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Departamento de Personalidad, Evaluación y Tratamiento Psicológico

TOMA DE DECISIONES MORALES EN DROGODEPENDENCIAS: APROXIMACIÓN NEUROPSICOLÓGICA

TESIS DOCTORAL

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ÍNDICE

Presentación

La Neuropsicología ha generado un interés creciente por la investigación de los procesos relacionados con la cognición social, como por ejemplo, la teoría de la mente (Tirapu-Ustárroz, Pérez-Sayes, Erekatxo-Bilbao, & Pelegrín-Valero, 2007; Young, Cushman, Hauser, & Saxe, 2007), la empatía (Fernández-Pinto, López-Pérez, & Márquez, 2008; Preston et al., 2007) y la toma de decisiones sociales y afectivas (Rilling & Sanfey, 2011; Verdejo-García & Bechara, 2010). En todos estos procesos complejos la emoción se ha revelado como un componente esencial que contribuye de manera crítica a su funcionamiento óptimo (Sánchez-Navarro & Roman-Lapuente, 2004; Verdejo-García & Bechara, 2010). En este contexto, ha surgido una nueva línea de investigación focalizada en el estudio de la toma de decisiones morales, también denominada juicio moral, y su relación con los procesos emocionales (Cushman, Young, & Hauser, 2006; Koenigs et al., 2007a). La investigación científica en este ámbito se ha centrado en la toma de decisiones morales por su capacidad para guiar la conducta social de un grupo cultural, determinando así la inclinación a comportarse de cierta forma (Casebeer, 2003; Greene, 2003; Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005).

En los últimos años un gran número de estudios demuestran la implicación de los procesos emocionales en la toma de decisiones morales (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Moll & de Oliveira-Souza, 2007; Ugazio, Lamm, & Singer, 2012; Van Dillen, van der Wal, & van den Bos, 2012) . Los estudios con pacientes con daño cerebral en regiones implicadas en la integración de contenidos cognitivos y marcadores afectivos, como la Corteza Prefrontal Ventromedial (VMPFC), han demostrado una asociación entre los déficits de procesamiento de información afectiva y las alteraciones de la toma de decisiones en situaciones morales, favoreciendo opciones de respuesta utilitaristas –donde se desconsidera el daño inflingido a una persona si éste es en beneficio del colectivo (Ciaramelli, Muccioli, Làdavas, & di Pellegrino, 2007; Greene, Nystrom,

Engell, Darley, & Cohen, 2004; Koenigs et al., 2007).

En su conjunto, los hallazgos sobre la toma de decisiones-morales señalan un patrón utilitario del jucio moral en poblaciones que presentan alteraciones en áreas cerebrales vinculadas con la emoción, alteraciones en el procesamiento emocional y alteraciones conductuales, como conductas de agresividad y violencia (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Ciaramelli et al., 2007; Koenigs et al., 2007; Mendez, Anderson, & Shapira, 2005; Moretto, Làdavas, Mattioli, & Pellegrino, 2010; Young et al., 2010). Sin embargo, la mayoría de estas investigaciones se realizan en pacientes neurológicos que han sufrido algún daño cerebral adquirido. La investigación en estos pacientes está limitada por la disponibilidad de pacientes con deterioros neurológicos tan selectivos, por lo que consideramos que ampliar la investigación de juicios morales a patologías más prevalentes en las que se hayan descrito tales alteraciones sería de gran interés.

Una población de estudio que clumple con estos criterios son los pacientes drogodependientes, en los cuales se han descrito alteraciones de la CPFVM, alteraciones emocionales y alteraciones en la toma de decisiones, así como conductas agresivas o antisociales (Aguilar de Arcos, Verdejo-García, Peralta-Ramírez, Sánchez-Barrera, & Pérez-García, 2005; Fernández-Serrano, Lozano, Pérez-García, & Verdejo-García, 2010a; Fernández-Serrano, Pérez-García, Schmidt Río-Valle, & Verdejo-García, 2010b; Verdejo-García, Rivas-Pérez, Vilar-López, & Pérez-García, 2007; Verdejo-García, Lawrence, & Clark, 2008). Por ello, en la presente tesis doctoral nos propusimos ampliar la investigación de toma de decisiones morales a la población drogodependiente, tanto para aumentar el conocimiento neurocientífico de la toma de decisiones morales, como para una mejor comprensión de los déficits que subyacen los problemas de interacción social y la violación de normas sociales que se producen en esta población.

Resumen

La presente tesis doctoral está formada por un conjunto de ocho capítulos agrupados en cuatro secciones: introducción; justificación y objetivos; memoria de trabajos enviados y publicados; discusión general, conclusiones y perspectivas futuras.

La primera sección es la introducción y consta de dos capítulos, siendo el primero sobre la toma de decisiones morales, y el segundo sobre las drogodependencias como una nueva población de estudio de los procesos morales. En el Capítulo 1 hemos abordado la conceptualización de la toma de decisiones morales, incluyendo el estudio del patrón de respuesta utilitarista y deontológica, los principales hallazgos en voluntarios sanos y poblaciones clínicas, así como las bases neurales y los modelos teóricos subyacentes. Finalmente nos centramos en los dilemas morales como instrumento de evaluación de la toma de decisiones morales, aportando información sobre la tipología de los dilemas y sus ventajas e inconvenientes. En el Capítulo 2 abordamos la dependencia del consumo de sustancias adictivas. En primer lugar exponemos la definición y otros conceptos introductorios, así como el modelo del marcador somático de las adicciones. A continuación describimos las principales alteraciones neuropsicológicas en la población drogodependiente, centrándonos en los deterioros emocionales y de las funciones ejecutivas, y finalmente presentamos los hallazgos en esta población sobre la toma de decisiones morales.

La segunda sección contiene el Capítulo 3 dónde se lleva a cabo la justificación de la tesis, así como el objetivo principal y los objetivos específicos e hipótesis que se persiguen en este trabajo.

La tercera sección titulada “memoria de trabajos” está formada por cuatro capítulos en los que se incluyen los cuatro estudios empíricos que constituyen la tesis doctoral, el primero de ellos dedicado a la obtención de un instrumento de evaluación de toma de decisiones morales y los otros tres dedicados al estudio de la toma de decisiones morales

en la población drogrodependiente.

El Capítulo 4 consiste en un estudio para la obtención de un cuestionario breve de decisiones morales basado en el conjunto de dilemas morales de Greene (2001), de extensa longitud y desarrollado en población anglófona. Tras un proceso de adaptación del instrumento al español y reducción del número de ítems a través de metodología Rasch, la nueva versión fue validada en una muestra de 133 controles sanos. Los resultados indicaron una buena fiabilidad y validez discriminativa del instrumento, postulándose como un instrumento útil para la evaluación de la toma de decisiones morales.

El Capítulo 5 está formado por un estudio que pretende examinar la toma de decisiones morales en pacientes policonsumidores que siguen tratamiento en una comunidad terapéutica. El patrón de consumo de estos pacientes era mixto, incluyendo distintas drogas, tales como cannabis, cocaína, heroína, anfetaminas, metadona, éxtasis, benzodiacepinas y alcohol. Los resultados mostraron que la toma de decisiones morales de los pacientes policonsumidores ante los dilemas personales o emocionalmente salientes, difiere significativamente de un grupo control no consumidor, siguiendo un patrón utilitarista en el que se asume una conducta emocionalmente aversiva en favor de un beneficio mayor (por ejemplo, matar a una persona para salvar un mayor número de vidas). Así mismo la dificultad que les supone tomar la decisión moral es menor que en los participantes no consumidores. Este patrón es específico de los dilemas morales personales, ya que no se producen en las otras tipologías de dilemas con menor caga emocional, indicando el rol fundamental que juega la emoción en el proceso de toma de decisiones morales. Además, se halló una correlación entre las respuestas utilitaristas ante los dilemas personales y la severidad del consumo de alcohol, sugiriendo la incidencia del alcohol en la toma de decisiones morales.

El Capítulo 6 recoge un estudio realizado en personas dependientes al alcohol que investiga los procesos psicológicos que subyacen el sesgo utilitarista en la toma de decisiones morales. En concreto, se evaluaron los efectos predictivos de la gravedad del consumo de alcohol, los síntomas de ansiedad y depresión, la impulsividad, y la decodificación emocional. Los resultados de este estudio demuestran que los pacientes dependientes al alcohol presentan un sesgo utilitario y una menor dificultad percibida para llevar a cabo la decisión. Estas alteraciones son específicas para los dilemas morales personales, replicando así los resultados hallados anteriormente en los pacientes policonsumidores. Así mismo, se observó que una peor decodificación de miedo y asco predecía significativamente los sesgos utilitarios en los dilemas morales personales, incluso en mayor medida que la severidad de consumo de alcohol, mientras que la impulsividad y los síntomas de ansiedad y depresión no fueron predictores de las decisiones morales. En otras palabras, este estudio reveló que el déficit en la decodificación del miedo y el asco es un factor clave para predecir el sesgo utilitarista en los pacientes con dependencia al alcohol.

El Capítulo 7 consiste en un estudio que investiga los correlatos psicofisiológicos durante la toma de decisiones morales en los pacientes dependientes al alcohol, a través del estudio de la tasa cardiaca. Los resultados pusieron de manifiesto una menor respuesta de la tasa cardiaca ante los dilemas morales en las personas con dependencia al alcohol en comparación con los controles sanos. En concreto presentaban un déficit para modular la tasa cardiaca en función del tipo de dilema, mostrando una menor desaceleración cardiaca (índice de experiencia emocional aversiva) durante los dilemas morales personales. Estos déficits no estaban relacionados con las diferencias entre grupos en la tasa cardiaca durante la línea base. Además, las opciones utilitarias en dilemas personales se asociaron con una disminución en la variabilidad de la tasa cardiaca, sin embargo, esta asociación no se mantuvo en cada grupo por separado, por lo que en futuros estudios debe ser

estudiada con mayor profundidad. En su conjunto los resultados de este estudio indicaron un déficit de las personas dependientes del alcohol para experimentar emociones aversivas ante violaciones morales personales.

La cuarta sección contiene el Capítulo 8 en el que llevamos a cabo la discusión conjunta de los hallazgos obtenidos en los cuatro estudios empíricos anteriormente descritos, considerando sus implicaciones teóricas y clínicas. Finalmente se exponen las conclusiones y perspectivas futuras de investigación que se extraen de la presente tesis doctoral.

I. INTRODUCCIÓN

Capítulo 1

Toma de decisiones morales

1. Definición y conceptos introductorios

Durante años la moralidad humana fue temática de debates filosóficos que pretendían identificar los principios que rigen la conducta moral, sin embargo en las últimas décadas se ha convertido en el centro de novedosas investigaciones científicas que integran el conocimiento de múltiples disciplinas, tales como la neurociencia, la psicología, la biología y la genética, entre otras áreas.

Desde la aproximación científica, la moral se define como el consenso de valores, costumbres y conductas dentro de un grupo cultural que guían la conducta social (Casebeer, 2003; Greene, 2003; Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005). Según los mismos autores, los juicios morales, también llamados toma de decisiones morales, son un tipo de evaluación basada en la adecuación de la propia conducta y la de los demás a las ideas sociales de lo que es correcto y de lo que es incorrecto. En otras palabas, el juicio moral es un proceso decisional que integra la información situacional con el input emocional vinculado a los escenarios de contenido social y moral. En consequencia, la toma de decisiones morales guía la conducta social de un grupo cultural, determinando así la inclinación para comportarse de cierta forma.

2. Decisiones morales utilitaristas vs. Decisiones morales deontológicas: el papel de la emoción y otras variables explicativas

Tomamos decisiones morales de dos tipos, utilitaristas (basadas en la maximización del beneficio colectivo) o deontológicas (regidas por un deber moral básico, como por ejemplo “No matar”). Las decisiones utilitaristas se refieren a asumir una acción emocionalmente muy aversiva a favor del bienestar agregado, por ejemplo, asfixiar a un bebé para salvar un grupo de personas. En cambio, las opciones deontológicas conllevan el rechazo a llevar a cabo un daño, a pesar de las ventajas que éste supondría en términos

de coste beneficio, por ejemplo, decidir no asfixiar al bebé pese a que esto supone la muerte de un número mayor de personas. A continuación se exponen los principales estudios que han hallado sesgos utilitaristas y deontológicos en población control y clínica.

2. 1. Estudios en voluntarios sanos

La evidencia en voluntarios sanos señala que la elección entre una respuesta utilitarista o una deontológica depende de la carga emocional que conlleva el dilema moral (Bartels & Pizarro, 2011; Fumagalli et al., 2010; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Youssef et al., 2012), optando por decisiones utilitaristas ante los dilemas impersonales o de menor carga emocional y por decisiones deontológicas ante los dilemas personales que implican alta carga emocional. Por ejemplo, la mayor parte de la población considera moralmente aceptable pulsar un botón para desviar un tren que está a punto de atropellar a cinco personas a otra vía dónde solo hay una persona (dilema impersonal), en cambio, cuando la única manera para salvar a las cinco personas es empujar directamente a un desconocido a las vías del tren (dilema personal), la mayoría elige la opción deontológica. Mediante técnicas de neuroimagen, Greene (2001) evidencia como las regiones cerebrales asociadas con el control cognitivo presentan una mayor actividad ante juicios morales utilitaristas, mientras que ante los juicios deontológicos, las áreas más activadas son aquellas que se relacionan con el procesamiento emocional. La relación entre la emoción y el juicio moral también se pone de manifiesto en los estudios conductuales que muestran cómo la manipulación del estado afectivo puede alterar los juicios morales, relacionando las decisiones utilitaristas con la indución de emociones con valencia positiva, como por ejemplo la felicidad o el humor, y las decisiones deontológicas con emociones negativas como la tristeza o el asco. (Pastötter, Gleixner, Neuhauser, & Bäuml, 2012; Schnall, Haidt, Clore, & Jordan, 2008;

Valdesolo & DeSteno, 2006; Van Dillen, van der Wal, & van den Bos, 2012; Wheatley & Haidt, 2005).

A pesar del rol de la emoción en los juicios morales, también hay evidencia que señala la implicación de los procesos cognitivos. En este sentido, Greene (Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008) muestra la existencia de una relación causal entre el procesamiento cognitivo y juicios utilitaristas encontrando que a menor carga cognitiva disminuye el tiempo de respuesta y la frecuencia de juicio moral utilitarista. Otros estudios han hallado una correlación positiva entre la capacidad en memoria de trabajo y el pensamiento deliberativo con la toma de decisiones utilitaristas (Bartels, 2008; Feltz & Cokely, 2008; Moore, Clark, & Kane, 2008).

En cuanto a las variables psicológicas, estudios recientes investigan las posibles relaciones de la toma de decisiones morales con la ansiedad (Starcke, Polzer, Wolf, & Brand, 2011; Youssef et al., 2012), la depresión y la personalidad, incluyendo rasgos antisociales y la impulsividad (Bartels & Pizarro, 2011; Marsh & Cardinale, 2012). La investigación centrada en los problemas de ansiedad ha demostrado que la inducción de estrés predispone la toma de decisiones morales utilitaristas en los dilemas de alta carga emocional (Youssef et al., 2012). La toma de decisiones morales egoístas también se correlaciona positivamente con niveles de cortisol elevados, a pesar de que no se encontraron diferencias en la proporción de respuestas egoístas/altruistas en función del nivel de estrés (Starcke et al., 2011). Los estudios de Bartels y Pizarro (2011) y Marsh y Cardinale (2012) mostraron una asociación entre las respuestas utilitaristas en los dilemas más emocionales y puntuaciones altas en psicopatía e impulsividad, así como en la escala de falta de sentido por la vida, que correlaciona con medidas de depresión (Kunzendorf & Maguire, 1995).

Finalmente, los estudios sobre el efecto de las variables sociodemográficas en la toma de decisiones morales, señalan diferencias en la proporción de decisiones utilitaristas en función del género (Fumagalli et al., 2010; Fumagalli et al., 2010), la edad (Navarrete, McDonald, Mott, & Asher, 2012) y el nivel socioeconómico y educativo (Abarbanell & Hauser, 2010). Sin embargo, la influencia de las características sociodemográficas en la cognición moral continúa siendo un tema controvertido ya que otros autores no han hallado tales diferencias (Banerjee, Huebner, &Hauser, 2010; Cushman, Young, & Hauser, 2006; Hauser, Cushman, Young, Kang-Xing, & Mikhail, 2007).

2. 2. Estudios en poblaciones clínicas

Los estudios con pacientes con daño cerebral en regiones implicadas en la integración de contenidos cognitivos y marcadores afectivos, como la Corteza Prefrontal Ventromedial (CPFVM), han demostrado una asociación entre los déficits de procesamiento de información afectiva y las alteraciones de la toma de decisiones en situaciones morales, favoreciendo opciones de respuesta utilitaristas a pesar de preservar su conocimiento declarativo social y de las normas sociales (Ciaramelli et al., 2007; Koenigs et al., 2007; Moretto et al., 2010; Young et al., 2010). Estas personas ante dilemas morales emocionalmente salientes llevan a cabo un cálculo utilitario que prioriza el bienestar global, a pesar de infligir conductas que conllevan una fuerte aversión emocional, por ejemplo escogen sacrificar la vida de una persona para salvar la vida de otras cinco. Sin embargo los juicios morales ante dilemas menos emocionales o impersonales no difieren de la población sin daño. Además, el daño en el área CPFVM produce un desajuste emocional ya que disminuye notoriamente emociones como la culpa, la compasión y la vergüenza por un lado, y por otro, la ira y la tolerancia a la frustración se encuentran mal reguladas. En este sentido Damasio y colaboradores (Anderson et al., 1999) demostraron

la importancia de la CPFVM en el desarrollo de la moralidad, comprobando como pacientes con lesiones en esta área adquiridas a una edad temprana, presentaban déficits tanto en el razonamiento como en la conducta moral. La toma de decisiones morales de estos pacientes estaba deteriorada y su ejecución en tareas con implicación emocional era muy pobre, mostrando respuestas aplanadas ante imágenes emocionales (Anderson et al., 1999).

El sesgo utilitarista en la toma de decisiones morales con alta carga emocional, también se ha encontrado en otras poblaciones clínicas con deterioros en el procesamiento emocional, incluyendo pacientes con demencia frontotemporal (Gleichgerrcht, Torralva, Roca, Pose, & Manes, 2011; Mendez et al., 2005; Mendez & Shapira, 2009), psicopatía (Blair, 2007; Cima, Tonnaer, & Hauser, 2010; Koenigs, Kruepke, Zeier, & Newman, 2011; Koenigs, 2012; Young, Koenigs, Kruepke, & Newman, 2012), autismo (Buon et al., 2012; Gleichgerrcht et al., 2012; Moran et al., 2011), y recientemente en pacientes con adicción a drogas (Carmona-Perera, Verdejo-García, Young, Molina-Fernández, & Pérez-García, 2012; Carmona-Perera, Clark, Young, Pérez-García, & Verdejo-García; Khemiri, Guterstam, Franck, & Jayaram-Lindström, 2012; Verdejo-Garcia et al., 2012)

3. Bases neuroanatómicas

Los estudios de neuroimagen estructural y funcional coinciden en señalar las principales regiones del cerebro implicadas en la cognición y el comportamiento moral, siendo éstas la corteza prefrontal, la corteza temporal posterior y anterior y áreas límbicas y paralímbicas (Greene et al., 2004; Moll, de Oliveira-Souza, Bramati, & Grafman, 2002; Moll et al., 2005; Young & Saxe, 2008; Zahn et al., 2009).

