed to compare questionnaire scores between police trainees and officers. Police trainees were more anxious than police officers ($t(75) = 2.15$, $p < .05$, $\eta^2_p = .06$). T-tests revealed no significant difference between the two groups on the depression ($t(75) = 1.77$, $p > .05$, $\eta^2_p = .04$) and PTSD symptoms scale ($t(75) = 1.01$, $p > .05$, $\eta^2_p = .01$).

Discussion

This investigation examined if police trainees and officers would be faster to detect threatening stimuli in a visual search task, compared to neutral ones, and whether this effect could be influenced by explicit processing strategies. The findings show that threatening targets were detected faster than neutral targets, amongst neutral distractors, both by police trainees and officers. This threat superiority effect was amplified when an emotional processing strategy was induced, also in both samples. Police officers and trainees showed enhanced threat detection abilities when answering a question aimed at determining the emotional value of the target. This suggests that threat detection in police officers and trainees can be modulated by explicit top-down strategies.

These findings show that the type of processing strategy used can influence the attentional orientation toward threatening stimuli. These results are consistent with the work of Vromen, Lipp, Remington, and Becker (2016) showing that threatening stimuli evoke a faster attentional orientation when they are relevant to the task than when they are not. The findings are also consistent with the results of Huang and Yeh (2011) showing that attentional effect of affective stimuli can be influenced by what task participants are required to perform. Indeed, it seems that the weight given to a specific stimulus dimension can improve the detection of targets defined in that dimension (Müller & Krummenacher, 2006; Müller, Krummenacher, & Heller, 2004). Inducing an emotional processing strategy may lead to a greater threat superiority effect because of the increased activation of specific brain region, such as the amygdala, that are involved in emotional

influences on attention (Phelps & LeDoux, 2005). These results question the view that processing threatening stimuli is purely automatic (Hansen & Hansen, 1988). Automatic processes occur independently of the availability of cognitive resources and they cannot be affected by intentions or strategies (Pessoa et al., 2010). Accordingly, our results do not support conclusions concerning the automatic nature of threat processing (Hansen & Hansen, 1988; Mathews & Mackintosh, 1998), because threat detection was influenced by top-down processing strategies. Minimally, if automaticity is considered on a continuum, our results suggest that threat detection is not entirely automatic.

Our results show that there was no modulation of the threat superiority effect by PTSD symptoms either in police trainees or officers. One possibility is that there may not have been enough variability in the PTSD scores to find an effect. In our two groups, we have approximately the same mean on the PCL-C scale (28 and 26.6 respectively, with SDs 6.6 and 8.6). Other studies have found a link between PTSD symptoms and attention towards threatening stimuli with military samples exhibiting higher mean (60.9) and greater variability (13.28) on the same scale (Olatunji et al., 2013). Another possible explanation for the unexpected lack of individual differences is that induced processing strategies might have changed the way participants do the task and attenuated differences. Participants with PTSD symptoms may naturally activate certain beliefs or expectations about upcoming targets, in a context where threatening and neutral targets are presented. This may lead to privileged processing of upcoming threatening stimuli. The induction of

top-down processing strategies in our task could have eliminated a priori differences in the strategies spontaneously used by participants (Baumann & DeSteno, 2010).

Depression and anxiety similarly did not modulate the threat superiority effect in police trainees and officers. This is consistent with the results of Damjanovic et al. (2014) who also found no effect of anxiety on the threat superiority effect in a visual search task with police officers. Our results are also in line with the ideas of Eysenck et al. (2005, 2007), and Williot and Blanchette (2018) suggesting that the use of compensatory strategies may counter the effect of emotional state. Indeed, it is possible that the use of top-down processing strategies masks or eliminates the effect of anxiety, depression or PTSD symptoms on the orientation of attentional resources toward threatening stimuli. The use of processing strategies would make more attentional resources available for the goal-directed attentional system and limit the increased processing of threatening stimuli attributable to anxiety. More specifically, biased or targeted processing of specific types of stimuli can be considered a form of emotional regulation (Gross, 1998; Todd et al., 2012). Emotional regulation can modulate the activity of specific brain regions, including the lateral temporal cortex, that indirectly influence emotion-related responses in the amygdala (Buhle et al., 2014). One possibility is that the induced semantic processing strategy in our study led to such indirect amygdala modulation, more specifically an attenuation of amygdala responses to threatening stimuli, which can interrupt the sensitivity normally found with anxiety that can be less effective with the emotional processing strategy.

The results of this research showed that the threat superiority effect increased with years of services in police officers when participants performed the task under an emotional strategy. This suggests the possibility that experienced police officers may be better able to manage their threat detection ability depending on the context. Damjanovic et al. (2014) investigated the impact of expertise in crowd management on police officers' ability to detect threat. Using a visual search task, these researchers observed that experienced police officers were better at detecting threatening faces compared to police recruits and trainees. This was the case as no processing strategies were induced. In our study, we observed the same link between expertise and threat detection, only when the question was emotional (see cross-study comparison section). Together these facts suggest that trainees and police officers can benefit from the emotional strategy to detect threat and the more experience police officers have, the more efficiently they can benefit from the emotional strategy in threat detection.

The work of police officers is, in part, to be prepared to detect potentially threatening information. It would be interesting to see if our results could be replicated under situations involving high levels of stess/pressure. Indeed, considering the hypothesis that top-down processing strategies may minimize the effect of individual differences in emotional state on threat detection, we can speculate that these same strategies could also reduce the impact of contextual stress (Oudejans, 2008)? This question has important implications for policing and military operations. Indeed, excluding situational or individual variability in threat detection can be very useful. Interventions could eventually

be less influenced by the emotion evoked by situations or by the affective state of the first responders and they could feel more comfortable to do their duty if they know that a processing strategy can help them to be effective.

This study has some limitations. First, participants had to detect if one stimulus was different from others and then answer a question about the target stimulus. On target-absent trials, participants did not have to answer the question. This experimental context is very similar to a dual-task situation. It is difficult to know exactly how participants proceeded to complete this dual task. Participants could first concentrate on detecting the target and then try to answer the question, by reactivating the representation of the target in memory. However, if participants had used this strategy, we should have seen faster RTs, closer to what is typically observed in similar visual search tasks. This was not the case. The fact that we observed longer RT suggests that the induced strategies were applied simultaneously with the attentional task, which loaded working memory. Second, we did not include a control condition with no processing strategy. This is because our main goal was to examine the relative impact of a more emotional strategy, compared to a less emotional (semantic) strategy. Furthermore, there would be difficulties in interpreting the results of a comparison with a condition where no strategy was induced. In such case participants would not be in a dual task situation. They would only be responding to the target without having to answer a question about the cue presented before the target. This would have an important effect on RTs and would make comparisons between conditions very difficult. Nevertheless, other studies need to be

conducted with the use of the same processing strategies in order to have a broader portrait of the effect of top-down processing strategies on threat detection. Third, all targets were objects while only half of targets were dangerous. This means that the answer to the semantic question was always ''yes'', while the answer to the emotion question was either ''yes'' or ''no''. This could explain the fact that RTs for the semantic question were overall faster. However, while this may explain the main effect of processing strategy on reaction times, it is more difficult to see how it would explain the fact that the threat superiority effect was greater for the emotional, compared to the semantic strategy. Furthermore, participants did not know anything about the stimuli they would have to process during the task. They were invited to stay vigilant during the entire task, even if the question was the same throughout a block. Also, it is important to note that it was important that all stimuli be inanimate, to equate the level of processing which can be different for animate and inanimate objects (Naselaris, Stansbury, & Gallant, 2012; Wiggett, Pritchard, & Downing, 2009).

In conclusion, we found a threat superiority effect amplified when an emotional processing strategy was induced relative to a semantic processing strategy among police trainees and officers. This effect was not modulated by individual differences in affective state including depression, anxiety, and PTSD symptoms but was greater with increased years of services. Our results suggest that top-down processing strategies can influence threat detection and possibly minimize the impact of emotional states on attentional bias

towards threat. Our study provides new insights into the mechanisms underlying the threat superiority effect.

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Conflict of Interest

We declared to have no conflict of interest for this research.

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Conclusion générale

L'objectif principal de la thèse était d'examiner l'influence de stratégies *descendantes* émotionnelle et sémantique sur la détection de la menace chez des officiers de police et aspirants policiers. Premièrement, nous avons démontré qu'une stratégie de traitement de l'information de type émotionnel augmentait la rapidité de détection de stimuli menaçants relativement aux stimuli neutres, et cela, pour deux types de tâches attentionnelles à la fois chez des policiers en formation et de terrain. Deuxièmement, nous avons constaté que l'état affectif des participants, chez les aspirants policiers et les officiers de police, n'avait pas d'influence sur la détection de la menace, que ce soit lors de l'utilisation de stratégies *descendantes* émotionnelle ou sémantique.