Como resultado de la investigación realizada en pacientes con lesiones cerebrales

adquiridas y en el ámbito de la psicopatía surgen la mayoría de los conocimientos neuroanatómicos relacionados con la moral. Los estudios de pacientes con daño cerebral adquirido, describen el desarrollo de una sociopatía adquirida que conlleva importantes cambios en la conducta social y moral (Ciaramelli et al., 2007; Koenigs et al., 2007; Moretto et al., 2010). Estos pacientes muestran lesiones en las siguientes áreas cerebrales: la corteza prefrontal anterior, la corteza orbitofrontal, el córtex prefrontal ventromedial, la corteza dorsolateral, la corteza cingulada anterior, el surco temporal superior, el lóbulo temporal anterior, y determinadas áreas límbicas y paralímicas, particularmente, la amígdala, el hipotálamo, el tálamo dorsomedial y la cabeza del núcleo caudado (Ciaramelli et al., 2007; Koenigs et al., 2007; Mendez et al., 2005; Moll et al., 2011; Young et al., 2010; Zahn et al., 2009). La investigación en el ámbito de la psicopatía a través de técnicas de neuroimagen funcional y estructural también señala anormalidades en casi todas estas regiones (Birbaumer et al., 2005; Blair, 2007; Harenski, Kim, & Hamann, 2009; Koenigs, 2012; Marsh et al., 2011).

Los estudios de neuroimagen en voluntarios sanos (Greene et al., 2001, 2004; Heekeren et al., 2005; Luo et al., 2006; Moll et al., 2002; Prehn et al., 2008), corroboran el papel central del procesamiento afectivo sobre los juicios morales, demostrando la activación de regiones implicadas en el procesamiento emocional (p.e., corteza prefrontal ventromedial, ínsula y amígdala) durante la consideración de los dilemas morales .

4. Modelos teóricos

Existen diversas propuestas teóricas que dan diferentes explicaciones a los resultados obtenidos en los estudios de neurociencia moral detallados en los apartados anteriores. A continuación se exponen los principales modelos explicativos que aportan información acerca los procesos emocionales y cognoscitivos implicados en la conducta moral.

4. 1. Teoría Verbal-racional (Kohlberg, 1958)

La teoría clásica de Kohlberg (1958) postula que la percepción de un estímulo moral es seguida por un razonamiento deliberativo que conlleva la toma de decisiones morales. La emoción puede surgir del juicio moral, sin embargo no se encuentra relacionada de forma causal con el proceso de toma de decisiones morales. Desde esta perspectiva, los juicios morales son conscientes, voluntarios y racionales, siendo la conducta moral una capacidad que varía en función de las experiencias personales, la educación y de la cultura. A pesar de que la teoría de Kohlberg ha contribuido de forma notable al conocimiento del desarrollo de la moral, en los últimos años un gran número de estudios demuestran la implicación de la emoción en el juicio moral (Greene & Haidt, 2002; Koenigs et al., 2007; Moll, de Oliveira-Souza, Eslinger, et al., 2002; Moretto et al., 2010).

4.2. Teoría Social-intuitiva (Haidt, 2001)

La teoría Social-intuitiva (Haidt, 2001) propone que el juicio moral es intuitivo e implica un papel relevante de la emoción. El juicio moral no está determinado por razones meditadas ni explícitas, sino que el juicio de aprobar o condenar una acción se da muy rápidamente, de forma relativamente automática e inconsciente, y la justificación racional del juicio, más permeable a las influencias culturales, se elabora a posteriori (Greene & Haidt, 2002). En otras palabras, tras la percepción de un evento moralmente relevante se producen un conjunto de reacciones afectivas, como por ejemplo la emoción de asco, que determinan el juicio moral. El razonamiento moral interviene cuándo tratamos de justificar nuestra elección, apoyando normalmente nuestras reacciones afectivas, aunque en algunos casos puede ser incongruente con el juicio afectivo. Por ejemplo, ante la observación de una persona junto a otra que ha sido asesinada, a pesar de

que no existan razones obvias que puedan justificar nuestro juicio (arma en la mano, señales de violencia, etc.) las personas suelen considerar que ha sido un asesinato. Este fenómeno es nombrado por Haidt (2001) como perplejidad moral (moral dumbfounding) para mostrar que en algunos casos el razonamiento no juega ningún papel en la toma de decisiones morales, siendo únicamente la emoción la que desencadena el juicio moral.

La teoría social-intuitiva también postula la existencia tanto de valores morales dependientes de la cultura –por ejemplo las leyes de una determinada zona o la doctrina de una religión–, como de valores morales universales, independientes del grupo cultural de pertenencia –por ejemplo el valor de no hacer daño a los demás (Haidt, 2007) –.

4.3. Hipótesis del Embotamiento Emocional (Emotional Blunting)

La hipótesis del embotamiento emocional otorga únicamente a la emoción la función de explicar los procesos morales, dejando los procesos cognoscitivos al margen, de manera que un problema en el procesamiento emocional causaría un patrón anormal del juicio moral. Según este modelo, los pacientes con lesiones cerebrales en áreas emocionales, como por ejemplo la Corteza Prefrontal Ventromedial (CPFVM) son más propensos a llevar a cabo conductas utilitaristas como resultado de un embotamiento emocional general debido al daño cerebral que presentan. No obstante en la tarea del juego del ultimátum en el que los sujetos pueden elegir una opción económicamente racional (moralmente injusta pero económicamente provechosa) o bien rechazarla y castigar un acto injusto, escogiendo así la opción emocional (moralmente justa pero económicamente desventajosa), se observó que los pacientes con daño en el CPFVM preferían la opción emocional en lugar de la racional, de manera que en este caso no se daba el embotamiento emocional general hipotetizado (Koenigs & Tranel, 2007). En contraposición a la hipótesis del embotamiento emocional, varios estudios aportan

evidencia a favor de la implicación del procesamiento cognitivo en los juicios morales utilitaristas (Greene et al., 2001; Greene et al., 2008, 2004). En esta línea, se ha demostrado una correlación positiva entre la capacidad en memoria de trabajo y el pensamiento deliberativo con la toma de decisiones utilitaristas (Bartels, 2008; Feltz & Cokely, 2008; Moore et al., 2008).

4.4. Hipótesis de la sensibilidad moral (Moll, de Oliveira-Souza, & Eslinger, 2003)

La hipótesis formulada por Jorge Moll defiende que los acontecimientos socio-emocionales vinculados a la sensibilidad moral surgen de la integración entre mecanismos emocionales y cognitivos (Moll et al., 2003; Moll, Eslinger, & Oliveira-Souza, 2001).

Estudios de neuroimagen (Moll et al., 2003; Moll, de Oliveira-Souza, Eslinger, et al., 2002) mostraron que la visualización de violaciones morales activa áreas específicas, como el CPFVM y el Surco Temporal Superior (STS), que no son activadas por imágenes desagradables sin contenido moral. Estos resultados son consistentes con la existencia de una red específica vinculada a la sensibilidad moral que relaciona los eventos socio-emocionales con los valores morales. Esta red conecta las áreas implicadas en el procesamiento emocional y la experiencia de sentimientos pro-sociales como la culpa y la compasión con las áreas relacionadas con la experiencia emocional aversiva como las emociones de cólera, frustración o repugnancia moral.

La hipótesis de la sensibilidad moral, permite dar una explicación a los resultados hallados por Koenigs et al. (2007) según los cuales los pacientes CPFVM responden de forma utilitarista ante los dilemas morales personales pero son más emocionales en el juego del ultimátum. Estos pacientes presentarían una disminución de los sentimientos pro-sociales y un aumento de sentimientos “egoístas” que aumentaría las respuestas

utilitaristas en los dilemas personales. A su vez preservarían la experiencia emocional negativa que intensificaría el castigo hacia los actos injustos del juego del ultimátum haciendo que los sujetos se decantaran por la opción emocional (Moll & de Oliveira-Souza, 2007). Sin embargo, los juicios utilitaristas de pacientes con daño en áreas emocionales también se dan cuando el dilema no conlleva una motivación "egoísta" o beneficiosa para el propio sujeto, sino en beneficio de la comunidad (Koenigs et al., 2007a; Mendez et al., 2005). La hipótesis de la sensibilidad moral tampoco explica por qué la inducción de emociones positivas a personas sanas aumenta sus juicios morales utilitaristas (Pastötter et al., 2012; Valdesolo & DeSteno, 2006), mientras las emociones negativas los disminuyen (Schnall, Haidt, Clore, & Jordan, 2008; Wheatley & Haidt, 2005).

4.5. Hipótesis del doble proceso (Greene, 2007)

En la explicación que propone Greene acerca del juicio moral, la emoción concibe un importante papel, sin embargo el razonamiento moral también es fundamental, ya que existe una competición entre mecanismos cognitivos y emocionales que da lugar a los juicios morales.

La hipótesis del doble proceso (Greene, 2007) postula que los dilemas morales con mayor carga emocional o personales evocan una respuesta emocional automática, la cual genera una elección en contra de causar daño, sin embargo la respuesta emocional puede ser anulada por el control cognitivo. De manera que la respuesta utilitarista en los juicios morales personales estaría controlada por mecanismos cognoscitivos, mientras que en los juicios deontológicos o no utilitaristas sería la emoción la que prevalecería por encima del razonamiento. Prueba de ello es el incremento de la activación de áreas cognitivas (p.e. Corteza Prefrontal Dorsolateral, CPFDL) ante los juicios morales utilitaristas y

áreas emocionales (p.e. Corteza Prefrontal Ventromedial, CPFVM) en los juicios deontológicos (Greene et al., 2001), así como de las áreas asociadas con el conflicto cognitivo (Corteza del Cíngulo Anterior) ante los dilemas dónde la dificultad para llevar a cabo la decisión es mayor, siendo el tiempo de reacción elevado y el consenso de respuesta bajo (Greene et al., 2004; Koenigs et al., 2007). En esta línea, los estudios en pacientes con daño cerebral adquirido (Ciaramelli et al., 2007; Koenigs et al., 2007; Moretto et al., 2010) han demostrado que la lesión focal en la CPFVM conduce a una mayor proporción de respuestas utilitaristas en los dilemas personales, sin embargo, los pacientes con lesión en la CPFDL presentan un aumento las respuestas deontológicas.

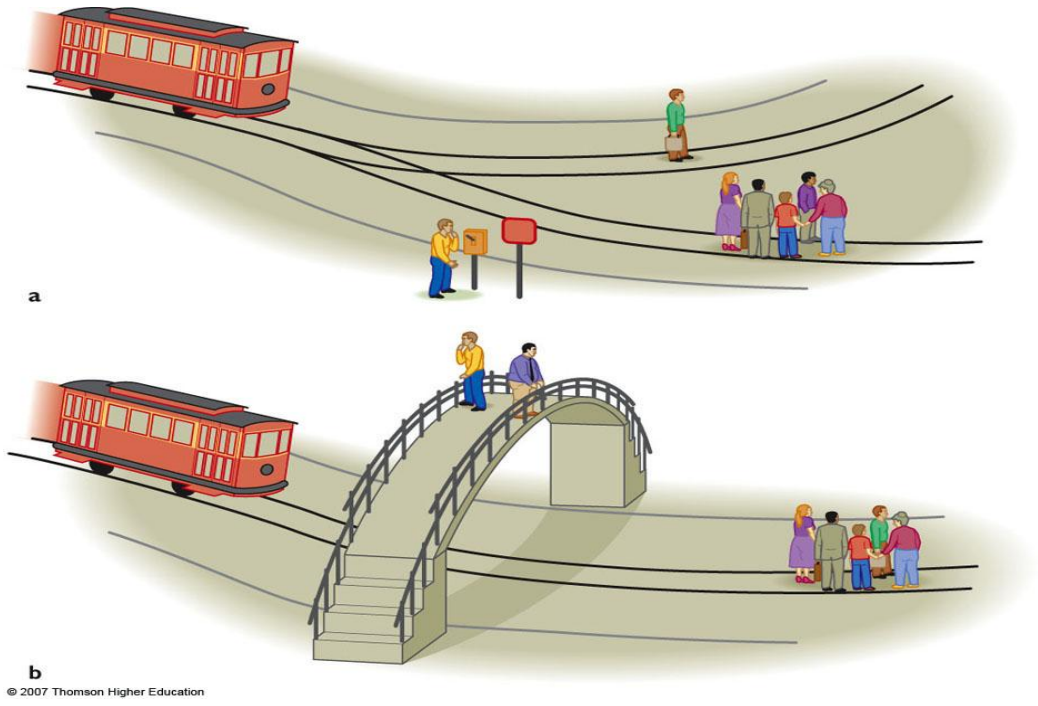
5. Instrumentos de evaluación: los dilemas morales

El método más extendido para generar la toma de decisiones morales son los dilemas morales. Un dilema moral es el planteamiento de una situación hipotética que genera en la persona un conflicto moral cuya resolución permite estudiar los procesos psicológicos subyacentes. Cada dilema exige que las personas realicen un juicio dicotómico acerca de cómo se comportarían si se enfrentasen a ese dilema, al que deben responder aceptando o rechazando la opción utilitarista que se les propone. A través de los dilemas morales podemos valorar características de las personas en función de si éstas se rigen por un patrón utilitarista o deontológico en sus juicios morales.

El banco de dilemas recopilado por Greene (Greene et al., 2001) es actualmente el más empleado en los estudios experimentales sobre la toma de decisiones morales (Ciaramelli et al., 2007; Greene et al., 2004; Khemiri et al., 2012; Koenigs et al., 2007; Moretto et al., 2010; Youssef et al., 2012). Está formado por un conjunto de 60 escenarios hipotéticos clasificados en tres categorías principales, no morales, morales impersonales y morales personales. Los primeros implican una decisión lógica o racional. Por ejemplo,

en el denominado "train or bus" hay que decidir si viajar en tren o en autobús a una reunión sabiendo que con el tren es seguro que llegues a tiempo y con el autobús puede que llegues o puede que no. Los de tipo moral impersonal tienen contenido moral pero conllevan una baja implicación emocional, ya que aunque se debe decidir sobre si infligir daño físico o no, éste es de poca gravedad o se lleva a cabo de forma indirecta y sobre una persona desconocida. En cambio, los morales personales presentan contenido moral de alta implicación emocional, planteando un daño físico grave que debe ejercerse directamente por el propio para poder salvar un mayor número de personas. Por ejemplo, en la versión impersonal (a) del dilema "Standard Trolley" se debe decidir entre apretar o no un interruptor para desviar un tren que está a punto de matar a cinco personas hacia otra vía en la que sólo mataría a una persona, mientras que la versión personal (b) plantea empujar un hombre a las vías para detener el tren y salvar a las cinco personas (Figura 1).

Figura 1. Versión impersonal (a) y personal (b) del dilema "Standard Trolley" recogido en el banco de dilemas morales de Greene (2001).



(a) ¿Apretarías el interruptor para evitar la muerte de estas cinco personas?
(b) ¿Empujarías al hombre corpulento a las vías para salvar a las cinco personas?

Entre los dilemas morales personales se han establecido dos grupos denominados de bajo y alto conflicto emocional en función del tiempo de respuesta y el consenso en las mismas (Greene et al., 2004; Koenigs et al., 2007). En los de bajo conflicto emocional el tiempo de respuesta es significativamente inferior que en los de alto conflicto, mientras que el consenso en responder de forma deontológica es significativamente mayor (Koenigs et al., 2007). Un ejemplo de los de bajo conflicto es el dilema "Architect", dónde el participante debe decir si empujaría al vacío a un jefe que te hace la vida imposible a ti y a todo aquel que le rodea, sabiendo que la gente pensaría que se cayó por accidente. Un ejemplo de los de alto conflicto es el "Crying Baby" que propone al sujeto la posibilidad de asfixiar a su hijo para poder salvarse él mismo y un grupo de ciudadanos.

A pesar de que los dilemas de Greene constituyen el principal paradigma experimental en el estudio de la toma de decisiones morales, algunos autores indican varios tipos de dudas e inconvenientes en los propios dilemas y en su aplicación (Abarbanell & Hauser, 2010; Cushman, 2008; Christensen & Gomila, 2012; Hauser et al., 2007; Kahane & Shackel, 2010). Los problemas detectados en la literatura se pueden resumir en los siguientes puntos. En primer lugar, la posibilidad de influencia de variables extrañas en la respuesta a los dilemas, entre las que se destacan aspectos económicos, de género y preferencias personales o gustos en el contenido de los dilemas, así como un elevado nivel de dificultad en la comprensión de algunos dilemas. Hauser (2007) sugiere que solo el control de las variables demográficas puede determinar la influencia o no de dichas variables en el juicio moral. El segundo inconveniente tiene relación con la variabilidad metodológica en el uso de este conjunto de dilemas de Greene. Las fuentes de variabilidad están en la selección de dilemas que se presentan, la formulación de la pregunta en términos de si/no o correcto/incorrecto, el formato de presentación de la tarea

de tipo computarizado o de lápiz y papel; y el orden de presentación de los dilemas. Esta heterogeneidad metodológica plantea como problema fundamental la dificultad para comparar y replicar estudios realizados (Cushman, 2008; Christensen&Gomila, 2012; Hauser et al., 2007; Kahane & Shackel, 2010). En tercer lugar, algunas propiedades psicométricas como fiabilidad y validez no están determinadas claramente por lo que se dificulta su aplicación como instrumento de evaluación fuera del ámbito experimental, ya sea en población normal o clínica. Finalmente, el tiempo de aplicación de los 60 dilemas puede resultar excesivo. El tiempo medio empleado por la población normal es de 45 minutos, pero éste aumenta significativamente en poblaciones clínicas dónde la evaluación de los juicios morales podría ser muy recomendable, como por ejemplo en personas drogodependientes o con daño cerebral adquirido (Carmona-Perera et al., 2012; Greene et al., 2004; Koenigs et al., 2007).

En conjunto, los hallazgos sobre la toma de decisiones-morales señalan un patrón utilitario del jucio moral en poblaciones que presentan alteraciones en áreas cerebrales vinculadas con la emoción, alteraciones en el procesamiento emocional y alteraciones conductuales, como conductas de agresividad y violencia. Una población de estudio que cumple con estos criterios son los pacientes drogodependientes, en los cuales se han descrito alteraciones de la CPFVM, alteraciones emocionales y en la toma de decisiones, así como conductas violentas o antisociales. Por ello, sería de gran interés ampliar la investigación de toma de decisiones morales a la población drogodependiente.

Capítulo 2

Drogodependencias: una nueva población de estudio

1. Definición y conceptos introductorios

La dependencia del consumo de sustancias adictivas es definida por el DSM-IV (American Psychiatric Association & others, 2000) como un trastorno recidivante crónico que se caracteriza por un conjunto de manifestaciones cognitivas, conductuales y físicas, la compulsión de buscar y consumir tales sustancias, así como una pérdida de control de la conducta. Se manifiesta a través del consumo abusivo y continuo de drogas a pesar de las consecuencias adversas que origina a nivel psicológico, físico y social a la propia persona y su entorno familiar. Según el manual de diagnóstico DSM-IV, la dependencia se diferencia del abuso de sustancias por la presencia de síntomas de abstinencia, tolerancia y fuertes deseos y preocupación por el alcohol.

De acuerdo con el informe mundial de drogas de las Naciones Unidas de 2013 (EMCDDA Annual Report, 2013) la tasa de prevalencia del consumo de drogas durante el periodo 2011-2012 se sitúa alrededor del 5% de la población mundial. El patrón de abuso predominante en las adicciones es el policonsumo de diversas drogas como la heroína, la cocaína, el cannabis, las anfetaminas, el éxtasis (MDMA) y el alcohol, siendo éste el tipo de consumidor que más demanda tratamiento, por lo que el estudio de la población de policonsumidores aborda un problema clínicamente relevante.

La prevalencia de los trastornos por consumo de alcohol es muy elevada, siendo del 4.7% para el abuso de alcohol y del 3.8% para la dependencia de alcohol (NESARC, National Epidemiologic Survey on Alcohol and Related Conditions). El consumo abusivo de alcohol es un problema de alcance mundial que origina diversos trastornos somáticos, psicológicos y neurológicos, así como una elevada mortalidad, causando 2.5 millones de muertes al año.