Dans le deuxième article, nous avons démontré un effet de vigilance non dépendant de l'emplacement spatial suite à la présentation de stimuli menaçants lorsque la stratégie de traitement était de type émotionnel dans une tâche d'indiçage, et cela, chez des aspirants policiers et officiers de police.

Dans le troisième article, nous avons voulu examiner l'impact des stratégies de traitement de l'information émotionnelle et sémantique lors de la réalisation d'une tâche de recherche visuelle, plus complexe que la tâche d'indiçage. Cet article montre que les officiers de police et les aspirants policiers sont plus rapides pour détecter les stimuli menaçants que neutres et que cet effet est amplifié lorsque la stratégie de traitement de

l'information est émotionnelle. De plus, les officiers de police démontrent un effet de supériorité de la menace plus élevé que les aspirants policiers lorsque la question est émotionnelle alors que c'est l'inverse lors de la question sémantique.

Ces travaux montrent que l'orientation attentionnelle envers la menace peut être modulée par des stratégies *descendantes* chez des officiers de police et des aspirants policiers. Ces résultats sont en accord avec les travaux de Vromen et collaborateurs (2016) montrant que les stimuli menaçants suscitent une orientation attentionnelle rapide quand ils sont pertinents pour la tâche plutôt que non pertinents. Huang et Yeh (2011) utilisent une tâche de recherche visuelle en manipulant les instructions données aux participants. Dans une condition, l'instruction est de favoriser un traitement perceptuel des stimuli et dans l'autre, de favoriser un traitement lié à la dimension affective des stimuli. Leurs résultats montrent que favoriser un traitement perceptuel améliore la détection de stimuli neutres et émotionnels et non lorsque le traitement affectif est encouragé. Ces données montrent qu'une stratégie de traitement de l'information induite, via des instructions, concernant les caractéristiques des futurs stimuli, sans anticipation spatiale, peut influencer l'orientation de l'attention. Toutefois, l'étude de Huang et Yeh ne montre pas qu'un traitement relié à la dimension affective des stimuli améliore la détection de stimuli émotionnels, à l'inverse de mes travaux de thèse. Une explication possible de cette différence serait dans l'induction du type de traitement. Huang et Yeh donnent une instruction générale aux participants alors que dans ma thèse, nous incitons à un traitement émotionnel via une question répétée à chaque essai sur la cible qui devait être détectée. Il

est possible qu'au fur et à mesure des essais de l'étude de Huang et Yeh, les participants soient moins investis à faire la tâche. Ils doivent fournir un effort afin de favoriser un traitement émotionnel sans incitatif comme nous le faisons avec la question répétée à chaque essai et dont le participant connaissait la nature avant de commencer le bloc expérimental. Par ailleurs, Huang et Yeh n'incitent pas directement un traitement émotionnel de leurs stimuli, mais plutôt un traitement de la signification des stimuli, qui amènerait à rendre plus accessible le contenu émotionnel de l'information selon d'autres travaux (Huang, Baddeley, & Young, 2008; Storbeck, Robinson, & McCourt, 2006). En outre, si favoriser un traitement sémantique des stimuli rend plus facile l'accès à la signification émotionnelle, nous devrions avoir observé des temps de réaction similaires pour détecter la menace dans les conditions de traitement sémantique et émotionnel. Or, ce n'est pas le cas. Il est possible aussi que le traitement de type sémantique favorise le traitement affectif, mais de manière moins accentuée que le traitement de type émotionnel dans ces expériences. Il est aussi important de noter que Huang et Yeh ont demandé aux participants de juger de la direction d'une discontinuité d'un rectangle présenté autour des stimuli cibles sachant que les distracteurs étaient entourés d'un rectangle fermé. C'est ensuite, suivant la condition, qu'on leur disait que le stimulus cible (entouré d'un rectangle ouvert) serait en couleur pour favoriser un traitement perceptif ou bien que le stimulus cible contiendrait des humains ou des animaux. Dans ce cas, il est fort possible que leurs effets soit attribuables à un effet de *priming* plutôt que de stratégies *descendantes* dans la mesure où l'élément d'intérêt premier (ouverture du rectangle) revient à chaque essai (Theeuwes, 2010) contrairement à mes travaux ou la cible change à chaque essai pour la

tâche de recherche visuelle et l'indice change aussi à chaque essai pour la tâche d'indiçage. Au final, les données de thèse appuient l'idée d'une modulation stratégique de l'orientation attentionnelle envers la menace sans que cela semble être en lien avec un effet de *priming*.

Dans les quatre expériences de ma thèse impliquant le corps policier, la stratégie de traitement émotionnelle a eu un impact sur l'orientation de l'attention en lien avec des stimuli menaçants, que ce soit dans le traitement des images dans une tâche de recherche visuelle ou des mots dans une tâche d'indiçage. Cela fournit une preuve que les attentes liées à une tâche de détection liées à la menace peuvent améliorer la détection de stimuli négatifs comparativement aux neutres. Les participants, sachant les caractéristiques à favoriser en lien avec la question, peuvent placer plus de « poids attentionnel » sur cet aspect de l'information. Le raisonnement est que la détection de la stimulation d'intérêt (cible dans la tâche de recherche visuelle et indice dans la tâche d'indiçage) implique un mécanisme attentionnel qui va modifier le système de traitement en allouant plus de poids aux dimensions qui définissent potentiellement cette stimulation (Müller, Reimann, & Krummenacher, 2003). Ce type de traitement attentionnel serait modulable par des attentes de type *descendantes* et interviendrait de façon précoce (Müller et al., 2003; Müller & Krummenacher, 2006). Müller et al. (2003) utilisaient une tâche d'indiçage symbolique dans laquelle les participants recevaient un indice verbal sur les caractéristiques (orientation ou couleur) de la cible à détecter parmi des distracteurs. Lorsque la cible possédait la caractéristique indicée, les temps de réaction pour la détecter

étaient plus rapides que lorsque la cible ne possédait pas la caractéristique. Ces données sont en accord avec mes résultats de thèse et soutiennent l'idée que les participants peuvent utiliser des instructions pour allouer plus de poids attentionnel à la dimension d'intérêt afin de détecter efficacement la cible.

Les stratégies de traitement de l'information ont eu un effet sur l'orientation de l'attention envers les stimuli émotionnels, peu importe le niveau d'expertise des policiers et la complexité de l'environnement expérimental. Cela signifie qu'il n'est pas nécessaire d'avoir une expérience concrète de terrain en lien avec la survenue d'éléments menaçants pour que les stratégies de traitement puissent influencer le traitement attentionnel. Par ailleurs, il est aussi possible que la formation des aspirants policiers les prépare suffisamment bien pour faire face à des situations complexes de terrains réelles. Il serait envisageable de refaire ces expérimentations auprès d'aspirants policiers en début de formation et non en fin de formation à l'École nationale de police afin de mieux examiner l'impact de la formation sur le traitement attentionnel des stimuli menaçants et de l'influence des stratégies de traitement sur les habiletés de détection en situation complexe. Par ailleurs, il reste important de déterminer l'impact de situations stressantes sur l'orientation de l'attention envers les stimuli menaçants en lien avec les stratégies de traitement de l'information. Un examen approfondi des effets à court et à long terme d'entrainements en situation de stress élevé avec utilisation de stratégies de traitement sur l'orientation de l'attention envers la menace fournirait de précieuses indications sur les influences *descendantes* du traitement des émotions (Nieuwenhuys & Oudejans, 2011).

L'état affectif des policiers et futurs policiers tel que l'anxiété n'a pas influencé l'orientation attentionnelle envers les stimuli émotionnels. Cela pour les deux types de tâches attentionnelles dans les données présentées dans cette thèse. De ce fait, la théorie du contrôle attentionnel d'Eysenck et collaborateurs (2007) n'est pas vérifiée ici. Il aurait pu être possible d'avoir un effet potentialisateur de la stratégie de traitement de l'information émotionnelle sur l'orientation attentionnelle envers la menace. Le fait que l'anxiété augmente l'attention envers les stimuli menaçants au détriment du contrôle attentionnel de type *descendant* aurait pu être renforcé par l'influence de la stratégie de traitement de l'information émotionnelle. Toutefois, cela n'a pas été le cas; il semble plutôt que l'utilisation d'une stratégie de traitement de l'information renforce une influence *descendante* qui pourrait faire en sorte d'éviter que la perte de contrôle attentionnel via l'anxiété ne se produise. On constate également que la dépression et les symptômes de stress post-traumatique n'ont pas influencé l'orientation de l'attention selon les stratégies de traitement de l'information utilisées. Une explication possible serait en lien avec des scores pas suffisamment élevés sur les échelles en question. Nous ne nous sommes pas intéressés à une population clinique et nous avons regardé des scores à des échelles autorapportées qui peuvent être influencées par la désirabilité sociale. Cela est en contraste avec les études montrant un effet de ces états affectifs avec l'orientation de l'attention envers les stimuli émotionnels (Felmingham et al., 2011; Kimble et al., 2010; Peckham et al., 2010). Les résultats de ces études étaient en lien avec l'hypothèse que les expériences vécues passées fournissent une source d'informations importantes sur laquelle nous nous basons pour guider notre comportement (Stokes et al., 2012; Barrett &