2. Modelo Marcador somático de las adicciones (Verdejo-García & Bechara, 2009)

De acuerdo con el modelo original del marcador somático (Damasio, 1994), la toma de decisiones es un proceso guiado por la señales emocionales (marcadores somáticos) que anticipan las consecuencias de las posibles opciones de respuesta. En el caso de las adicciones (Verdejo-García & Bechara, 2009), se produce una disfunción en la generación, la lectura o la regulación de las señales emocionales asociadas a la consideración de las consecuencias aversivas del consumo de sustancias. Los estímulos relacionados con las drogas o la imaginación de experiencias previas de consumo generan marcadores somáticos muy potentes que intervienen sobre áreas cerebrales específicas (p.e. la corteza prefrontal ventromedial, la amígdala, la insula o la corteza cingulada anterior) y sesgan la toma de decisiones hacia el consumo, en detrimento de otras posibilidades más adaptativas a largo plazo. En otras palabras, el vacío afectivo que muestran las personas drogodependientes en el proceso de toma de decisiones propicia la elección de opciones de consumo caracterizadas por un reforzamiento inmediato a pesar de las consecuencias negativas a medio y largo plazo (miopía de futuro).

A pesar de no centrarse explícitamente en los procesos morales, la teoría del marcador somático ha influido en la neurociencia moral y se considera un posible mecanismo subyacente al juicio moral utilitarista (Moll et al., 2005). Desde el modelo de Damasio (1994) las respuestas utilitaristas se conciben como resultado del déficit en la integración de los marcadores emocionales en el proceso de toma de decisiones morales.

3. Deterioro neuropsicológico en drogodependencias

Desde una perspectiva neuropsicológica, la adicción se considera como el resultado de un conjunto de alteraciones cerebrales que afectan a diversos procesos cognitivo-afectivos que intervienen en el juicio moral (Fernández-Serrano, Pérez-García, Río-Valle, &

Verdejo-García, 2010; Verdejo-García, Bechara, Recknor, & Perez-Garcia, 2006). Por ejemplo, se han hallado problemas en la generación, la lectura o la regulación de las señales emocionales asociadas a la consideración de las consecuencias aversivas de la respuesta utilitaristas (Aguilar de Arcos et al., 2008; Fernández-Serrano et al., 2010a); déficits en la integración de información cognitiva y emocional durante la toma de decisiones morales (Fernández-Serrano et al., 2010b; Verdejo-García & Bechara, 2009); o déficits en el control cognitivo de respuestas predominantes o impulsivas (Verdejo-García, Rivas-Pérez, Vilar-López, & Pérez-García, 2007; Verdejo-García, Lawrence, & Clark, 2008). Estos deterioros se asocian a la disfunción del lóbulo frontal, especialmente del córtex prefrontal ventromedial (Goldstein & Volkow, 2002; Verdejo-García et al., 2007), mostrando los pacientes policonsumidores reducciones estructurales en esta área (Franklin et al., 2002; Tanabe et al., 2009) que persisten después de peridos prologados de abstinencia (Kornreich et al., 2001; Verdejo-García & Bechara, 2009). A continuación, describimos con mayor exactitud los principales deterioros neuropsicológicos en drogodependencias que se encuentran implicados en la toma de decisiones morales, clasificándolos en dos apartados: procesos emocionales y funciones ejecutivas.

3. 1. Procesos emocionales

En relación a los problemas de procesamiento emocional, las personas drogodependientes en fase de abstinecia presentan alteraciones neuropsicológicas tanto en el reconocimiento de emociones como en la experiencia emocional de las mismas (Aguilar de Arcos et al., 2005; Fernández-Serrano et al., 2010a; Verdejo-García et al., 2007).

3. 1. 1. Percepción emocional

Se han hallado déficits de percepción emocional en consumidores de distintos tipos de sustancias psicoadictivas (Fernández-Serrano et al., 2010a; Foisy et al., 2007; Kemmis, Hall, Kingston, & Morgan, 2007; Kim, Kwon, & Chang, 2011). En concreto, ante imágenes de rostros que expresan emociones, las personas drogodependientes presentan dificultades para identificar correctamente las emociones expresadas, sobreestiman su intensidad y necesitan más tiempo y estímulos más intensos para pecibirlas (Foisy et al., 2007; Kemmis et al., 2007; Kim et al., 2011; Maurage, Campanella, Philippot, Martin, & Timary, 2008; Townshend & Duka, 2003; Verdejo-García et al., 2007). La mayoría de estudios señalan que los problemas en la percepción emocional son específicos para las emociones negativas (Clark, Oscar-Berman, Shagrin, & Pencina, 2007; Fernández-Serrano et al., 2010; Foisy et al., 2007; Townshend & Duka, 2003), sin embargo otros estudios han encontrado un deterioro generalizado, incluyendo también las emociones positivas (Maurage et al., 2011; Uekermann & Daum, 2008).

La dificultad para identificar emociones a partir de las expresiones faciales de otras personas constituye un elemento importante en los problemas de cognición social y en la teoría de la mente que presentan las personas drogodependientes (Maurage et al., 2008; Uekermann, Channon, Winkel, Schlebusch, & Daum, 2007; Uekermann & Daum, 2008). De hecho, algunos autores (Kornreich et al., 2002; Plutchik, 2003) plantean que los déficits en la percepción emocional se encuentran implicados en el mantenimiento de la drogodependencia al dificultar las relaciones interpersonales y propiciar el aislamiento social, favoreciendo así el consumo de drogas y las recaídas.

3. 1. 2. Experiencia emocional

En cuanto a la experiencia emocional ante estímulos afectivos, estudios

neuropsicológicos han detectado una menor activación de las personas drogodependientes ante los estímulos naturales cotidianos de naturaleza apetitiva y negativa, indicando un aplanamiento de la experiencia emocional (Aguilar de Arcos et al., 2005) En un estudio posterior (Aguilar de Arcos et al., 2008), se encontró que la disminución de gratificación ante estas situaciones perdura en el tiempo y en muchos casos es definida por los propios sujetos como "vacío afectivo" o una falta de interés por todo, lo que podría ser equiparable al desajuste emocional descrito en los pacientes neurológicos con daño cerebral adquirido.

Varios autores (Blair & Blair, 2003; Calder & Young, 2005; Fernández-Serrano et al., 2010) señalan el papel fundamental del procesamiento emocional en el comportamiento prosocial. En esta línea, se han encontrando correlaciones significativas entre los déficits de reconocimiento y experiencia emocional, y las alteraciones en el comportamiento prosocial, como por ejemplo conductas antisociales (Calder & Young, 2005; Homer et al., 2008; Reay, Hamilton, Kennedy, & Scholey, 2006).

3. 2. Funciones ejecutivas

Varios estudios han demostrado que los pacientes policonsumidores presentan un deterioro neuropsicológico significativo en distintos componentes de las funciones ejecutivas: memoria de trabajo, razonamiento analógico, fluidez, flexibilidad cognitiva, inhibición de respuesta, autorregulación y toma de decisiones (Fernández-Serrano et al., 2010b; Goldstein & Volkow, 2002; Verdejo-García et al., 2007). Entre estos déficits cabe destacar por su incidencia en los mecanismos neuropsicológicos de la adicción el deterioro en la capacidad de inhibición de respuesta, la autorregulación y la toma de decisiones.

La capacidad de inhibición de respuestas inadecuadas y de autocontrol constituye

un factor decisivo en los procesos adictivos caracterizados por una tendencia automática a la búsqueda de consumo y a cometer actos impulsivos en situaciones de afecto negativo, además estos déficits se correlacionan significativamente con mayores índices de problemas psicosociales y legales (Verdejo-García et al., 2007, 2008).

La alteración en la toma de decisiones en personas drogodependientes se encuentra mediada por las alteraciones afectivas que caractarizan esta población (Aguilar de Arcos et al., 2005; Verdejo-García et al., 2006; Verdejo-García & Bechara, 2009). Desde esta perspectiva, el modelo del marcador somático del grupo de Iowa (Damasio, 1994) propone que las señales corporales (marcadores somáticos) generadas durante el procesamiento emocional sesgan el proceso de toma de decisiones en situaciones de ambigüedad e incertidumbre. En las adicciones, el componente emocional necesario en el proceso de toma de decisión está alterado, produciendo una disfunción que hace que las personas drogodependientes no antecedan las consecuencias negativas del consumo y magnifiquen las recompensas a corto plazo.

En resumen, el deterioro en las funciones ejecutivas tiene como resultado una incapacidad para considerar simultáneamente las consecuencias inmediatas y demoradas de las distintas alternativas, impidiendo así una maximización global de las consecuencias sociales, mecanismo imprescindible para llevar a cabo un juicio moral normalizado (Barkley, 2001; Verdejo-García et al., 2006)

4. Toma de decisiones morales en drogodependencias

A pesar de que en la población drogodependiente se han descrito alteraciones emocionales y en la toma de decisiones similiares a los pacientes con daño frontal adquirido (Aguilar de Arcos et al., 2005; Fernández-Serrano et al., 2010a; Fernández-Serrano et al., 2010b; Verdejo-García et al., 2007; Verdejo-García et al., 2008),

no ha sido hasta el último año que han aparecido los primeros estudios sobre toma de decisiones morales en pacientes con adicción a sustancias psicoactivas. Hasta el momento, encontramos cinco estudios en población drogodependiente, tres de los cuales forman parte de esta tesis, y por tanto se expondrán íntegramente en el apartado de memoria de trabajos y en los anexos en el formato de la revista. Los otros dos estudios investigan la toma de decisiones morales en el alcoholismo (Khemiri et al., 2012) y en las personas con adicción a la cocaína (Verdejo-García et al., 2012).

El estudio de Khemiri (2012) llevado a cabo en 20 personas dependientes al alcohol y 20 controles, mostró que el grupo experimental presentaba una mayor proproción de respuestas utilitaristas ante los dilemas morales personales, en comparación con el grupo control. Además no se hallaron diferencias en los otros tipos de dilemas morales, ni tampoco en el conocimiento explícito de las normas sociales. El segundo estudio mostró que las personas dependientes a la cocaína presentaban alteraciones funcionales en los sitemas frontolímbicos implicados en la toma de decisiones morales (Verdejo-García et al., 2012). En concreto, mostraron una menor activación de la corteza cingulada anterior, la ínsula y el tronco cerebral durante la presentación de los dilemas morales, así como una menor conectividad funcional entre estas estructuras en estado de resposo. Estos resultados sugieren una falta de connexión entre las áreas frontolímbicas implicadas en la anticipación cognitiva y los marcadores emocionales (Verdejo-García et al., 2012).

En resumen, los pacientes drogodependientes presentan alteraciones neuropsicológicas y neuroanatómicas tanto en el procesamiento emocional como en la toma de decisiones. Sin embargo, prácticamente se desconoce como es su proceso de toma de decisiones morales, por lo que ampliar el estudio de los juicios morales en esta población sería de gran interés.

II. OBJETIVOS E HIPÓTESIS

Capítulo 3

Objetivos e hipótesis de la tesis

1. Justificación y objetivo principal

La adicción se asocia con problemas de interacción social (Leeman, Toll, Taylor, & Volpicelli, 2009; Volkow, Baler, & Goldstein, 2011) y con conductas antisociales que incluyen comportamientos ilegales, agresividad y violencia (Verdejo-García et al., 2007). De acuerdo con la neurociencia, estas características pueden derivarse de alteraciones del juicio moral, entendido como un proceso decisional que integra información situacional con el input emocional vinculado a los escenarios de contenido social y moral (Cushman et al., 2006; Moll & de Oliveira-Souza, 2007; Moll et al., 2005). Por ejemplo, los estudios neurológicos demuestran que pacientes con lesiones selectivas de las áreas que integran información cognitiva y afectiva (p.e., corteza prefrontal ventromedial) presentan rasgos utilitaristas en su juicio moral, caracterizados por priorizar el bienestar agregado a pesar de infligir una acción emocionalmente aversiva, como por ejemplo empujar a una persona a las vías del tren para salvar a un grupo de personas (Ciaramelli et al., 2007; Koenigs et al., 2007; Mendez et al., 2005; Moretto et al., 2010). Del mismo modo, los estudios de neuroimagen en voluntarios sanos demuestran que la exposición a dilemas morales produce activaciones en regiones implicadas en la generación y regulación de emociones y en el control cognitivo (Heekeren et al., 2005; Moll et al., 2002; Prehn et al., 2008; Young & Koenigs, 2007).

Las personas drogodependientes presentan un deterioro neuropsicológico significativo de las capacidades cognitivas y afectivas (Aguilar de Arcos et al., 2005; Fernández-Serrano et al., 2010a, 2012b; Verdejo-García et al., 2007; Verdejo-García et al., 2008), incluyendo problemas en la percepción, generación y la regulación de las emociones (Aguilar de Arcos et al., 2005; Fernández-Serrano et al., 2010a), déficits en el control cognitivo (Fernández-Serrano et al., 2010b; Verdejo-García et al., 2007;

Verdejo-García et al., 2008), así como déficits en la integración de la información cognitiva y emocional en el proceso de toma de decisiones (Verdejo-García & Bechara, 2009). Estos deterioros se asocian a la disfunción de la corteza prefrontal ventromedial, mostrando los pacientes drogodependientes reducciones estructurales en esta área (Franklin et al., 2002; Goldstein & Volkow, 2002; Tanabe et al., 2009). Las alteraciones neurales y neuropsicológicas descritas anteriormente persisten después de períodos prolongados de abstinencia (Goldstein & Volkow, 2002; Verdejo-García & Bechara, 2009).

Por todo ello, el objetivo principal de esta tesis fue investigar la toma de decisiones morales de las personas drogodependientes, estudiando su patrón de respuesta Utilitarista vs. Deontológica. Además investigaremos las variables psicológicas implicadas en la toma de decisiones morales en esta población, así como los correlatos psicofisiológicos durante la consideración de los dilemas morales, para una mejor comprensión de los déficits que subyacen los problemas de interacción social y la violación de normas sociales que se producen en las persononas con adicción a sustancias psicoactivas.

2. Objetivos específicos e hipótesis

Para la consecución del objetivo principal se realizaron cuatro estudios que abordan los objetivos específicos e hipótesis que se desarrollan a continuación. Cada estudio se corresponde con uno de los cuatro artículos que incluye la presente tesis doctoral.

Dado la ausencia de medidas de juicios morales validadas en población española y de extensión breve, el primer objetivo fue la obtención de un instrumento breve que nos permitiera evaluar de forma válida y fiable la toma de decisiones morales. Para ello se realizaron dos estudios consecutivos con los dos siguientes objetivos específicos (**Objetivos estudio 1**):

1- Desarrollar una versión reducida y en español del cuestionario original de dilemas morales de Greene mediante un análisis Rasch.
2- Evaluar las propiedades psicométricas de esta versión abreviada y su capacidad para superar las limitaciones metodológicas asociadas al instrumento original.

En el primer estudio se hipotetizó que la calibración de los ítems a través del análisis rasch permitiría seleccionar los más adecuados, y así reducir considerablemente el cuestionario. Las hipótesis de partida del segudo estudio fueron que (i) la nueva versión del instrumento presentará una alta fiabilidad, (ii) será válida para diferenciar los distintos tipos de dilemas morales en función del tiempo de respuesta y la proporción de respuestas afirmativas, y (iii) los dilemas incluidos en ella estarán libres de sesgos por la influencia de variables como el género, la edad, el nivel educativo y socioeconómico. Los resultados de este primer trabajo que incluye los dos estudios mencionados anteriormente, se encuentran en proceso de revisión en la revista *Assessment*, siendo el título del artículo "Brief moral decision-making questionnaire: a Rasch-derived short form of the Greene dilemmas" (Ver Anexo 1 para consultar la versión final del artículo).

Una vez dessarrollada la adaptación a la población española del instrumento de dilemas morales de Greene (2001), se procedió a estudiar la toma de decisiones morales en una población de pacientes policonsumidores. Específicamente, los **objetivos del segundo** estudio fueron:

1- Investigar la toma de decisiones morales en pacientes policonsumidores de sustancias adictivas en comparación con un grupo control de personas no consumidoras.
2- Estudiar la posible asociación entre la gravedad de consumo de los distintos tipos de sustancias (producto de la cantidad consumida al mes por la duración del

consumo en años) y las respuestas utilitaristas.

Conociendo los déficits cognitivo-emocionales, la disfunción de la corteza ventromedial y las alteraciones en la conducta social y legal de los pacientes policonsumidores, se hipotetizó que esta población presentaría: (i) una alteración en la toma de decisiones morales, caracterizada por un sesgo utilitarista del juicio moral y una menor dificultad de juicio, de modo específico para los dilemas con alta saliencia emocional (personales), y (ii) una correlación significativa entre la gravedad del consumo de sustancias y la toma de decisiones morales utilitaristas ante los dilemas personales. Los resultados identificaron la existencia de un sesgo utilitarista en la toma de decisiones morales de las personas policonsumidoras de drogas, así como una asociación entre este patrón utilitarista y la gravedad del consumo de alcohol, señalando el alcohol como la sustancia de mayor incidencia en la toma de decisiones morales, en comparación con los otros tipos de drogas. Este estudio, titulado "Moral decision-making in polysubstance dependent individuals", está publicado en la revista *Drug and Alcohol Dependence* (Carmona-Perera, Verdejo-García, Young, Molina-Fernández, Pérez-García, 2012). (Ver Anexo 2 para la versión íntegra del artículo).

A partir de los resultados del segundo estudio en pacientes policonsumidores, procedimos a realizar un tercer estudio con el fin de investigar los procesos psicológicos que subyacen el sesgo utilitarista en la toma de decisiones morales en las personas dependientes al alcohol. En concreto, los **objetivos del tercer estudio** fueron:

1- Replicar en los pacientes dependientes al alcohol el sesgo utilitarista encontrado previamente en los pacientes policonsumidores.
2- Determinar la capacidad predictiva de los factores psicológicos que se han asociado previamente con el sesgo utilitarista. En concreto, se evaluaron los

efectos predictivos de la gravedad del consumo de alcohol, el estado de ánimo, la impulsividad, y la decodificación emocional.

En este estudio se hipotetizó que las personas dependientes al alcohol (i) emitirían juicios morales más utilitarios ante los dilemas emocionalmente salientes (dilemas personales), y (ii) que la toma de decisiones morales utilitaristas estaría vinculada a la gravedad del consumo de alcohol, puntuaciones elevadas en impulsividad, ansiedad y depresión, así como a una deficiente decodificación de las emociones negativas. Este estudio ha sido enviado a la revista *Alcoholism Clinical and Experimental Research,* dónde se encuentra en prensa bajo el título "Impaired decoding of fear and disgust predicts utilitarian moral judgment in alcohol-dependent individuals". (Ver Anexo 3 para la versión íntegra del artículo).

Tras el tercer estudio realizado en pacientes dependientes al alcohol, y una vez demostrada su alteración en la toma de decisiones morales y el papel relevante de la decodificación de emociones negativas, concretamente el miedo y el asco, se llevó a cabo un cuarto estudio en la misma población para examinar los correlatos psicofisiológicos del sesgo utilitarista a través de la tasa cardiaca. En concreto, los **objetivos** de este **cuarto estudio** fueron:

1- Determinar la contribución de la experiencia emocional en la toma de decisiones morales utilitaristas, a través del estudio de la tasa cardiaca durante los dilemas morales, como índice de experiencia emocional aversiva.
2- Examinar si el patrón de respuesta utilitarista hallado se asocia con déficits en la variabilidad de la tasa cardiaca en condiciones basales (en reposo), como índice de regulación emocional.

En este estudio se hipotetizó que las personas dependientes al alcohol mostrarían: (i)

una disminución de la reactividad cardiaca ante los dilemas morales, en concreto una menor desaceleración cardiaca, que indicaría una menor experiencia emocional aversiva durante los dilemas morales personales, y (ii) una reducción de la variablidad cardiaca durante la línea base, señalando una menor regulación emocional que se correlacionaría con una mayor proporción de respuestas utilitaristas en los dilemas personales de alta saliencia emocional. Los resultados de este estudio titulado "Heart rate correlates of utilitarian moral decision-making in alcoholism" se encuentran en proceso de revisión en la revista *Drug and Alcohol Dependence*" (Ver Anexo 4 para la versión íntegra del artículo).

Para una mayor comprensión, los objetivos citados se presentan en el siguiente diagrama de flujo:

Objetivo principal

Investigar la toma de decisiones morales y sus correlatos psicológicos y psicofisiológicos en pacientes drogodependientes

Objetivo 1: Desarrollar un instrumento breve de evaluación de la toma de decisiones morales.

Objetivo específico 1: Desarrollar una versión en español y reducida del cuestionario original de dilemas morales de Greene mediante un análisis Rasch.
Objetivo específico 2: Evaluar las propiedades psicométricas de la versión abreviada del instrumento.

→ **1ª Publicación**
Brief moral decision-making questionnaire: a Rasch-derived short form of the Greene dilemmas

Objetivo 2: Estudiar la toma de decisiones morales en los pacientes policonsumidores de sustancias adictivas.

Objetivo específico 1: Investigar la toma de decisiones morales y la dificultad de juicio en pacientes policonsumidores.
Objetivo específico 2: Estudiar la asociación entre la gravedad del consumo de sustancias y la toma de decisiones morales.

→ **2ª Publicación**
Moral decision-making in polysubstance dependent individuals

Objetivo 3: Investigar la toma de decisiones morales en las personas dependientes al alcohol y las variables psicológicas asociadas al sesgo utilitarista.

Objetivo específico 1: Replicar en los pacientes dependientes al alcohol el sesgo utilitarista encontrado previamente en los pacientes policonsumidores.
Objetivo específico 2: Evaluar los efectos predictivos de la gravedad del consumo de alcohol, el estado de ánimo, la impulsividad y la decodificación emocional, en la toma de decisiones morales.

→ **3ª Publicación**
Impaired decoding of fear and disgust predicts utilitarian moral judgment in alcohol-dependent individuals

Objetivo 4: Estudiar los correlatos psicofisiológicos del sesgo utilitarista en las personas dependientes al alcohol a través de la tasa cardiaca.

Objetivo específico 1: Examinar la tasa cardiaca durante los dilemas morales, como índice de experiencia emocional aversiva.
Objetivo específico 2: Examinar la variabilidad cardiaca en reposo, como índice de regulación emocional.

→ **4ª Publicación**
Heart rate correlates of utilitarian moral decision-making in alcoholism

III. MEMORIA DE TRABAJOS

Capítulo 4

Brief moral decision-making questionnaire: a Rasch-derived short form of the Greene dilemmas

Carmona-Perera, M., Caracuel, A., Pérez-García, M., Verdejo-García, A. (Under review). Brief moral decision-making questionnaire: a Rasch-derived short form of the Greene dilemmas. *Assessment*.

1. Introduction

Moral decision-making reflects the appropriateness of our own and others' behaviors against the social views of right and wrong, thus establishing social behavior on a continuum ranging from prosocial acts to aggressive and violent behaviors (Moll, Zahn, Oliveira-Souza, Krueger, & Grafman, 2005). Our moral decisions can be classified as utilitarian or deontological; utilitarian decisions entail endorsement of an emotional aversive action in favor of communitarian well-being (e.g., smothering a baby to save a group of individuals during wartime) whereas deontological decisions involve refusal to cause harm despite the advantages it would bring in terms of costs-benefits (e.g., deciding not to smother the baby although this implies the death of a greater number of individuals).

The most common method to assess moral decisions is through moral dilemmas scenarios. A moral dilemma is a hypothetical scenario that generates a moral conflict, and then requires the individual to decide whether s/he would accept or refuse to take the utilitarian action. The response decision biases (whether acceptance rates are high or low) allows the classification of individuals based on predominantly utilitarian or deontological patterns. The battery of dilemmas by Greene (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001) is currently the most widely used in experimental studies on moral decision-making (Cushman & Greene, 2011; Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008; Greene, Nystrom, Engell, Darley, & Cohen, 2004; Koenigs et al., 2007). The battery consists of 60 scenarios classified into three main categories: non-moral, impersonal-moral and personal-moral (see dilemmas in http://wjh.harvard.edu/ ~ mcl / materials / Greene-CogLoadSupMats.pdf). Non-moral dilemmas involve a rational decision without moral content. For example, in the "Train or Bus" dilemma, one must decide whether to travel by train or bus, given certain time

constraints. The impersonal-moral dilemmas involve indirect and not serious bodily harm, inducing a low emotional salience. For example, the "Standard Trolley" dilemma posits flipping a switch to turn a train away from five individuals but towards one person. By contrast, personal-moral dilemmas involve high emotional salience, inflicting directly a severe physical harm to a person or specific group in order to save a greater number of people. Personal dilemmas are further divided into low and high-conflict dilemmas based on response times and degree of consensus (Greene et al., 2004; Koenigs et al., 2007). An example of high-conflict would be the "Smothering Baby" dilemma. An example of low-conflict is the "Architect" dilemma in which participants must decide (whether or not) to push a "bullying boss" off a building knowing that the rest of the office would think he fell by accident. In low-conflict dilemmas, the response time is significantly lower than in high-conflict dilemmas, whereas the utilitarian answers consensus is significantly greater (Koenigs et al., 2007). Notably, the application of this battery of moral dilemmas has shown substantial sensitivity to detect social decision-making problems in a range of clinical groups relevant to neuropsychological research and practice, including acquired brain injuries (Koenigs et al., 2007; Moretto, Làdavas, Mattioli, & di Pellegrino, 2010), frontotemporal dementia (Gleichgerrcht, Torralva, Roca, Pose, & Manes, 2011; Mendez, Anderson, & Shapira, 2005; Mendez & Shapira, 2009), psychopathy (Blair, 2007; Cima, Tonnaer, & Hauser, 2010; Young, Koenigs, Kruepke, & Newman, 2012), drug addictions (Carmona-Perera, Verdejo-García, Young, Molina-Fernández, & Pérez-García, 2012; Carmona-Perera, Clark, Young, Pérez-García, & Verdejo-García, In press; Khemiri, Guterstam, Franck, & Jayaram-Lindström, 2012), autism (Buon et al., 2012; Gleichgerrcht et al., 2012, Moran et al., 2011), and anxiety (Youssef et al., 2012).

The Greene's battery of dilemmas has therefore demonstrated sensitivity and discriminant validity to assess moral decision-making in clinical populations in

neuroscientific research. However, the fact that it was not originally designed as a clinical assessment tool has raised a number of concerns related to its applicability outside the laboratory context (Abarbanell & Hauser, 2010; Cushman, 2008; Christensen & Gomila, 2012; Hauser, Cushman, Young, Kang-Xing Jin, & Mikhail, 2007; Kahane & Shackel, 2010). First, the administration time of the full battery of 60 dilemmas is too long to make feasible its application to clinical settings (Carmona-Perera et al., 2012; Greene et al., 2004). Second, its psychometric properties have not been firmly established (Christensen & Gomila, 2012, Hauser et al., 2007). Third, several studies have showed that individual differences in demographic variables (Abarbanell & Hauser, 2010; Fumagalli et al., 2010; Navarrete, McDonald, Mott, & Asher, 2012) and discrepancies in stimuli presentation (Cushman, 2008; Christensen & Gomila, 2012) can significantly impact on decision patterns. Both inter-rater variability and heterogeneity of applications hamper the opportunity to compare and replicate the findings from different studies or to use the dilemmas for clinical assessment purposes (Cushman, 2008; Christensen & Gomila, 2012, Hauser et al., 2007; Kahane & Shackel, 2010). Consequently, the development of a standardised questionnaire measure based on the original dilemmas and able to control the previously identified confounding variables have important advantages for neuropsychological research and practice.

Possible methodologies to obtain a standardized version of the Greene battery of dilemmas include joint measurement models encompassed in the Item Response Theory, particularly the Rasch model (1980). This model provides an adequate framework to revamp the moral dilemmas battery and make it both more feasible for application to clinical populations and more psychometrically robust and resistant to the impact of extraneous variables. Rasch analysis is the most frequently applied method in health sciences to reduce questionnaires without diminishing its psychometric properties

(Blanchin et al., 2011). Rasch analysis offers statistic criteria such as calibration and item fit that can be used for deleting redundant items and low quality items that contain harmful elements for construct validity. It also provides statistical proofs of construct unidimensionality, a requirement to use an overall score based on the sum of the item responses. Rasch analysis provides statistic indexes of reliability and suitability for the particular sample being evaluated. This method checks the presence of differential item functioning (DIF) or an item bias among the sample groups, for example, age, gender or economic status (Tennant & Conaghan, 2007). Statistical information provided by the Rasch analysis allows us to refine the instruments, shorten their length without losing the measure of the constructs in its entirety, standardize the quality of all items and eliminate those that reflect the influence of other variables distinct from constructing moral judgments.

We conducted two consecutive studies in order to (1) develop a shortened version of the original set of dilemmas based on the principles of Rasch analysis, and (2) test the psychometric properties of this shortened version and to what extent this version addresses the methodological limitations associated with the original set of dilemmas.

We hypothesized that a calibration of items will be helpful for retaining appropriate items in a shortened form. Second study aimed to determine psychometric properties of this brief questionnaire in a community sample. We hypothesize that this abbreviated moral dilemmas questionnaire (i) will have sound reliability in accordance to both Rasch model and Classical Test Theory parameters, (ii) will have adequate criterion validity by differentiating the distinct types of moral dilemmas in terms of the proportion of affirmative responses, decision difficulty and time response, and (iii) will be low impacted by typical confounders such as gender, age, education and socioeconomic level.

2. Method

The inclusion criteria were aged over 18 years old and to have at least a primary school education to ensure reading comprehension. Exclusion criteria include not having current or past diagnoses of substance abuse or dependence, and the absence of clinically significant psychiatric symptoms. The Interview for Research on Addictive Behaviour (IRAB; Verdejo-García, López-Torrecillas, Aguilar de Arcos & Pérez-García, 2005) was used to assess compliance with drug abuse criterion, and the Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 2000) was used to assess compliance with psychiatric symptoms criterion. This study was approved by the Ethics Committee of the University of Granada. The participants were informed of the study conditions and signed an informed consent form.

2.1. Study 1. Development of a Brief Moral Decision-Making Questionnaire (BrMoD)

2.1.1. Participants and procedure

One hundred and seventy two undergraduate students participated in this study. Participants were recruited from the schools of education and health sciences of the University of Granada (Spain) between April 2009 and June 2009. Eighteen participants were excluded due to drug dependence or clinically significant psychiatric symptoms; therefore, the final sample was composed of 154 participants (120 women and 34 men). The mean age of participants was 21.51 years (SD = 5.22) and the mean years of education were 16.80 years (SD = 1.97). The moral decision-making assessment was administered in groups of 20 participants that performed the dilemmas in paper-and-pencil format with no time limits. The mean duration of administration was of 45 minutes.

2.1.2. Instrument and variables

Participants filled out the battery of 60 dilemmas compiled by Greene (Greene et al., 2001) adapted to Spanish population. This version showed adequate psychometric properties in a community sample (Cronbach's alpha = .71 and Spearman Brown coefficient = .76; Carmona-Perera, Verdejo-García & Pérez-García, 2009). The Dependent measure was the proportion of affirmative responses to the dilemmas. Affirmative answers were considered "utilitarian" for moral dilemmas and "logical" for non-moral dilemmas.

2.1.3. Analysis

Separate Rasch analyses were conducted on two sets of dilemmas (20 non-moral and 40 moral) in order to calibrate the items. Calibration is a process for locating items on a Rasch scale according to their probability of being responded positively (logically on the scale of non-moral dilemmas and in a utilitarian manner for moral dilemmas). Generally, items are distributed in positions ranging from -3 (a greater probability of a positive response) to +3 (less probability) (Tesio, 2003). Rasch analyses were performed with RUMM2030 software (RUMM Laboratory Pty. Ltd., Perth, Australia).

2.2. Studt 2. Psychometric properties of the BrMoD Questionnaire and capacity to address previously identified confounding variables

2.2.1. Participants and procedure

One hundred and thirty three individuals (72 women and 61 men) participated in this study. Participants were recruited from community and leisure centers (e.g., singing choirs, sport clubs or traditional dances) between May 2010 and June 2011 using flyers-based advertisement and word-of-mouth communication. The average age was

37.90 (SD = 14.04) with a range of 19-69 years. The educational level ranged between 9 and 20 years of education with an average of 17.29 (SD = 2.90). For socioeconomic status, 16.36% of the sample was at a low level, 64.40% at an average level and 19.24% at the highest level. The brief moral decision-making questionnaire (BrMoD) was administered individually through a computer implementation. Each administration lasted approximately 20 minutes.

2.2.2. Instrument and variables

We used the Brief Moral Decision-Making Questionnaire (BrMoD) derived from the battery of moral dilemmas by Greene (Greene et al., 2001) in study 1. (See table 2 for a description of 32 dilemmas in the BrMoD). The items were presented in a counterbalanced order across three consecutive computer screens. On the first screen, the description of the dilemma appeared. The second screen asked the participant whether he would perform the proposed action and recorded the response time. On the last screen, the participant was asked to indicate the degree of subjective difficulty to decide, on a scale of 1 (low difficulty) to 10 (high difficulty). Each screen continued with no time limit as the participants read and responded to the dilemmas.

The dependent variables of the study 2 were the participant's responses to the 32 dilemmas. For Rasch analyses, affirmative and negative responses, coded as 1 and 0, were respectively introduced, whereas for the remainder of analysis, the proportion of affirmative answers for each type of dilemma was considered. Consistent with previous studies (Greene et al., 2004; Koenigs et al., 2007) the average difficulty to decide and mean time response were used as the dependent variables to discriminate between personal low and high-conflict personal dilemmas.

2.2.3. Analysis

We applied the analyses included under both the traditional Classical Test Theory, and the modern Item Response Theory. Initially, descriptive analyses were applied to determine the demographic profile of the participants. A Rasch analysis was subsequently applied to dichotomous responses of the items to determine the fit of the short questionnaire to the Rasch model and those psychometric characteristics of the instrument that this type of analysis provided. Subsequently, reliability was analyzed using Cronbach and Spearman Brown's *alpha* coefficients. Subsequently, repeated mean ANOVA analyses were conducted to examine differences in the dependent variables in terms of the dilemma types. Finally, performance in the task of moral dilemmas was analyzed in terms of differences in the demographic variables using ANOVA tests. The analyses were performed with SPSS (IBM SPSS Statistics, Somers, New York) and RUMM2030 (RUMM Laboratory Pty. Ltd., Perth, Australia) programs.

3. Results

3.1. Study 1. Development of a Brief Moral Decision-Making Questionnaire (BrMoD)

3.1.1. Reduction of non-moral dilemmas

As non-moral dilemmas assess logical reasoning ability, our criterion was to ensure the exclusion of items that were less likely to be answered in a logical manner. Then, just the eight items that were located above zero on the Rasch scale were retained. These items, that were the most frequently answered in a logical manner for the sample, constitute a true control subscale absolutely free from the possibility of responses influenced of variables outside of the "logical reasoning" construct. These items maintain the structure of the original battery because one-half of them were of the reverse type, i.e., the logical response is "no", and have to be coded as positive.

3.1.2. Reduction of moral dilemmas

Criterion for excluding moral items was their location at both ends of the Rasch scale, in which the consensus of deontological (items near +3) or utilitarian responses (items near -3) was greater than 95%. This high consensus indicated that the two possible response options were too unbalanced to propose a real dilemma to the subject. Sixteen of the forty items were excluded. In examining all these items, five of them belonged to the impersonal category, were located consecutively at the end of the deontological pole, and it is noteworthy that were of fundamentally economic content. From the personal category, only three items were removed and were those that did not meet the criterion of invariance among groups required to fit the Rasch model. These findings support that excluding these items prevents the subjects' economic levels from influencing their responses and those that did not fit the Rasch model. Finally, the Brief Moral Decision-Making Questionnaire (BrMoD) based on Greene's dilemmas was composed of 24 moral items, in which 8 were in the impersonal category, 6 in the personal low emotional conflict category and 10 in the high conflict category, including a control scale consisting of 8 non-moral items. These dilemmas are showed in the table 2.

3.2. Study 2. Psychometric properties of the BrMoD Questionnaire and capacity to address previously identified confounding variables

3.2.1. Psychometric properties according to the Rasch model

The overall fit and unidimensionality of the questionnaire. Table 1 shows the results of the conducted Rasch analyses. In the first analysis, all 32 BrMoD dilemmas were included with the results of the item-trait interaction indicated by a statistically significant chi-square value; therefore, overall, the questionnaire did not meet the fit criteria for the Rasch model. This result suggests that the included dilemmas

corresponded to more than one latent construct. This result makes sense because the questionnaire consisted of moral and non-moral dilemmas; therefore, the subsequent Rasch analyses were performed, including responses only to the moral type of items. The results (see Analysis 2 in Table 1) indicated that this battery of dilemmas showed a good fit to the Rasch model (a non-significant chi-square). Subsequently, a review of the unidimensionality of the moral dilemmas was undertaken, which indicated that all included items were useful in evaluating a single coherent capacity, i.e., a component of the identical construct. The method used to study unidimensionality, described by Tennant and Pallant (2006) as the preferred and most rigorous method, consisted of performing a principal component analysis of the residuals and included defining two subsets of items according to the positive or negative sign for each item in the first component (Smith & Miao, 1994). A fit to the Rasch model was then performed separately for each subset, and the forecast of the location of the subjects was obtained for each and was compared with a paired *t*-test. The criterion used to accept or reject unidimensionality was the percentage of *t*-tests that fell outside a 95% confidence interval and did not exceed 5% of the total (Tennant & Conaghan, 2007).

Table 1. Results of Rasch analyses applied to 133 participant's responses to determine the fit and psychometric properties of the Brief Moral Decision-Making questionnaire.

Analysis	Item-trait interaction	Item Fit residual	Person Fit residual	Reliability	Unidimensionality
	χ^2 (*p*)	Mean (SD)	Mean (SD)	PSI	Significant t-test at CI 95%
All 32 items	122.17 (.000)	-.16 (1.16)	-.33 (.71)	.78	Non aplicable
24 moral items	83.79 (.161)	-.29 (.94)	-.28 (.57)	.80	3.76% (5/133)

χ^2*:* Chi square value; PSI: Person Separation Index; CI: Confidence Interval.

A Rasch analysis cannot be applied to non-moral items because, unsurprisingly, they are too easy and homogeneous for scaling (Styles & Andrich, 1993). Two (Train or Bus and

Computer) were answered affirmatively by 100% of the sample, and the remaining six (Standard Turnips, Scheduling, Reversed Turnips, Investment Offer, Broken CVR and New Job) were affirmatively answered by more than 94% of the participants.

Reliability. After confirming that the sample data fit the model, one could obtain other parameters on the quality of the items and entire questionnaire. Reliability from the perspective of the Rasch model was indicated by the Person Separation Index (PSI). This index measured the ability of the BrMoD moral dilemmas to discriminate among individuals in the sample based on the amount of the construct they possessed, i.e., their degree of moral judgment. A value of 0.8 was acceptable because it allowed us to separate individuals into three levels (low, medium or high) with a confidence level of 95% (Fisher, 1992).

Construct validity. The construct validity and coverage for proper measurement was determined. The calibration or location of the items on the Rasch scale allowed us to observe that they were distributed over a wide range from -4.1 (an item with high probability of utilitarian type response) to +5.05 (an item with high probability of ethical type response), as shown in Table 2.

Table 2. Item location order for moral dilemmas of the Brief Moral Decision-Making questionnaire (BrMoD).