Bar, 2009b). Cependant, l'utilisation de stratégies *descendantes* a pu probablement affecter la relation entre la mémoire des événements vécus et le traitement des stimuli émotionnels pour que le biais de traitement habituellement rapporté ne soit pas observé. Il est aussi possible que l'absence d'effet pour les corrélations soit en lien avec un manque de puissance statistique. Basanovic et MacLeod (2016) ont montré une corrélation significative parmi trois corrélations réalisées avec 70 participants et D'Hondt, Honoré, Williot et Sequeira (2014) ont montré également une corrélation significative parmi trois comprenant 84 participants. Dans les articles 2 et 3 de cette thèse, nous n'avons aucune corrélation significative parmi 24 et 12 respectivement. Une analyse de puissance post-hoc réalisée avec G*Power pour une corrélation de petite amplitude avec 38 participants (article 2, expérience 1) révèle une puissance de 0.46. C'est effectivement inférieur au standard de 0.80. D'autres corrélations ont été conduites en jumelant les participants de l'expérience 1 et 2 de cette étude pour augmenter la puissance à travers le nombre de participants et nous n'avons trouvé aucune corrélation supérieure à 0.16. De ce fait, l'absence d'effet significatif des corrélations en lien à un manque de puissance est une possibilité qui semble pouvoir être raisonnablement écartée.

Certains travaux considèrent qu'il n'y a pas d'influences *descendantes* possibles concernant des caractéristiques non spatiales des stimuli sur l'orientation de l'attention, mais que c'est l'ajustement du faisceau attentionnel qui serait modulé (Theeuwes, 2010; Theeuwes, Reimann, & Mortier, 2006). Dans le cadre de l'utilisation de la stratégie *descendante* émotionnelle ou sémantique, pour la tâche d'indiçage, on constate qu'il n'y

a pas d'effet de priorisation spatiale. En d'autres termes, que la cible apparaisse au même emplacement que l'indice ou non, il n'y avait aucun bénéfice. Il est possible que l'influence de la stratégie de traitement de l'information ait pu élargir le focus attentionnel suffisamment pour détecter les informations pertinentes comme la cible, que celle-ci ait été indicée spatialement ou non auparavant. Theeuwes et collaborateurs (2006) présentaient un indice verbal dans une tâche favorisant un traitement sur une cible à venir. Le traitement pouvait porter sur la couleur ou la forme et la cible pouvait être distincte des distracteurs sur la couleur ou la forme. Les participants devaient détecter la présence de la cible. Les participants étaient plus rapides pour détecter la présence de la cible lorsqu'elle était congruente sur la couleur plutôt que sur la forme. Dans une seconde expérience similaire, les participants devaient cette fois juger de l'orientation d'un segment placé au sein de la cible ou lieu de la présence de la cible. Les résultats montrent qu'en changeant les exigences de réponses, l'effet de congruence n'est plus présent. Les auteurs expliquent leurs résultats avec l'idée que les attentes *descendantes* interviennent tardivement dans le traitement de l'information. Toutefois, leurs résultats peuvent aussi s'expliquer par le fait que les stratégies de traitement sont différentes. En effet, une stratégie de traitement orientée sur des caractéristiques physiques comme la couleur ou encore la forme et une stratégie axée sur la disposition d'un segment ne sont pas similaires et cette dernière peut être plus influente sur la taille du focus attentionnel comme pour les stratégies de traitement utilisé dans cette thèse. Nous présentons les indices dans la tâche d'indiçage à 1,6° et Theeuwes et collaborateurs à 3,4° et il semble que les effets de l'indiçage sont minimes à partir de 3° d'excentricité (Ducrot & Grainger, 2007; Golla, Ignashchenkova,

Haarmeier, & Thier, 2004). Cette idée d'élargissement du faisceau attentionnel en fonction de la stratégie de traitement utilisée est en lien avec la théorie « *zoom lens* » qui stipule que l'attention peut être répartie sur une zone restreinte ou sur un champ visuel vaste (Theeuwes, 1989). En somme, le type de traitement induit par une stratégie *descendante* pourrait avoir un effet modulatoire sur l'élargissement du faisceau attentionnel.