Dilemma Category	Item content description	Location	SE	Item Fit Residual	χ^2	*p*
Impersonal	Standard Trolley	-4.10	.44	-.17	1.11	.775
	Guarded Speed Boat	-3.23	.33	.25	1.71	.634
	Environmental Policy A2	-3.22	.32	-.55	5.83	.120
	Environmental Policy B2	-3.15	.32	-.87	4.49	.213
	Environmental Policy A1	-2.86	.29	.42	.77	.857
	Standard Fumes	-2.67	.28	.48	.87	.834
	Environmental Policy B1	-2.28	.25	2.19	6.19	.103
	Vaccine Policy	-1.43	.22	.75	3.84	.279

Personal	Lifeboat Modified	-1.07	.21	-.36	.61	.895
High-conflict	Vaccine Test	-1.04	.21	-.64	5.02	.171
	Euthanasia	-0.99	.21	-.78	2.45	.484
	Lawrence of Arabia	-0.85	.21	-1.04	3.98	.264
	Ecologists	-0.35	.21	-1.85	5.19	.158
	Vitamins	.22	.21	.73	6.17	.104
	Sophie's Choices	.41	.21	-.18	1.24	.743
	Sacrifice	1.26	.23	-2.31	8.19	.042
	Footbridge	1.31	.23	.21	8.30	.040
	Crying Baby	1.56	.24	-1.57	6.34	.100
Personal	Transplant	2.23	.28	.26	6.71	.082
Low-conflict	Plane Crash	2.41	.30	-.69	1.28	.734
	Architect	3.83	.48	-.94	1.14	.776
	Smother for Dollars	3.91	.50	-.10	1.69	.639
	Infanticide	5.04	.81	-.14	.35	.950
	Country Road	5.05	.81	-.13	.34	.952

Note: SE: Standard error; χ^2: Chi square value

The construct validity of the test was empirically verified and determined whether the location of the items corresponded to the theoretical postulates. It was noted that at the extreme negative sign, all items were impersonal and centered among those of high conflict, and on the positive extreme, the items were of low-conflict with no overlap among the three types of dilemmas. This distribution reflected the existence of a continuum from the utilitarian pole (the negative end of the scale) to the deontological pole (the positive end). The construction of the continuum was performed as a function of the utilitarian response probability of each item, as determined by the Rasch analysis. This structure corresponded closely with the categorization of dilemmas encountered by Greene (2004) and Koenings (2007) and demonstrated the validity of the BrMoD construct. Regarding covering the continuum, both Table 2 and Figure 1 show that the items covered the entire space without leaving large gaps, which enabled an accurate measurement of the entire moral judgment construct.

Targeting. The third parameter of the Rasch analysis was the appropriateness of the item

set to measure the moral judgment of the sampled participants. Therefore, we compared the average of the sample localization shown in Table 1 (mean = -.28, SD = .57) with the value .0, at which the Rasch analysis located the mean of the items by default. The closeness between two means indicated the suitability of the items to measure the amount of this construct in all participants. Furthermore, we graphically confirmed the person-item map (Figure 1) and observed that there was a good match between the distribution of participants (the upper section of Figure 1) and items (the bottom of Figure 1) in the construct. On the positive end of the scale, we observed the two items least likely to be answered in a utilitarian manner (Infanticide and Country Road), and because of their significant deviation from the location of the sample, these items could be useful in detecting individuals whose positive responses indicated that they differed greatly from what was socially expected in these two cases.

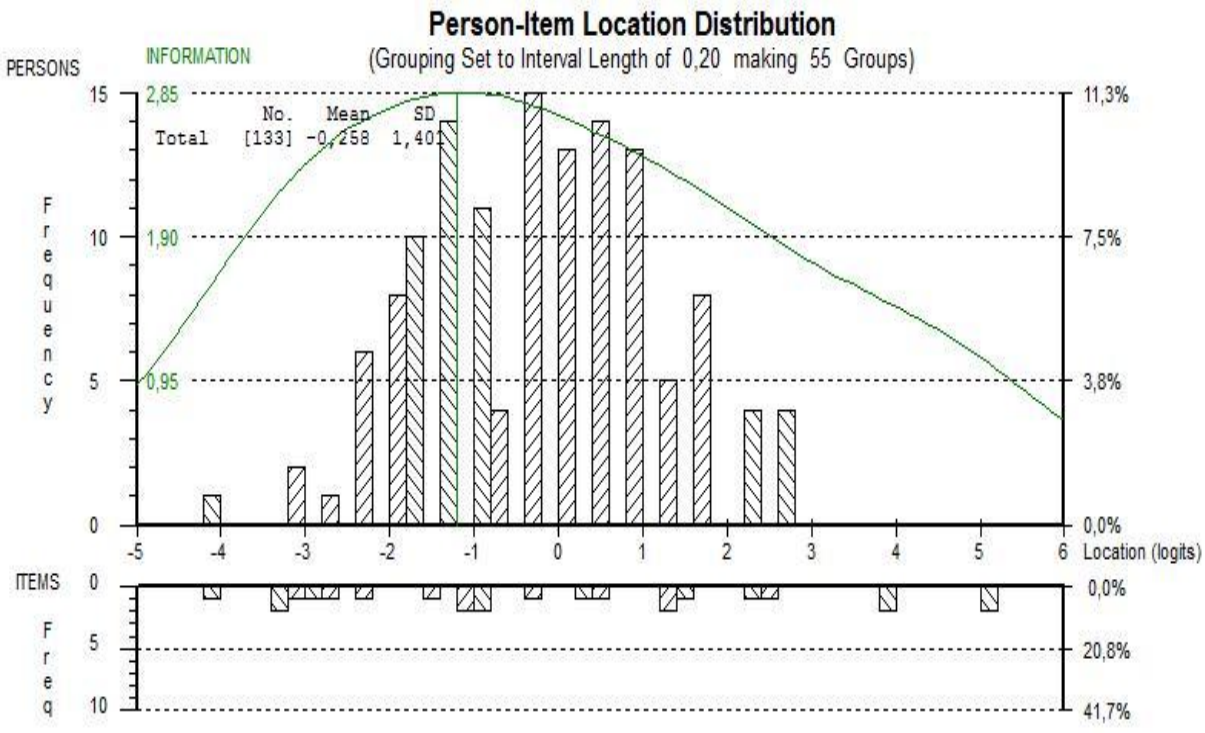


Figure 1. Distribution of item (lower half) and person locations (upper half) along the judgment construct. Grouping is set to interval length of .20.

Differential Item Functioning (DIF). The Rasch analysis determined whether there were biases because of any item that behaved invariably in the different groups identified in the sample, for example, in men and women. For this analysis, sex, age (categorized in groups of 18 to 27, 28 to 37, 38 to 47 and older than 48), education (primary, secondary and tertiary) and economic level (low, medium and high) were introduced to investigate whether any items showed DIF among different levels defined in each group. An ANOVA of person-item deviation residuals with person factors and class intervals as factors was run using the RUMM2030 software. No DIF was observed by any factor, thus supporting the construct validity of the shortened set of dilemmas.

3.2.2. Psychometric properties according to the classical test theory

Reliability. The three dependent variables showed good reliability as measured by the internal consistency coefficient Cronbach alpha (Affirmative Responses = .78, Difficulty in deciding = .75 and Response Time = .73). There was also a good reliability with these variables as indicated by the split-half coefficient of the Spearman Brown analysis (.76, .67 and .70, respectively).

Construct validity. We determined the ability to discriminate the categories of dilemmas by an ANOVA, which showed significant differences among the various categories of dilemmas depending on the main dependent variable proportion of positive responses F (3,396) = 967.88, MSE = 429.18, $p < .001$. Pairwise comparisons showed significant effects in all contrasts, with the high-conflict personal dilemmas obtaining less answer consensus with 44.69% of the utilitarian responses (Figure 2 a). The comparison between the personal high and low emotional conflict dilemmas showed greater decision difficulties F (1,132) = 613.67, MSE = 1.96, $p < .001$ and higher response times F (1,132) = 91.75, MSE = 238.34, $p < .001$ for high-conflict dilemmas (Figure 2 b and 2 c).

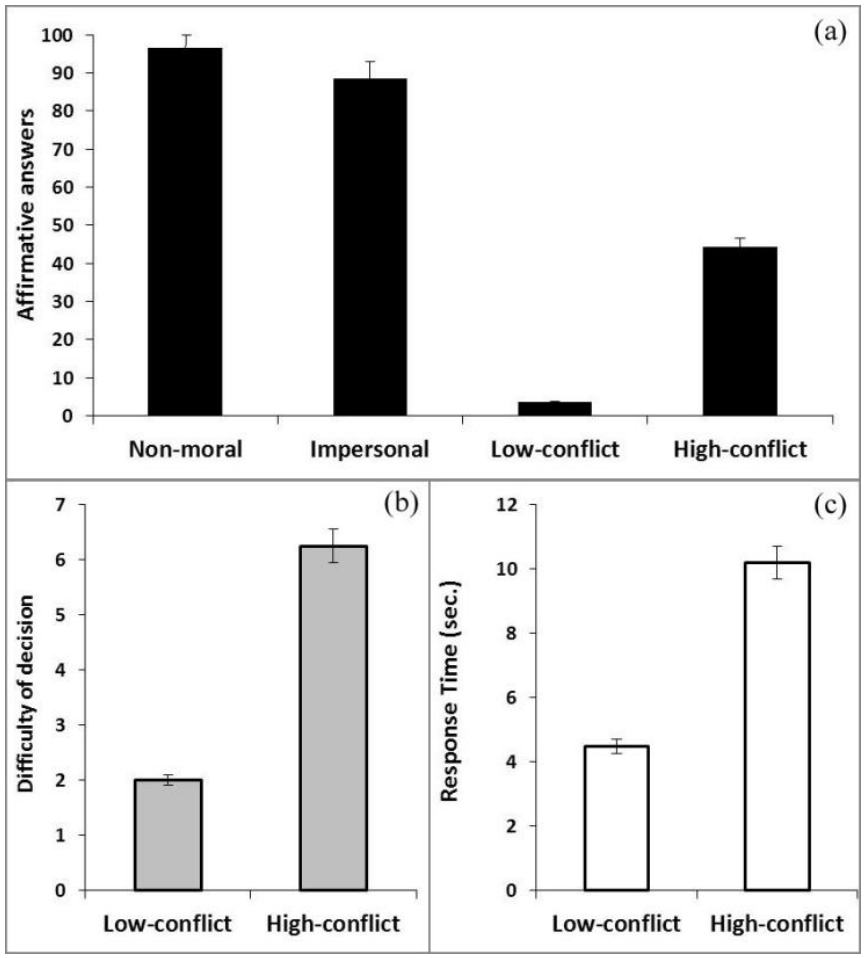


Figure 2. Proportion of affirmative answers (a), difficulty of decision mean (b), and average time response in seconds (c) in function of dilemma category for the 133 community sample in the Brief Moral Decision-Making questionnaire (BrMoD).

The influence of socio-demographic variables (gender, age, educational level and socioeconomic status) in moral decisions-making. The ANOVA analyses for the dependent variable proportion of positive responses did not significantly differ by gender F (3,393) = .16, MSE = 649.63, p = .219, age F (9,387) = .94, MSE = 392.69, p = .462, education F (6,351) = .56, MSE = 245.66, p = .671 or socioeconomic status F (6,303) = 1.49, MSE = 688.19, p = .216. For the decision difficulty and response time variables in personal dilemmas, no significant differences were observed in either with the value of p < .05 in any demographic variable analyzed.

4. Discussion

We report two consecutive studies directed to (1) obtaining a shortened standardized questionnaire based on the original set of Greene's moral dilemmas (2001) through the use of Rasch analyses, and (2) testing the psychometric properties of this questionnaire, and its ability to control previously identified confounding variables. In our first study we obtained a Rasch-derived Brief Moral Decision-making Questionnaire (BrMoD). In our second study we demonstrated that the BrMoD questionnaire has adequate psychometric properties and correctly addresses the main limitations associated with the Greene's original battery.

The selection of 32 dilemmas from the set of 60 Greene dilemmas (2001) using a Rasch analysis reduced the length of the questionnaire by almost half, thus minimizing potential fatigue and distraction factors. Regarding psychometric properties, the questionnaires demonstrated good reliability and construct validity in both classical and modern test theories. A Rasch analysis allowed us to define the moral judgment construct as a continuous function of the items probability to be answered in a utilitarian manner. Between the extremes of the continuum, consisting of utilitarianism and deontology, the three categories in the order of "impersonal and personal dilemmas of high or low personal conflict" were correctly graded. The calibration of the dilemmas on the Rasch scale indicated an underlying pattern in which impersonal items were more easily answered in a utilitarian manner than personal dilemmas. The ability of the continuum to differentiate between personal and impersonal dilemmas was consistent with the dual-process hypothesis (Greene et al., 2004; 2008), in which impersonal dilemmas are leaded by cognitive mechanisms, whereas personal dilemmas evoke an aversive emotional response that generates a deontological decision against causing harm. In turn, discrimination on the continuum between personal dilemmas of high and low-conflict

allows the adjustment of the level of utilitarianism, thus situating the dilemmas of low-conflict at an ethical extreme in which most individuals choose to reject aversive action. Specifically, only those individuals who have a more utilitarian pattern answer affirmatively answer to low-conflict dilemmas, whereas the percentage of utilitarian and deontological options in high-conflict dilemmas is practically divided in the normal population. The ability of the questionnaire to discriminate between the three types of moral dilemmas may allow clinicians and researchers to profile different patterns of performance based on the moral gradient. Construct validity is further supported by invariable operation of the dilemmas regardless of the influence of potential demographic confounders, such as sex, age, educational level or socioeconomic status. Further evidence of construct validity is offered by the discrimination of the three moral dilemma categories using affirmative responses, and the difficulty of decision and response times to differentiate between the two subtypes of personal dilemmas. The latter two variables were used for the validation of the instrument but were not a component of the proposed assessment with the standardized BrMoD application.

Regarding score standardization, the unidimensionality of the brief questionnaire allowed us to obtain a valid overall score of moral decision-making through the BrMoD. The adjustment of these moral dilemmas to the Rasch model indicated the overall score of the BrMoD is an interval level measure (Tennant et al., 2004), which offers significant advantages over ordinal measures obtained with instruments that do not fit the Rasch model.. Therefore, the overall scores are appropriate for later parametric analyses which are more robust than the non-parametric indicated for ordinal scores (Polit & Beck, 2004, p. 484).

Non-moral category is used as an element or level of control over the ability of logical reasoning and is understood as a prerequisite for examining the understanding and

management of the information contained in all set of dilemmas. Applying the minimum 94% percent of correct logical answers obtained in the sample, one can set a cut-off of 7 correct items to eliminate problems of understanding and reasoning. Because the questionnaire consists of items that a normal population mainly responds to logically, it could be used as a test for detecting malingering in subjects undergoing legal processes, such as in individuals with brain damage from traffic accidents (Lange, Iverson, Brooks, & Rennison, 2010).

Following the criteria to ensure methodological rigor in the abbreviation of questionnaires (Smith, McCarthy, & Anderson, 2000), the BrMoD was separately tested in two independent samples. The initial selection of 32 dilemmas from 60 Greene's scenarios was based on a student sample highly biased towards women and high educational level, and this may stand as a limitation. However, the second study was conducted in a community sample more representative of the general population, and the questionnaire showed similar robustness when dealing with even males and females ratios, and more heterogeneous age and education distributions. The 32 dilemmas included in the BrMoD measure a wide range of the moral judgment constructs (from -4.1 to +5.05 on the Rasch scale). In the present research, we have not replicated the psychometric properties of the BrMoD to other independent samples, as suggested by Smith (2000). However, in future studies, validation of the BrMoD in different clinical populations is proposed, specifically in terms of its potential uses. The BrMoD obtains adequate rates of reliability and construct validity for both the traditional and Rasch models, to which the BrMoD fits, showing unidimensionality, adequate coverage of the construct and targeting of the sample, thus making it a useful tool for evaluating moral decision-making.

In conclusion, the BrMoD is a shortened standard version of the original set of

Greene's moral dilemmas with demonstrated reliability, validity and ability to control the most relevant limitations of the original experimental version. These properties make it a suitable instrument for use in broader research or professional fields.

Capítulo 5

Moral decision-making

in polysubstance dependent individuals

Carmona-Perera, M., Verdejo-García, A., Young, L., Molina-Fernández, A, & Pérez-García, M. (2012) Moral decision-making in polysubstance dependent individuals. *Drug and Alcohol Dependence, 126,* 389-392.

1. Introduction

Moral judgments depend on the integration of complex cognitive and emotional processes (Cushman et al., 2006; Young et al., 2007). Recent work in moral psychology and neuroscience suggests that impairments in these processes lead to systematic biases in moral judgments (Mendez et al., 2005; Koenigs et al., 2007). For example, patients with focal lesions to the ventromedial prefrontal cortex are more likely to deliver utilitarian moral judgments for moral scenarios that are high in emotional content (e.g., it is morally permissible to smother a baby to save a group of hidden people during wartime) (Koenigs et al., 2007; Moretto et al., 2010). According to dual-process models of moral cognition (e.g., Greene et al., 2008), a prepotent emotional aversion to harming an innocent individual (the deontological response) competes with a utilitarian cost-benefit analysis to maximize aggregate welfare. When scenarios elicit a sufficiently robust emotional response, deontological moral judgment tends to prevail. In the current study, we test the hypothesis that emotional impairments associated polysubstance abuse, and the inability to integrate emotional inputs for appropriate decision-making, lead to systematic biases in moral judgments (Bechara et al., 2000).

Addiction, and, in particular, polysubstance dependence, is associated with core deficits in higher cognitive processes and emotional skills, and with real-life difficulties related to social interaction (Leeman et al., 2009; Volkow et al., 2011) and illegal behavior (Verdejo-García et al., 2006, 2007; Yechiam et al., 2008). Recent research has revealed deficits in emotional processing, including in emotion regulation and emotion perception, in polysubstance abusers (Aguilar de Arcos et al., 2005, 2007; Fernández-Serrano et al., 2010). For example, polysubstance abusers tend to outweigh immediate rewards over negative future outcomes and to act impulsively (Verdejo-Garcia et al., 2007; Verdejo-García et al., 2008). Polysubstance dependent individuals also show defective decoding of moral

emotions like anger or disgust (Fernández-Serrano et al., 2010), reduced reactivity to emotionally competent stimuli (Aguilar de Arcos et al., 2005), and poor affective-based decision making, due to a failure to trigger bodily markers signaling negative outcomes (Bechara et al., 2002).

Recent research on polysubstance dependence has also revealed enduring anatomical abnormalities in a key region for social and moral cognition, the medial prefrontal cortex (Tanabe et al., 2009). Polysubstance abusers show long-term reductions of gray matter volume in the medial prefrontal cortex (Franklin et al., 2002; Tanabe et al., 2009), and abnormal activation of this region during the extraction of empathic information from social vignettes (Kim et al., 2010).

Do polysubstance dependent individuals show utilitarian biases in moral judgments? We predicted that polysubstance dependent individuals would deliver more utilitarian moral judgments as a direct result of their cognitive-emotional deficits in decision-making.

2. Methods

2.1. Participants

We tested 32 polysubstance dependent individuals and 32 control participants (See Table 1). Polysubstance dependent individuals were recruited during residential treatment in a therapeutic community. Selection criteria for polysubstance dependent individuals consisted for the following: (i) meeting the DSM-IV criteria for substance dependence; (ii) minimum abstinence duration of 30 days before testing, confirmed by weekly urine analyses; (iii) not having history of head injury or neurological disorders; and (iv) absence of clinical diagnosis of comorbid Axis I or Axis II disorders (four participants were excluded due to diagnosis of personality disorders, and one participant due to comorbid

mood disorder). Selection criteria for control participants consisted of the following: (i) absence of current or past diagnoses of substance abuse or dependence; (ii) not having history of head injury or neurological disorders; and (iii) absence of history of psychiatric disorders. To minimize the impact of any alcohol or drug use in the control group, we included only control participants who reported having used any illegal drugs no more than 5 times during their lifetime; furthermore, we allowed current alcohol consumption only at levels below 10 standard units per week (mean alcohol use in the control group: 9.34 units per month).

The polysubstance dependent and control groups were matched on sex and ethnicity; all participants were European-Caucasian males. The groups also showed similar distributions for handedness (four left handed in the polysubstance group and one left-handed in the control group, $\chi^2=2.58$, $p>0.1$), socioeconomic status (70.4% of polysubstance dependents and 81.3% of controls had middle socioeconomic status, $\chi^2=2.58$, $p>0.1$) and levels of religiosity (89% of polysubstance dependents and 79% of controls were religious –all catholics, $\chi^2=1.21$, $p>0.1$), which is known to impact moral judgment (Pyysiäinen and Hauser, 2010). The groups did differ in age; mean ages for the polysubstance dependent and control group were 33.56 years (SD=6.81) and 26.03 years (SD=10.05) respectively ($t=3.30$, $p<0.002$). However, age did not significantly correlated with moral decision-making and therefore it was not further considered in subsequent analyses. The groups also differed in education; mean years of education for the polysubstance dependent and control group were 14.31 years (SD=1.57), and 16.06 years (SD= 1.76) respectively ($t =3.96$, $p <0.001$). Education significantly correlated with moral decision-making, and was therefore used as a covariate in all subsequent analyses.

2.2. Instruments

Interview for Research on Addictive Behavior (Verdejo-García et al., 2005): This semi-structured interview focuses on patterns of use for different classes of drugs, including typical amount per month and duration of use.

Structured Clinical Interview for DSM-IV (SCID; First et al., 1994): We used the substance abuse and dependence subscale to obtain diagnoses related to substance use.

Moral judgment task (Greene et al., 2001): Participants read and responded to 60 hypothetical scenarios. Participants' responses consisted of reporting whether they would perform ("yes") or refuse to perform ("no") an action. Participants also reported the subjective difficulty of the decision. As in prior work, scenarios were categorized as either impersonal (not emotionally salient) or personal (emotionally salient). In addition, personal scenarios were classified as either low-conflict (easy) versus high-conflict (difficult) (Koenigs et al., 2007). Thus, scenarios fell into four categories: (1) non-moral scenarios, (2) impersonal moral scenarios, (3) personal moral low-conflict scenarios, and (4) personal moral high-conflict scenarios.

For all moral scenarios, affirmative answers represent utilitarian judgments: the participant endorses an emotionally aversive action (e.g., to kill someone) in order to maximize aggregate welfare (e.g., to save more people). For example, a utilitarian choice could involve throwing a dying into the sea to keep a lifeboat full of people afloat. By contrast, negative answers represent non-utilitarian or deontological judgments: the participant rejects the harmful action at the expense of the greater good.

The main dependent measures were the proportion of *Affirmative Answers* and the perceived level of *Difficulty* for each of the four categories of scenarios. In the case of

moral scenarios, Affirmative Answers represent utilitarian moral judgments, i.e., endorsing an emotionally aversive action to maximize aggregate welfare. Difficulty reflects the mean score of difficulty ratings, ranging from 1 (low difficulty) to 10 (high difficulty). We used a Spanish version of this instrument, adapted through back-translation procedure, which holds adequate psychometric properties (Cronbach's alpha = 0.71, Spearman Brown coefficient = 0.38) (Carmona-Perera et al., 2009).

2.3. Procedure

The study was approved by the Ethical Committee for Research in Humans of the University of Granada. All participants read the research protocol and signed an informed consent form before inclusion in the study. Polysubstance dependent individuals were initially screened by the clinical staff for fulfillment of inclusion criteria, including urine tests to confirm abstinence, and then assessed in a single session including the toxicological interview and the moral dilemmas battery. Controls were recruited through advertisements placed in community centers in the same geographical area.

3. Results

The main hypothesis was tested, using a 2 (Group: Polysubstance dependent individuals vs. Control) x 4 (Category of dilemma) mixed-effects ANCOVAs of the two dependent variables (Affirmative Answers and Difficulty). Years of education were entered as covariate in these analyses. Results showed a significant Group x Category interaction on the index of Affirmative Answers [$F(3, 2.328) = 3.441$, $p < 0.018$]. Planned t-tests showed that this interaction was driven by significant differences between polysubstance users and controls on personal moral high-conflict dilemmas [$t(56, 51.402) = -2.555$, $p < 0.013$]; polysubstance dependent individuals endorsed a higher proportion of Affirmative Answers (Figure 1). We found no significant differences between groups on the other three categories

(all p>0.05). For Difficulty, a Group*Category interaction emerged as well [F (3, 1.962) = 3.510, p <0.017]. Planned t-tests revealed that polysubstance dependent individuals trended towards judging personal moral high-conflict dilemmas as less difficult [t (54, 41.534) = 1.920, p <0.059] (See Figure 1). We found no significant differences between groups on the other three categories (all p>0.05).

We also conducted Spearman correlation analyses to test the association between patterns of drug use and the dependent variables. A significant correlation emerged between the severity of alcohol use and Affirmative Answers for personal moral high-conflict dilemmas (r = 0.408; *p* = 0.043).

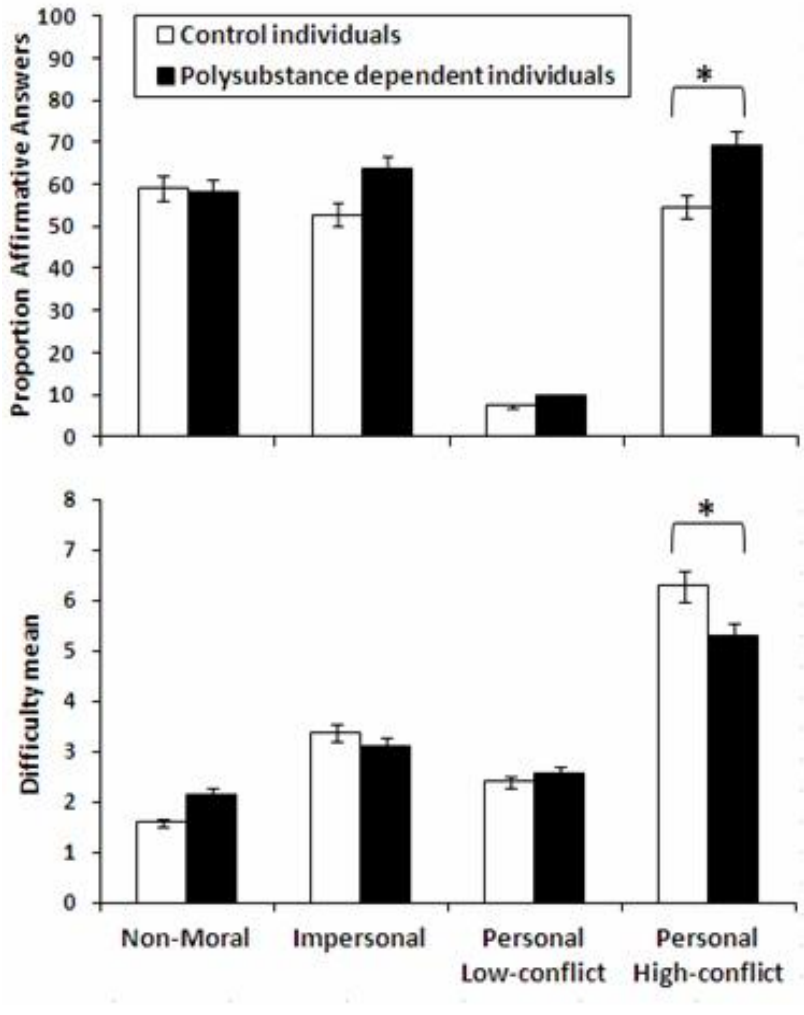


Figure 1. Proportion of affirmative answers and difficulty across scenario categories, for polysubstance dependent individuals and controls.

4. Discussion

The current study demonstrates that polysubstance dependent individuals deliver more utilitarian moral judgments in response to personal moral scenarios, which are high in emotional content. Polysubstance dependent individuals not only delivered a greater proportion of utilitarian judgments but also perceived these decisions as less difficult.

According to dual-process models of moral cognition, utilitarian choices are more readily endorsed by individuals who show reduced ability to integrate social-emotional inputs (Greene, 2007; Greene et al., 2008). Polysubstance dependent individuals are characterized by emotional blunting, abnormal triggering of emotional signals during outcome anticipation, and poor affective regulation (Aguilar de Arcos et al., 2005; Bechara et al., 2002; Payer et al., 2011). These deficits may therefore underlie the utilitarian pattern of their moral judgments. Nonetheless, future work should explore other explanatory accounts including impaired inhibition and impulsivity (Leeman et al., 2009) or degraded representations of social values (Moll et al., 2005).

The current analyses revealed a correlation between utilitarian moral judgments and severity of alcohol use. Previous studies have shown that alcohol use (compared to other drug classes) disproportionately damages emotion perception (Foisy et al., 2005; Kornrecih et al, 2003). Chronic alcohol dependent-individuals show deficits in emotional processing, including impaired appraisal of facial emotions and affective prosody (Maurage et al., 2011a; Uekerman et al., 2005) and impaired emotional but not cognitive empathy (Maurage et al., 2011b). Notably, these affective deficits are predictive of real-life interpersonal problems (Kornreich et al., 2002). We note, however, that the specificity of the link between alcohol use and utilitarian choices should be interpreted with caution, given the mixed sample of polysubstance abusers in the current study.

We also note that the current conclusions apply specifically to a sample of polysubstance dependent individuals who were referred to residential treatment due to inability to achieve treatment goals in a naturalistic setting. Therefore, the patients in the current study may have been more likely to show emotional blunting and decision-making deficits that impact moral judgment. Although the consumption patterns of the sample are representative of users demanding addiction treatment in the European Union (EMCDDA Annual Report, 2010), future work should target broader groups of substance abusers.

The utilitarian pattern observed in the current sample of polysubstance dependent individuals deviated from standard response patterns in not only the current control sample (Carmona-Perera et al., 2009) but also the control groups from two previous studies (Koenigs et al., 2007; Ciramelli et al., 2007). Polysubstance dependent individuals scored more than 1 standard deviation above the means reported by these previous studies. Future research should investigate whether this utilitarian response pattern reflects a premorbid trait or a consequence of drug dependence. In any case, the current finding may therefore yield important clinical implications. For example, novel interventions directed to improve cognition-emotion integration may contribute to correct the utilitarian biases of these individuals, thus fostering prosocial behavior (Crockett et al., 2010).

The present study provides initial clues about moral decision-making in polysubstance dependent individuals from a cognitive neuroscience perspective. In sum, the current findings indicate that polysubstance-dependent individuals are more prone to deliver utilitarian choices when confronted with moral dilemmas, and find these decisions easier to make.

Capítulo 6

Impaired decoding of fear and disgust predicts utilitarian moral judgment in alcohol-dependent individuals

Carmona-Perera, M., Clark, L., Young, L., Pérez-García, M. & Verdejo-García, A. Impaired decoding of fear and disgust predicts utilitarian moral judgment in alcohol-dependent individuals. Alcoholism: Clinical and Experimental Research, In press.

1. Introduction

Alcohol dependence is characterised by the persistent use of alcohol in the face of physical, psychological, and social consequences for oneself and close others (American Psychiatric Association & others, 2000). Alcohol-dependent individuals show deficits on decision-making tasks due in part to their impaired ability to attach emotional value to decision prospects (i.e., 'myopia for the future') (Fernández-Serrano et al., 2010; Park et al., 2010). Recent work has targeted these decision-making deficits in the domain of moral cognition (de Oliveira-Souza & Moll, 2009; Moran, Jolly, & Mitchell, 2012). Typically, participants are instructed to choose between a utilitarian option (i.e., harming one person to save a greater number of people) and a deontological option (i.e., refusing to harm someone and thus allowing a greater number of people to die). Alcohol-dependent individuals have been shown to endorse utilitarian options in response to moral dilemmas (Khemiri et al., 2012). Furthermore, among polysubstance users, severity of alcohol use predicts the degree of utilitarian bias (Carmona-Perera, Verdejo-García, Young, Molina-Fernández, & Pérez-García, 2012). Together, these prior studies reveal a link between alcohol use and utilitarian moral judgment. This link may be due to the specific neurotoxic effects of alcohol on frontal lobe function (Beck et al., 2012; Stephens & Duka, 2008), associated with co-morbidities and cognitive-affective deficits that contribute to moral judgment deficits. The primary aim of the current study was to identify key predictor variables of moral judgment deficits in alcohol dependence.

Prior work has explored moral judgment deficits. For example, studies have identified traits associated with impaired moral cognition, including antisociality and impulsivity (Bartels & Pizarro, 2011; Marsh et al., 2011). Induction of negative emotional states, such as disgust, has also been shown to reduce utilitarian bias choice in healthy individuals (Harlé & Sanfey, 2010; Schnall et al., 2008b; Ugazio, Lamm, &

Singer, 2012), while patients with focal damage to brain regions that support emotional responding tend to endorse utilitarian moral judgments to a greater extent (Koenigs et al., 2007; Moretto et al., 2010). Moreover, depression and anxiety levels in non-clinical samples are positively also associated with utilitarian choice (Bartels & Pizarro, 2011; Starcke et al., 2011; Youssef et al., 2012). Notably, alcohol-dependent patients exhibit depression and anxiety (Lai, Sitharthan, & Huang, 2012), impulse control problems (Mitchell, Fields, D'Esposito, & Boettiger, 2005; Stephens & Duka, 2008), poor emotion regulation and emotional expression recognition (Foisy et al., 2007; Uekermann & Daum, 2008).

This study aimed first to replicate the prior finding that alcohol-dependent patients show a utilitarian bias and second to determine which psychological and neuropsychological factors previously associated with utilitarian bias (severity of alcohol use, impulsivity, mood symptoms and cognitive-affective processes) predict moral judgments in alcohol-dependent patients. First, we hypothesised that alcohol-dependent individuals would deliver more utilitarian moral judgments on personal (emotionally salient) moral scenarios. since utilitarian moral judgments of moral personal scenarios have been previously associated with impulsivity, altered mood states and decoding affective deficits that are closely linked to alcohol dependence problems (Foisy et al., 2007; Lai et al., 2012; Stephens and Duka, 2008) we also hypothesized that high impulsivity, negative mood elevations, and poor affective decoding would significantly predict utilitarian choices in alcohol-dependent individuals. Specifically, based on our previous neural findings linking emotional processing with moral judgment (Koenigs et al., 2007; Verdejo-Garcia et al., 2012), we expected poor affective decoding to be the most significant predictor of utilitarian choices in alcohol-dependent individuals.

2. Materials and Methods

2.1. Participants

Alcohol-dependent individuals (n = 31) and healthy control individuals (n = 34) participated in the study. The two groups did not differ significantly in terms of gender, age, handedness, socioeconomic status (see Table 1). All participants were of European-Caucasian origin. The alcohol-dependent group reported significantly fewer years of formal education ($t_{(63)}$ = 5.63, $p < 0.001$); therefore, this variable was entered as a covariate in all subsequent analyses.

Alcohol-dependent individuals were recruited from the detoxification unit of Nostra Senyora de Meritxell Hospital between October 2010 and June 2011. All subjects met DSM-IV criteria for alcohol dependence and did not meet criteria for abuse or dependence of other substances, with the exception of nicotine. For eligibility, participants needed to have been abstinent for at least 15 days (mean 2.56 month, SD= 3.44), as confirmed by urine analyses performed approximately every three days, and not have comorbid diagnoses of Axis I or Axis II disorders, assessed by clinical reports. Controls were recruited from the community through word-of-mouth communication.

The main criterion for inclusion in the control group was the absence of significant alcohol use patterns, defined as fewer than 10 standard units of alcohol per week, taking a glass of whisky or other liquor to equal one unit, and a glass of wine or beer to equal 0.5 units. All participants scored at least 27 (i.e. normal cognitive state baseline) on the Spanish version of the Mini mental state examination (MEC; Lobo, Ezquerra, Bugarda, Sala, & Seva, 1979).

Table 1. Descriptive scores for the sociodemographic and alcohol use characteristics of alcohol-dependent individuals and healthy control individuals.

	Alcohol-dependent Mean (SD) / Proportion	Control Mean (SD) / Percentage	t / χ^2	*p*-value
Age	52.06 (6.48)	48.77 (10.66)	*-1.49	0.141
Educational level (years)	13.74 (1.98)	17.12 (2.75)	*5.63	0.000
Handedness			**1.42	0.889
Right handed	87.1%	88.2%		
Left handed	12.9%	11.8%		
Socioeconomic level			**0.02	0.492
Low	25.8%	14.7%		
Middle	64.5%	70.6%		
High	9.7%	14.7%		
Quantity alcohol per month (units)	565.79 (462.26)	21.38 (12.50)	*-6.87	0.000
Duration alcohol consumption (years)	26.50 (8.53)	20.66 (9.67)	*-2.55	0.013
Total alcohol consumption (units)	188026.78 (167376.61)	5076.99 (4358.61)	*-6.38	0.000

*Note: Socioeconomic status was collected from clinical history reported by clinical staff; *Value of Student's t; **Value of chi-squared χ^2.*

2.2. Instruments

- *Interview for Research on Addictive Behavior,* IRAB (Verdejo-García, López-Torrecillas, Aguilar de Arcos, & Pérez-García, 2005). This instrument evaluates the average amount of alcohol consumption per month and the duration of use in years. A combined quantity x duration variable was calculated for total alcohol consumption (i.e. alcohol units over lifetime) to illustrate group differences in alcohol exposure, despite the relative similarity in duration of alcohol use.
- *Barratt Impulsiveness Scale*, BIS-11 (Patton, Stanford, & Barratt, 1995); Spanish version (Oquendo et al., 2001). This scale was used as a measure of impulsive personality traits. Participants were asked to rate a set of impulsivity manifestations on frequency: never or rarely, occasionally, often and always or almost always (scoring from 0 to 4). The main dependent variable was the total impulsivity score, and three subscale scores: cognitive, motor, and non-planning impulsiveness.

- *Hamilton Depression and Anxiety Rating Scales* (Hamilton, 1960; 1969); Spanish version (Ramos-Brieva & Cordero Villafáfila, 1986). These scales assess depression and anxiety symptoms. The interviewer assigns a score between 0 and 4, depending on frequency and intensity of symptoms (maximum depression and anxiety scores are 52 and 56, respectively). In addition, the anxiety scale can assess psychic and somatic anxiety separately. We used depression and anxiety total scores and anxiety partial scores (psychic and somatic) as dependent variables.
- *Facial Expressions of Emotion: Stimuli and Tests,* FEEST (Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002). This cognitive-affective decoding task assesses recognition of facial emotional expressions. Participants must identify which emotion (anger, disgust, fear, happiness, sadness and surprise) best describes the facial expression displayed. A set of 60 faces was presented, in random order, for 5 seconds each; there was no time limit for responding. The number of correct identifications for each emotion (ranging from 0 to 10) was collected as a dependent measure.
- *Moral Judgment task* (Greene et al., 2001). We used 32 hypothetical dilemmas selected in a prior work through Rasch analysis (Carmona-Perera, Caracuel, Pérez-García, Verdejo-García, & Under review). The Spanish version was derived through back-translation, and its psychometric properties were adequate in an independent community sample (Cronbach's alpha = 0.78, Spearman Brown coefficient = 0.76; (Carmona-Perera et al., Under review). Participants chose if they *would perform* ("yes") or *refuse to perform* ("no") an action to resolve each moral dilemma. Participants also rated the subjective difficulty of the decision using a Likert scale ranging from 1 (very low) to 10 (extreme). For moral dilemmas,

affirmative answers ("yes") were considered 'utilitarian'. Dilemmas were classified into three types: non-moral dilemmas in a control condition (involving a cost-benefit decision without moral or emotional content; n = 8), moral-impersonal (involving a moral decision of low emotional salience; n = 8), and moral-personal (moral decisions of high emotional salience; n = 16). Personal dilemmas were further classified as low-conflict (shorter response latencies and high inter-subject agreement) versus high-conflict (longer responses latencies and low inter-subject agreement) (Koenigs et al., 2007). The dependent variables were the proportion of affirmative choices, the difficulty rating, and the decision latencies, for each of the dilemma categories.