Il est important de noter que les temps de réaction pour détecter la cible dans le cadre de la thèse sont relativement longs (environ 1000 ms) alors que les temps de réaction dans l'étude de Theeuwes et al. (2006) varient autour de 500 ms. Cela peut s'expliquer par le fait que nos participants devaient effectuer deux tâches étroitement reliées et successivement. Les participants devaient détecter une cible et répondre à une question connue à l'avance. Il est difficile de savoir exactement comment les participants ont exécuté la tâche. Les participants ont très bien pu garder la question en mémoire lors de la phase de détection ou ont essayé de s'en rappeler une fois la cible détectée. La première hypothèse pourrait permettre d'expliquer que le temps moyen de la détection de la cible, que ce soit pour la tâche de recherche visuelle ou la tâche d'indiçage, soit relativement long comparé à d'autres études sans stratégie de traitement induite (Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007) (400 ms). Si les participants ont maintenu les informations en mémoire de travail pour exécuter la tâche, cela nécessiterait des ressources attentionnelles et pourrait expliquer les longs temps de réaction. Cependant, les deux tâches doivent pouvoir se faire de manière successive et de ce fait, ne devraient

pas surcharger la mémoire de travail (Desimone & Duncan, 1995). En outre, il est parfaitement possible que la variabilité des temps de réaction soit aussi influencée plus largement par le temps de réponse des participants plutôt que par le traitement attentionnel déduit des temps de réaction. Cet aspect du traitement de l'information est délicat à contrôler dans des tâches comportementales.

Dans ce travail de Thèse, nous nous sommes intéressés à comparer deux stratégies de traitement de l'information de différentes natures, une sémantique et une émotionnelle. Il n'y a pas de condition contrôle sans stratégie, car dans ce cas, les participants ne seraient pas dans une condition où ils doivent exécuter deux tâches successivement et la comparaison des temps de réaction ne se ferait plus dans les mêmes conditions. En effet, dans une condition contrôle, les participants devraient répondre à une cible sans répondre à une question concernant l'indice présenté avant la cible (tâche d'indicage) ou à une question sur la cible elle-même (tâche de recherche visuelle). D'autres études devraient être menées en comparant différentes questions pour mieux comprendre l'impact des stratégies de traitement sur l'orientation de l'attention.

Il existe également un aspect méthodologique important qui doit être pris en compte dans ces travaux concernant les réponses aux questions. Dans la tâche de recherche visuelle, toutes les cibles sont des objets et la moitié sont dangereux. Cela signifie que la réponse à la question sémantique était toujours 'oui', alors que la réponse à la question émotionnelle était soit 'oui' soit 'non'. Cela pourrait expliquer le fait que les temps de

réaction pour la question sémantique étaient plus rapides, car la réponse était toujours la même. Cependant, cela n'explique pas le fait que l'effet de supériorité de la menace soit plus grand avec la question émotionnelle comparativement à la question sémantique. De plus, les participants ne connaissaient pas les stimuli qu'ils allaient traiter. Ils devaient rester vigilants pendant toute la tâche même si la question était la même pour tout un bloc.

Il a été rapporté que l'interférence causée par les distracteurs variait en fonction de la quantité d'essais de pratique (Theeuwes, 2010). Dans le cadre de cette thèse, il y avait un bloc pratique de 10 essais pour la tâche de recherche visuelle. On retrouve un procédé similaire dans d'autres travaux (Damjanovic & Santiago, 2015; Lipp & Waters, 2007; Nummenmaa & Hietanen, 2009). Néanmoins, certains travaux proposent 100 essais pratiques (Wolfe, 1994; Yeshurun & Carrasco, 1998). De façon générale, si ces expériences étaient à refaire, programmer les tâches avec un bloc pratique qui se termine lorsque les participants atteindraient 80 % de réussite serait une meilleure idée, et cela, afin de mieux contrôler leur performance à la tâche avant d'entamer les blocs expérimentaux. Probablement que commencer l'expérience avec la tâche attentionnelle seulement, soit de détecter la présence de la cible dans la tâche de recherche visuelle ou de la cible dans la tâche d'indiçage, serait préférable. Seulement une fois que la personne se sent à l'aise avec la tâche, alors elle pourrait débuter un nouveau bloc pratique incluant la question sur la cible dans la tâche de recherche visuelle et la question sur l'indice dans la tâche d'indiçage. Cet aspect méthodologique est crucial, car certains participants avaient plus de difficulté que d'autres et ce contrôle aurait surement permis de mieux