2.3. Procedure

Participants provided written informed consent, before completing two individual test sessions lasting 1 h each. In the first session, we administered the assessments of drug use, impulsivity, mood and emotional decoding. In the second session, we administered the moral judgment task, in a computerized format. Individual dilemmas were presented over three phases on successive screens: the first screen described the scenario; the second screen prompted the response; the third screen prompted the difficulty rating on a Likert scale (with no time limits imposed).

2.4. Data analyses

Performance differences on the moral judgment task were compared between groups using a series of 2 (Group) × 4 (Type of dilemma) mixed-model ANCOVAs, with years of education entered as a covariate, on the three dependent measures (affirmative choices, difficulty ratings, and decision latencies). Significant Group × Type of dilemma interactions were decomposed using t-tests on each of the four dilemma categories. Additional analyses

were conducted to determine the influence of education, by comparing two subsets (n = 20) matched on education. Group differences in emotion recognition, impulsivity, depression and anxiety were tested using univariate ANCOVAs (with years of education entered as a covariate).

To analyses the predictive capacity of the different psychological variables on utilitarian moral judgments, hierarchical multiple regression analyses were performed. The hierarchical regression approach was chosen to estimate the relative increase in the percentage of explained variance (and the statistical significance of the prediction change) provided by each of the consecutive sets of predictors. The four sets of predictors were entered in reverse sequence relative to our hypothesis: affective decoding measures were included last. Therefore, the affective decoding set had to increase the percentage of variance explained by the other predictors to attain significant. We included the dependent measures from the moral judgment task that showed significant group differences: proportion of affirmative (utilitarian) judgments for high-conflict dilemmas, proportion of affirmative (utilitarian) choices for low-conflict dilemmas, and self-reported difficulty assessments for high-conflict dilemmas. The predictor variables were the socio-demographic and psychological variables that elicited significant group differences, which were grouped on five theoretically-driven sets and introduced in this order: i) years of education, ii) total alcohol consumption (composite estimate of amount and duration of alcohol use), iii) impulsivity (BIS-impulsivity total score), iv) mood (combined Hamilton depression and anxiety score), v) emotional decoding (number of hits in the decoding of facial expressions of fear and disgust). To determine the differential contribution of each set of predictors, we estimated the R^2 change associated with the entrance of each new set and its statistical significance.

3. Results

3.1. Group differences

Table 2 shows descriptive statistics and between-group comparisons for the psychological variables. The alcohol-dependent group showed significantly higher levels of impulsivity, depression and anxiety, and significantly poorer recognition of fear and disgust compared to control participants, controlling for the effect of education. We found no significant differences in the perception of expressions of sadness, happiness, surprise and anger. Cohen's d coefficients for the group differences exceeded 1, indicating large effect sizes (Zakzanis, 2001).

Table 2. Descriptive scores, univariate analyses of covariance (ANCOVAs), and effect sizes on the psychological variables for alcohol-dependent group and control group.

	Alcohol-dependent Mean (SD)	Control Mean (SD)	*F*-value	*p*-value	Cohen's *d*
Impulsivity (total)	51.77 (15.71)	28.38 (10.69)	32.66	0.000*	1.76
Cognitive	15.77 (4.58)	11.35 (4.14)	9.84	0.003*	1.02
Motor	17.87 (7.69)	8.09 (3.99)	27.07	0.000*	1.62
Non-planning	18.03 (7.41)	9.59 (5.88)	19.22	0.000*	1.27
Depression	12.32 (8.88)	2.12 (2.32)	27.68	0.000*	1.61
Anxiety (total)	15.32 (12.46)	3.56 (3.95)	18.86	0.000*	1.30
Somatic	6.71 (5.76)	1.62 (2.26)	13.69	0.000*	1.19
Psychic	8.61 (7.61)	1.94 (2.39)	18.08	0.000*	1.21
Emotional Perception (total)	43.13 (5.69)	50.03 (5.52)	11.85	0.001*	1.23
Anger	7.09 (1.99)	8.18 (1.59)	2.17	0.146	0.60
Disgust	6.58 (1.84)	8.62 (1.58)	9.69	0.003*	1.19
Fear	4.32 (2.21)	6.65 (2.39)	10.30	0.002*	1.01
Happiness	9.71 (0.46)	9.85 (0.44)	1.19	0.280	0.32
Sadness	7.35 (2.27)	7.53 (1.79)	0.01	0.910	0.09
Surprise	8.52 (1.52)	9.18 (1.34)	1.61	0.210	0.46

Note: For the Emotional Perception Task, we obtained the number of correct

*identifications for each emotion (ranging 0–10), and the sum score of total correct identifications (ranging 0–60); * p-value < 0.05*

On the moral dilemmas task, a significant Group (Alcohol-dependent individuals vs. Healthy controls) × Category of dilemma interaction was observed for affirmative (utilitarian) answers ($F_{(3, 186)} = 10.32$, $p < 0.001$]. The main effects for Group ($F_{(1, 62)} = 6.26$, $P = 0.015$) and Dilemma category ($F_{(3, 186)} = 11.37$, $p < 0.001$) were also significant. The alcohol-dependent group was more likely to endorse utilitarian options for low-conflict personal dilemmas ($t_{(63)} = -5.23$, $p < 0.001$) and high-conflict personal dilemmas ($t_{(63)} = -4.35$, $p < 0.001$). No significant differences were observed on the non-moral scenarios ($t_{(63)} = 1.95$, p = 0.064), or impersonal dilemmas ($t_{(63)} = 0.08$, $p = 0.936$).

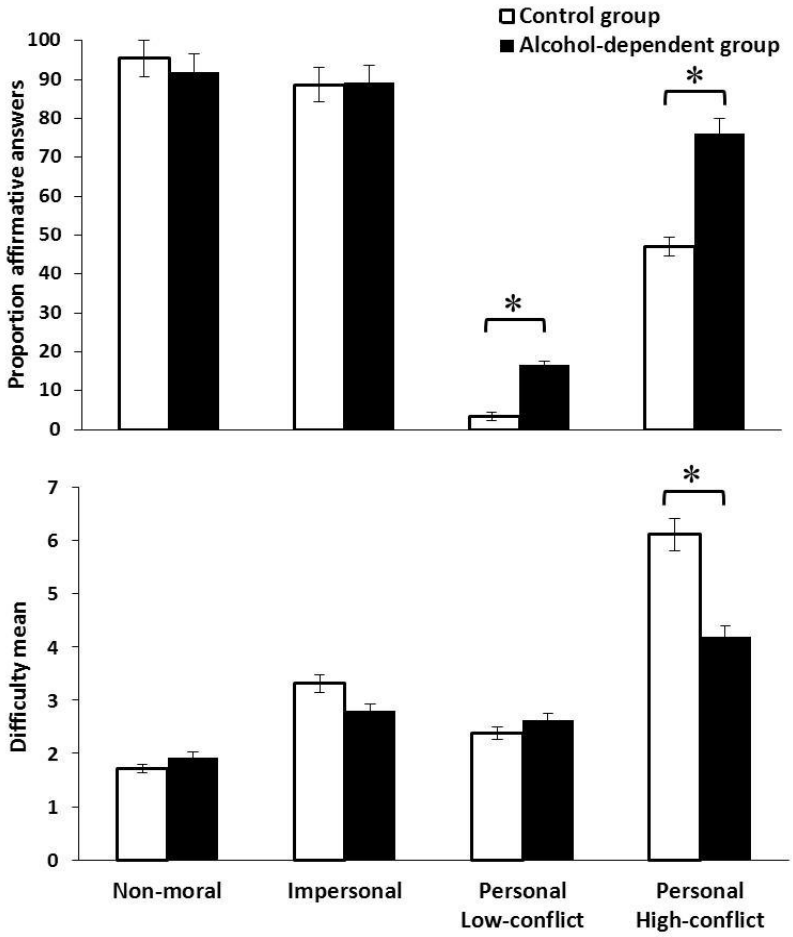


Figure 1. Proportion of affirmative answers and difficulty of judgment across scenario categories, for alcohol-dependent individuals and controls.

A significant Group × Category interaction also emerged for the Difficulty ratings [$F_{(3, 186)}$ = 6.56, p = 0.003], such that the alcohol-dependent group reported lower difficulty on the high-conflict dilemmas ($t_{(63)}$ = 3.07, p = 0.003), but not the other three categories (non-moral, p = 0.467; impersonal, p = 0.163; low-conflict, p = 0.565). No significant main effects were found for Group ($F_{(1, 62)}$ = 2.01, p = 0.162] or Dilemma category ($F_{(3,186)}$ = 1.79, p = 0.150].

In addition, no significant Group × Category interaction was observed for decision latencies ($F_{(3, 186)}$ = 0.55, p = 0.648]. The main effects for Group and Category were also non-significant (p > 0.05).

Additional analysis was conducted to further examine the influence of education. We selected subgroups from the alcohol-dependent group and healthy control group, that did not differ on years of education (AD subgroup, n = 20, mean = 14.84, SD = 1.80; HC subgroup n = 20, mean = 15.30, SD = 2.08) ($t_{(37)}$ = 0.73; p = 0.468). These matched subgroups nevertheless showed significant differences in utilitarian responding for personal moral dilemmas (low-conflict, $t_{(37)}$ = -3.24, p = 0.003; high-conflict, $t_{(37)}$ = -2.89, p = 0.006). These groups also differed on difficulty ratings for high-conflict dilemmas ($t_{(37)}$ = 2.47, p = 0.018). We found no significant differences between subgroups on the other three categories (all p > 0.05).

3.2. Moral decision-making predictors

The regression model for utilitarian choices for high-conflict personal dilemmas showed significant effects of the first and second blocks that entered the education and total alcohol consumption variables. Impulsivity and mood variables did not significantly improve the prediction level. However, inclusion of the emotional decoding block, including fear and disgust recognition, did significantly add to the model (see Table 3 for

regression values). The global model predicted 23.8% of total variance and the best individual predictor was the fear recognition score, which was inversely correlated to utilitarian choices (β = -0.311, p = 0.018).

For utilitarian choices on low-conflict personal dilemmas, the blocks of education and total alcohol consumption were significant predictors of utilitarian choices. Impulsivity and mood variables were not significant predictors. Entering the block of emotional decoding variables again significantly increased the predictive value, with 27.7% of total variance explained in the global model. Total alcohol consumption (β = 0.354, p = 0.026) and disgust recognition (β = -0.252, p = 0.072) were the variables that were individually significant predictors. Total alcohol consumption was positively correlated with utilitarian choices, while disgust recognition correlation was inversed.

For difficulty ratings on the high-conflict personal dilemmas, none of the blocks was significantly predictive.

Table 3. Multiple hierarchical regression models of the association of education, total alcohol consumption, impulsivity, mood and emotional decoding with moral judgments performance.

	Education R^2 change (p-value)	Tot Alcohol R^2 change (p-value)	Impulsivity R^2 change (p-value)	Mood R^2 change (p-value)	Em Decod R^2 change (p-value)	Full model R^2 adjusted (p-value)	Main Contributors (p-value)
Variable 1	0.119 (0.005)*	0.075 (0.020)*	0.005 (0.551)	0.018 (0.655)	0.107 (0.017)*	0.238 (0.002)*	Fear Rec (0.018)*
Variable 2	0.122 (0.005)*	0.143 (0.001)*	0.000 (0.941)	0.015 (0.543)	0.077 (0.042)*	0.277 (0.001)*	Tot Alcohol (0.021)* Disgust Rec (0.072)
Variable 3	0.044 (0.096)	0.006 (0.554)	0.000 (0.993)	0.033 (0.354)	0.013 (0.677)	-0.017 (0.554)	

Note: Variable 1; Proportion of utilitarian choices in high-conflict personal dilemmas; Variable 2; Proportion of utilitarian choices in low-conflict personal dilemmas; Variable 3; Mean of judgment difficulty in high-conflict personal dilemmas; Tot Alcohol, Total

Alcohol Consumption; Em Decod, Emotional Decoding; Fear Rec, Fear Recognition; Disgust Rec, Disgust Recognition; p-value < 0.05.*

4. Discussion

This study aimed both to replicate prior work revealing utilitarian bias in alcohol-dependent individuals, and to determine the predictors of this bias, e.g., severity of alcohol use, impulsivity, mood symptoms and emotional decoding. Our findings demonstrate a utilitarian bias on personal moral scenarios in individuals with alcohol dependence. In addition, alcohol-dependent individuals rated these decisions as less difficult, compared to controls. Critically, poor recognition of facial expressions of fear and disgust predicted utilitarian bias on personal moral dilemmas, over and above the impact of total alcohol consumption and years of education. Specifically, impaired fear decoding emerged as the main predictor of utilitarian choices for *high-conflict* dilemmas, whereas impaired disgust decoding emerged as the main predictor of utilitarian choices for *low-conflict* dilemmas. Although future work is required to explore these effects, we suggest that the perception of fear in specific individuals may lead to an aversion to harming those individuals even when doing so may lead to saving other people, as in high-conflict scenarios (Crockett, Clark, Hauser, & Robbins, 2010). On the other hand, low-conflict scenarios (e.g., causing harm for selfish benefit) may trigger moral disgust (Ugazio et al., 2012; Wheatley & Haidt, 2005).

Notably, impulsivity and mood symptoms were not significant predictors of moral decision-making, although they differed significantly between groups. Nevertheless, future work should use neuropsychological measures of impulse control or biological markers of affective disturbance such as salivary cortisol (Dallman, 2005).

The current demonstration of utilitarian responding in alcohol-dependent

individuals is consistent with prior work, including a previous study in a Swedish sample (Khemiri et al., 2012). The utilitarian bias observed in the current sample also appears to be broader than the pattern observed in our prior work in a polysubstance-dependent group (Carmona-Perera et al., 2012), in which the bias emerged only high-conflict personal dilemmas. In the current sample, utilitarian bias extended to low-conflict personal dilemmas, which elicit deontological judgments in healthy subjects and even patients with impaired emotional processing (Koenigs et al., 2007b; Moretto et al., 2010). Thus, the current sample of alcohol-dependent individuals appears to show relatively severe cognitive-affective deficits (Foisy et al., 2007; Stephens & Duka, 2008; Uekermann & Daum, 2008).

These findings are also consistent with prior evidence showing that alcohol-dependent individuals are impaired in their decoding of fear and disgust (Foisy et al., 2007; Uekermann & Daum, 2008). In the current study, these decoding deficits emerged as the key predictors of utilitarian choice on a subset of moral dilemmas. Poor emotional decoding is typically associated with deficits in aversive conditioning (Borlikova, Elbers, & Stephens, 2006; Stephens & Duka, 2008) and may render alcohol-dependent individuals less sensitive to the emotional consequences (e.g., causing personal harm) of utilitarian responding (Birbaumer et al., 2005; Gao, Raine, Venables, Dawson, & Mednick, 2010). Indeed, individuals with difficulty identifying fear-inducing behaviours tend to judge these behaviours as more morally acceptable (Marsh & Cardinale, 2012). More generally, interpersonal interactions are based in large part on our ability to perceive other emotions (Riggio, Riggio, Salinas, & Cole, 2003); thus, emotional decoding deficits in alcohol dependence may lead to social impairments observed in this population (Charles Kornreich et al., 2002; Maurage, Campanella, Philippot, de Timary, et al., 2008).

The present research can be understood in the context of dual-process models of moral judgment; alcohol-dependent individuals show reduced ability to integrate social-emotional inputs and therefore endorse utilitarian moral judgments (Greene, 2007). As such, the current results are also consistent with the proposed role of emotion in deontological judgments (Schnall et al., 2008b; Van Dillen, van der Wal, & van den Bos, 2012b; Wheatley & Haidt, 2005). More specifically, the successful induction of avoidance-related emotions (e.g., disgust or fear) may lead to deontological moral judgments (Harlé & Sanfey, 2010; Ugazio et al., 2012). Furthermore, according to the somatic-marker theory of addiction, the medial prefrontal cortex is the key brain region for generating and integrating emotional signals (somatic-markers), which arise in anticipation of the affective and social consequences of different courses of action (e.g., utilitarian vs. deontological), crucially guiding decision-making (Antonio Verdejo-García & Bechara, 2009).

We should acknowledge that our two groups were not closely matched for background education. We therefore included this variable as a covariate in our analyses, although, given some of the caveats raised about the use of ANCOVA (Grove and Meehl, 1996; Wallet et al, 2006), we also note that our group effects were substantiated both in the ANOVA models without the covariate term included, and in the sensitivity analysis using subsets matched for education. Our regression models also directly investigated any influence of education, with the psychological variables entered after education. We think the correlation with alcohol consumption reflects a consequence of alcoholism, but other explanations are possible, and future work should explore alternative premorbid factors including, especially, psychopathic traits (Bartels and Pizarro, 2011; Harensky et al, 2009) or altered attentional control (Van Dillen et al., 2012), which may also partially account for these findings.

In sum, our study not only replicates the association between alcohol dependence and utilitarian moral judgment but also reveals that defective fear and disgust decoding are key predictors of utilitarian choices in personal moral dilemmas. These findings have important clinical implications, given that poor decision-making is a well-validated predictor of alcohol and drug relapse (Allsop, Saunders, & Phillips, 2000; Bechara & Damasio, 2002). Furthermore, the impairments in fear and disgust recognition could be related to clinical observations in alcohol-dependent individuals, such as the lack of disgust of vomit, and poor personal hygiene (Hazelton et al., 2003; Johnson et al., 2008). Specific interventions directed at improving emotional decoding as well as transferring these emotional capacities into real-life decisions, for example the Micro Expression Training Tool (Ekman, 2003; Matsumoto and Hwang, 2009), and Multimodal Affective Systems (Duric et al., 2002; Lisetti and Nasoz, 2002; Zeng et al., 2009) may prove useful.

Capítulo 7

Heart rate correlates of utilitarian moral decision-making in alcoholism

Carmona-Perera, M., Reyes del Paso, G.A., Pérez-García, M., Verdejo-García, A. (Under review). Heart rate correlates of utilitarian moral decision-making in alcoholism. *Drug and Alcohol Dependence*.

1. Introduction

The somatic-marker model of addiction posits that addicted individuals exhibit problems to raise and process the emotional signals that normally guide adaptive decision-making (Verdejo-García and Bechara, 2009). When decision-making is framed in the context of moral judgment this notion is reminiscent of the dual-process model (Greene, 2007; Greene et al., 2008). This model posits that the surge of negative emotional states during consideration of personal moral dilemmas tend to foster deontological choices (i.e., refuse to harm someone regardless of its beneficial implications for societal well-being). However, in absence of these emotional signals moral decision-making is more likely to be approached from a cost-benefit analysis which favors utilitarian choices (i.e., smothering a baby to save a group of people during wartime). Recent studies demonstrate that alcohol-dependent individuals compared to non-alcohol using controls tend to endorse more utilitarian choices when faced with personal moral dilemmas (Carmona-Perera et al., Under review; Khemiri et al., 2012). In addition, they rate these utilitarian choices as less difficult to make (Carmona-Perera et al., Under review). Because the utilitarian choice patterns specifically emerge in response to personal emotionally salient dilemmas, and because difficulty ratings can be viewed as a proxy of the degree of emotional burden involved, we have proposed that the utilitarian choice patterns of alcohol-dependent subjects are associated with deficits to raise negative emotions during consideration of moral dilemmas. However, this notion has not been yet been tested using physiological recordings during moral judgment.

In order to evaluate the physiological concomitants of emotional responses, we assessed the heart rate (HR) response evoked by moral dilemmas. HR changes are considered to be an indicator of the valence dimension of emotion, since HR tend to

decrease under the experience of negative emotions and to increase when we experience positive ones (Greenwald et al., 1989; Lang et al., 1993). Accordingly, evidence show significant HR decreases in response to a plethora of unpleasant stimulus, including the reading of emotional drama texts (Danko et al., 2011; Lacey and Lacey, 1970) or the passive viewing of unpleasant pictures and films (Lang et al., 1993; Palomba et al., 2000). Blunted HR reactivity to emotional stimuli has been demonstrated in alcohol dependent-individuals compared to healthy participants (Kornreich et al., 1998; Ryan and Howes, 2002). Moreover, HR reactivity has shown to be less significantly impacted by mood states in alcohol users, since it is not correlated with levels of sadness, distress or irritation after negative mood induction (Jansma et al., 2000). Therefore, personal dilemmas should induce HR decreases in normal controls, but in agreement with the somatic-marker theory of addiction and the dual-process model of moral decision-making, this response may be attenuated in alcohol-dependent individuals.