contrôler la variabilité liée à mes variables indépendantes. Plus particulièrement, cela aurait pu avoir un impact sur l'effet de validité absent dans la tâche d'indiçage avec les aspirants policiers et officiers de police ainsi que dans la corrélation entre les temps de réaction et les scores aux questionnaires autorapportés.

Malgré certaines limites, des implications pratiques peuvent être discutées. L'utilisation de stratégie de traitement de l'information peut induire un état de préparation mentale pouvant réduire le temps de détection de certaines informations. Cet effet pourrait être particulièrement bénéfique lors d'un état de fatigue ou lorsqu'un agent est en poste depuis un long moment. Il pourrait avoir des attentes faibles concernant l'occurrence de certains stimuli et la stratégie de traitement pourrait permettre de réajuster les attentes afin d'avoir des habiletés de détection plus efficace le moment venu. La stratégie de traitement que l'agent pourrait utiliser serait de se poser une question favorisant un traitement de type émotionnel comme la question « Est-ce dangereux? » en faisant référence à différents éléments de la situation visualisée sans forcément avoir à y répondre par 'oui' ou par 'non'. L'objectif serait, ici, d'enclencher un possible recrutement de l'amygdale étant une structure impliquée dans le traitement des émotions et pouvant influencer l'orientation de l'attention (Phelps & LeDoux, 2005). Cette stratégie de traitement de type émotionnel pourrait être intégrée dans la formation des aspirants policiers afin de les guider sur la façon de procéder pour une détection efficace de stimuli menaçants, et cela, peu importe l'état affectif dans lequel ils sont. Il est possible que de connaitre l'existence de stratégie de traitement efficace pour la détection de la menace mette en confiance les agents et

qu'ils se sentent plus confortables à agir sur le terrain. De plus, il peut exister une grande variété de situations ou l'utilisation de stratégie peut être utile, que ce soit lors de manifestations, de prises d'otage, de contrôles routiers ou encore d'arrestations. L'utilisation de cette stratégie peut avoir lieu dans un contexte d'intervention afin de neutraliser la menace, mais cela peut aussi être simplement pour l'identifier dans le cas de vidéosurveillance ou encore de pouvoir s'en échapper si on prend le cas de pompiers qui se feraient agresser dans des émeutes de quartier par exemple. Par ailleurs, le fait de se poser une question avant d'agir peut solliciter différemment les ressources liées au contrôle du comportement et laisser moins de place à de possibles réponses stéréotypées comme cela peut être le cas lorsque des agents de police tirent plus facilement sur des cibles représentant des personnes de couleurs (Correll, Urland, & Ito, 2006). L'utilisation de la stratégie de traitement devrait inciter à rechercher des indices de danger et ainsi minimiser la réponse associative qui peut être faite entre une personne de couleur et la réponse de tir. Il semble donc qu'une modulation stratégique de l'orientation de l'attention envers la menace puisse être bénéfique dans différents contextes afin d'optimiser les interventions des premiers répondants.

Au final, ce travail de thèse permet de mieux comprendre l'interaction entre émotion et cognition. Il offre une meilleure compréhension des influences stratégiques sur les processus attentionnels envers la détection de la menace en milieu policier. Il est important de poursuivre les travaux de recherche afin de mieux comprendre comment des stratégies de traitement de l'information peuvent améliorer l'orientation de l'attention envers les

stimuli menaçants. Ultimement, développer des stratégies permettant d'optimiser la détection d'informations menaçantes faciliterait le travail des policiers sur le terrain. En effet, même si l'influence des émotions sur les processus cognitifs comme l'attention est bien admise, la façon avec laquelle nous pouvons optimiser son traitement, elle, l'est beaucoup moins et cette thèse permet d'entrouvrir cette possibilité.

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