In addition to examine HR responses to moral dilemmas, we also explored whether the emotional deficits proposed to relate to utilitarian choices were associated with general physiological deficits in baseline conditions, when no task is present. In particular, Heart Rate Variability (HRV), and especially Respiratory Sinus Arrhythmia (RSA), has been demonstrated to be reliable indices of emotional regulation (Thayer and Lane, 2000). Reduced HRV-RSA is interpreted as a physiological correlate of deficient generation of emotional responses (Appelhans and Luecken, 2006; Thayer and Lane, 2000). In its neuro-visceral integration model, Thayer and Lane interpreted HRV (especially vagal-mediated high frequency or RSA) as an index of attentional-emotional regulation related to tonic inhibitory influences from the prefrontal cortex to subcortical structures. The reduced HRV is then interpreted as a deregulation of this inhibitory network. This would suggest lower effects of emotion on regulation of cognitive

processing, and may therefore be relevant for moral decision-making. Accordingly, previous evidence have shown that variations in baseline HRV or RSA are associated with performance in emotion regulation and cognitive control tasks (Lane et al., 2001; Thayer et al., 2009; Thayer and Lane, 2000) and with adequate integration of prefrontal-subcortical systems in the linkage between peripheral physiology and cognitive control (Thayer et al., 2012).

In summary, this study is aimed to test whether autonomic nervous system responses to moral dilemmas indexed by heart rate contribute to explain utilitarian choice patterns in alcohol-dependent individuals. We hypothesized that alcohol dependent individuals would display: (i) reduced cardiac reactivity to the moral dilemmas, specifically a less pronounced HR deceleration during personal moral dilemmas, and (ii) reduced RSA at baseline, which would correlate with more utilitarian choices in personal dilemmas.

2. Methods

2.1. Participants

Thirty one alcohol-dependent individuals and 34 non-alcohol using controls participated in this study. Alcohol-dependent individuals were recruited as they commenced psychosocial treatment at the Addicted Behaviors Unit of Nostra Senyora de Meritxell Hospital (Andorra). We initially screened 43 participants between October 2010 and June 2011. Of them, we excluded 9 participants because they did not meet inclusion criteria. The inclusion criteria were defined as follows: (i) meeting DSM-IV criteria for alcohol dependence; (ii) absence of comorbid dependence of other drugs (excluding nicotine); (iii) maintained abstinence at least 15 days before testing, confirmed by twice weekly urine analyses; (iv) not having history of head injury or neurological disorders; (v) not

having current comorbid diagnoses of Axis I or Axis II disorders, assessed by clinical reports; and (vi) the absence of severe cognitive impaired caused by dementia. Compliance with inclusion criteria was assessed using the Structured Clinical Interview for DSM-IV (SCID-I; First, 2007) to diagnose alcohol dependence and exclude any other substance dependence disorder. All participants also completed the Millon Clinical Multiaxial Inventory III (MCMI-III; Millon and Davis, 1997) and the Symptom Check List, Revised (SCL-90-R; Derogatis, 1977) to provide information on personality disorders and psychopathological symptoms. To screen the presence of severe cognitive impairment we used Mental State Examination (MMSE, Folstein et al., 1975; Spanish version from Lobo et al., 1979), excluding participants who rates below normal baseline score (27; Folstein et al., 1975). Data regarding patterns of quantity and duration of drugs use, including typical amount per month, duration of use and total alcohol consumption (lifetime amount), was collected using the Interview for Research on Addictive Behavior (IRAB; Verdejo-García et al., 2005).

Controls were recruited through snowball communication among adults from the same geographical area as patients, during the same period of time. Additional selection criteria for control participants was the absence of current or past diagnoses of substance abuse or dependence, excluding past or current social drinking (less than ten standard units per week) and nicotine. Four control participants were excluded due to alcohol abuse and one participant due to cannabis use. For technical reasons HR-data were not available for three participants from the control group; Also, HRV were not available for three controls and three alcohol-dependents.

Alcohol-dependent individuals and controls did not differ on sex and ethnicity (all participants were European-Caucasian males). The groups also did not differ

significantly in terms of age [mean ± standard deviation (SD); alcohol-dependents 52.06±6.48; controls 48.77±10.66; p = 0.141], handedness (alcohol dependents 87.1% right handed and 12.9% left handed; controls 88.2% and 11.8%, respectively; p = 0.889) and socioeconomic level (64.5% of alcohol-dependents and 70.6% of controls had middle socioeconomic status, p = 0.492). The groups differed in years of education [alcohol dependents 13.74±1.98; controls 17.12±2.75; p < 0.001], and therefore this variable was included as a covariate in all subsequent analyses.

In the alcohol-dependent group, the mean amount of alcohol use was 565.80 (SD = 462.26) units/month, the mean duration of alcohol consumption was 26.50 (SD = 8.53) years, and the mean duration of abstinence was 11 weeks. In the control group, the mean alcohol use was 21.38 (SD = 12.50) units/month and the mean duration of consumption in years was 20.66 (9.67). From these data, we calculated the lifetime alcohol consumption (the product of mean amount × duration), which in the alcohol-dependent group was of 188027 units/lifetime (SD = 167377) and in controls was of 5077 units/lifetime (SD = 4359).

2.2. Instruments and procedure

This study was conducted according to the principles expressed in the Declaration of Helsinki. The protocol assessment was approved by the Ethics Committee for Human Research of the University of Granada and the Ethics Committee for Clinical Research of Nostra Senyora de Meritxell Hospital. All participants signed an informed consent before testing. The assessment was conducted individually in two sessions that lasted approximately one hour each. In the first session, participants were administered the clinical measures of addictive behavior, other psychiatric disorders and cognitive impairment. The moral decision-making task was administered in a second session. The

instruments included in this research belong to a more extensive evaluation protocol aimed at studying neuropsychological functions in alcoholism.

Moral decision-making were evaluated by 32 hypothetical dilemmas selected by Rasch analyses from Greene's moral dilemmas (Greene et al., 2001). The battery of dilemmas was adapted to Spanish language through a back-translation procedure, and its psychometric properties were tested in an independent community sample and found to be satisfactory (Cronbach's alpha = 0.78, Spearman Brown coefficient = 0.76; Carmona-Perera et al., Under review). In agreement with previous studies, we used four categories of dilemmas: non-moral dilemmas (involve non-moral decisions, e.g. buy a new camera or to have your old camera repaired for the same price; n = 8), impersonal moral dilemmas (involve non-emotional salient moral decisions, e.g. to turn a trolley away from five people, but toward one person; n = 8), and personal moral dilemmas (involve emotional salient moral decisions; n = 16), which were further divided into low-conflict, easy dilemmas (characterized by shorter decision latencies and high inter-subject response agreement, e.g. push a person off a bridge to stop a trolley from hitting five people), and high-conflict, more difficult dilemmas (characterized by longer decision latencies and lower levels of response agreement, e.g. smothering a baby to save a group people; Koenigs et al., 2007). Each dilemma had to be answered with ''yes'' or ''no'' and assessed the subjective difficulty of the decision on a scale ranging from 1 (low difficulty) to 10 (high difficulty). In the case of moral dilemmas, the answer ''yes'' indicates a utilitarian judgment which endorsed an emotionally aversive behavior for a higher societal well-being (e.g. to kill someone to save more people), while "no" indicate a deontological judgment which rejects the harmful action despite the aggregate welfare. The whole battery of dilemmas was administered in a computerized format. Each item consisted of three consecutive prompts: 1) description of the scenario, 2) a question

whether or not to execute the proposed action, and 3) the subjective difficulty question. The dilemmas were presented in a counter-balanced order across participants. The inter-trial interval between dilemmas was of 10 s, during which we used a blank screen to facilitate participants to return their psychophysiological responses to baseline. Participants were sitting in front of a computer screen in a quiet and dimly lit room. They read and responded without pre-established time limits, pressing "next" to advance from the reading to the decision screen, "yes" or "no" to advance from the decision to the difficulty judgment screen, and a number ranging from 1 to 10 to advance to the next dilemma. The Percentage of Affirmative answers and mean score of Difficulty of judgment ratings for each type of dilemma were collected as main dependent measures for behavioral data.

2.3. Psychophysiological Data Acquisition and Analyses

Heart Rate (HR) and Heart Rate variability (HRV) were used as dependent psychophysiological variables. For this purpose, the electrocardiogram (ECG) was continuously recorded at rest (baseline) and during performance on the moral decision-making test. During the 5 min baseline, participants were asked to sit still, not to speak, and maintain their eyes open. ECG was recorded at a sampling rate of 2000 Hz through a Biopac MP150 (Biopac Systems Inc., USA). Electrodes (Ag/AgCl) were placed according to Einthoven's II derivation attaching them to the participant's right and left ankles and wrist of the non-dominant hand. The ECG raw signal was processed using the software AcqKnowledge 3.8.1, allowing R-spike detection and quantification of R–R intervals (in ms). Inter-beat interval data were edited for artifacts using linear interpolation.

For baseline, Respiratory Sinus Arrhythmia (RSA), a vagal-based measure of heart

rate variability in the high frequency range (from 0.12 to 0.40 Hz), was extracted using CMetX software (Allen et al., 2007). The moral decision-making task was synchronized to the physiological recoding by event marking in association to the behavioral responses. This allow for the differential analysis of the different phases of trials. In such a way, each dilemma was divided in three time periods: i) presentation (from the onset of the dilemma in the computer screen to the time the participant press "next"), ii) decision (from the presentation of the dilemma question and the participant response), and iii) appraisal (from the presentation of the difficulty of judgment question and the subject's response). In order to extract the HR response pattern (ΔHR) to each experimental phase we obtained the 0.5 s by 0.5 s HR values expressed as differential scores with respect to mean HR obtained during the 5 s pre-dilemma. . The first 4 s (8 values) of each experimental period were computed as the analysis intervals. For all participants the comprised time for each period was at least 4 seconds, thus, the analyzed ΔHR intervals were recorded in all participants, including the fastest answers.

Data were analyzed using SPSS (IBM SPSS Statistics, Somers, New York). In order to examine between-group HRV differences in the resting condition we conducted Univariate Analysis of Variance ANOVA, including as dependent variable Log RSA. In addition, we performed parametric Pearson correlations between log HRV and moral decision making behavioral data (affirmative answers and difficulty ratings). To test whether the HR response pattern to the trials phases (presentation, decision and appraisal) differed as a function of dilemma subtype and group, we used 2(3x4x8) ANOVA, with a between-subject factor (group) and the three repeated-measures factors: experimental phase (presentation, decision and appraisal), dilemma category (non-moral, impersonal, low-conflict and high-conflict) and HR response pattern (8 HR values). The Huynh-Feldt epsilon correction was applied for the adjustment of the degrees of freedom in the

repeated measures factors. Results are reported with the original degrees of freedom and the corrected *p* values.

3. Results

3.1. Heart Rate response

A significant HR response change was observed [main effect of response pattern: $F(7, 420 = 32.22$, $p < 0.001$, $\eta^2 = 0.35$] which differed as a function of group [interaction effect: $F(7, 420) = 4.36$, $p = 0.016$, $\eta^2 = 0.07$]. Although the HR response was significant in the two groups, the effect was greater in the control [$F(7, 210) = 26.18$, $p < 0.001$, $\eta^2 = 0.47$] than in the alcohol-dependent group [$F(7, 210) = 7.72$, $p = 0.001$, $\eta^2 = 0.20$]. In the control group the HR increases during the presentation phase exhibited an increase and a posterior decrease during the decision phase (i.e. a biphasic response) and increases again during the appraisal phase (see Figure 1). A similar but blunted response was observed in the alcohol-dependent participants (see Figure 2).This pattern lead to a decrease in HR during the course of the experiment [main effect of phase: $F(2, 120) = 17.03$, $p < 0.001$, $\eta^2 = 0.22$].

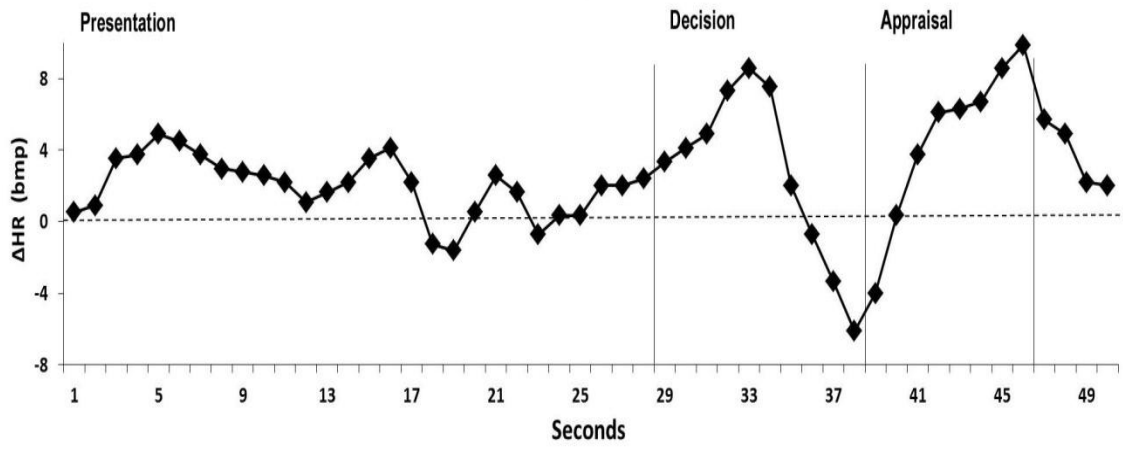


Figure 1. Example of Heart Rate response (ΔHR) recoded in a control participant during the high-conflict dilemma called "crying baby", where the participant have to accept or refuse smothering a baby to save a group of people.

There were significant differences between the types of dilemmas [main effect of type of dilemma: $F(3, 180) = 5.86$, $p < 0.001$, $\eta^2 = 0.09$] which differed as a function of group [interaction effect: $F(3, 180) = 5.06$, $p = 0.003$, $\eta^2 = 0.08$]. Significant differences between the different types of dilemmas were found in the control group [$F(3, 90) = 8.07$, $p < 0.001$, $\eta^2 = 0.21$] but not in the alcohol-dependent group [$F(3, 90) = 0.31$, $p = 0.787$, $\eta^2 = 0.01$].

For the three experimental phases, low and high-conflict personal dilemmas were associated with reduced HR levels compared to non-moral and impersonal dilemmas in the control group (see Figure 2).

Furthermore, the effect of the types of dilemmas is dependent of the experimental phase (interaction effect: $F(6, 360) = 2.41$, $p = 0.034$, $\eta^2 = 0.04$) as differences between dilemmas increases progressively during the course of the experiment [$F(3, 180) = 3.27$, $p = 0.05$, $\eta^2 = 0.05$ for presentation, $F(3, 180) = 5.75$, $p = 0.001$, $\eta^2 = 0.09$ for decision, and $F(3, 180) = 8.94$, $p < 0.001$, $\eta^2 = 0.13$ for appraisal].

Finally, the experimental phase also modulated the group × response pattern interaction [triple interaction effect: $F(14, 840) = 3.26$, $p = 0.019$, $\eta^2 = 0.05$]. The interaction group × response pattern was statistically significant for presentation [$F (7, 420) = 7.03$, $p = 0.003$, $\eta^2 = 0.11$], and appraisal [$F (3, 58) = 4.53$, $p = 0.021$, $\eta^2 = 0.07$] but not for the decision phase [$F (7, 420) = .90$, $p = 0.416$, $\eta^2 = 0.02$]. The inclusion of mean baseline HR as a covariate did not change these results.

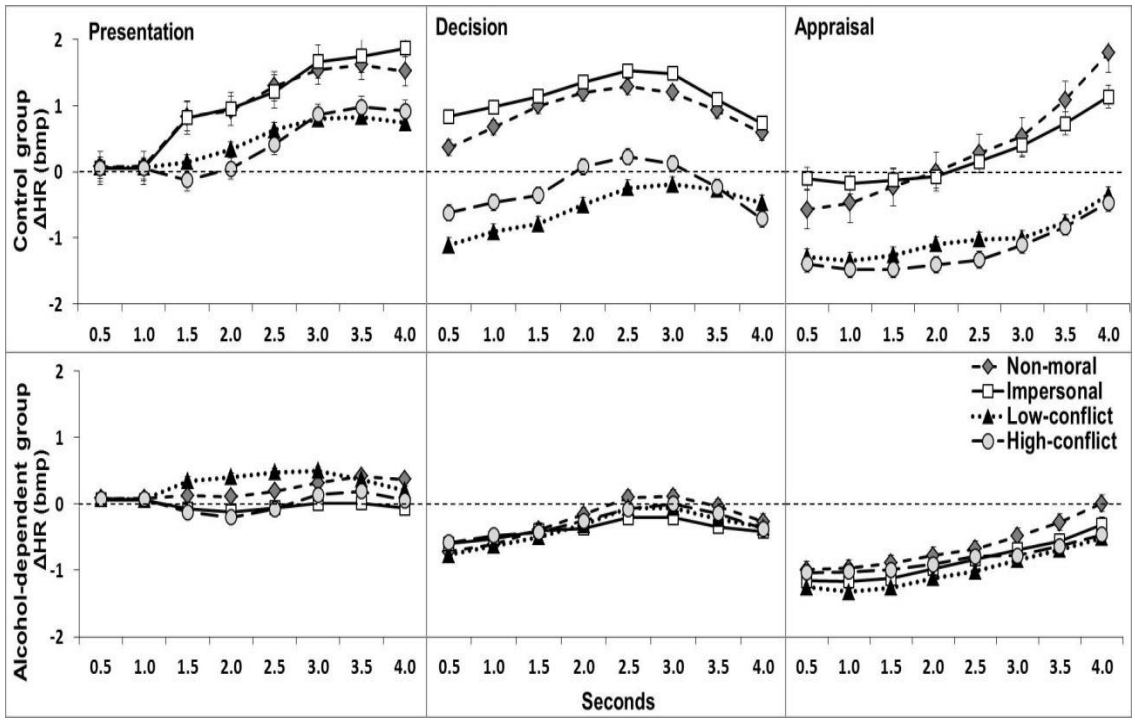


Figure 2. Heart rate response (ΔHR) during the three experimental phases (presentation, decision and appraisal), as a function of dilemma category and group.

3.2. Heart Rate Variability

Univariate ANOVA analysis to test HRV differences at baseline revealed that the alcohol-dependent group displayed significantly lower HRV (Mean = 3.78; SD = 1.37) than the control group (Mean = 5.15; SD = 1.48) in log RSA [$F(1, 57) = 13.49$, $p = 0.001$, $\eta^2 = 0.19$]. Pearson's correlations in the overall sample showed that utilitarian answers were significantly associated with reduced log RSA in low ($r = -0.34$; $p = 0.008$) and high-conflict ($r = -0.31$; $p = 0.019$) personal dilemmas, whereas no significant correlations were found for non-moral and impersonal dilemmas (see Figures 3a and 3b). Moreover, difficulty of judgment in high-conflict scenarios was positively correlated with increased log RSA ($r = 0.42$; $p < 0.001$) (see Figure 3c). However, correlations calculated separately within each group did not reach significance neither for controls (low conflict: $r = -0.12$, high conflict: $r = -0.10$), or alcohol-dependent participants (low conflict: $r = -0.13$, high conflict: $r = -0.10$). Difficulty of judgment in high-conflict

dilemmas was marginally associated with log RSA both in the control (r = 0.35, p = 0.053) and the alcohol-dependent groups (r = 0.32, p = 0.096).

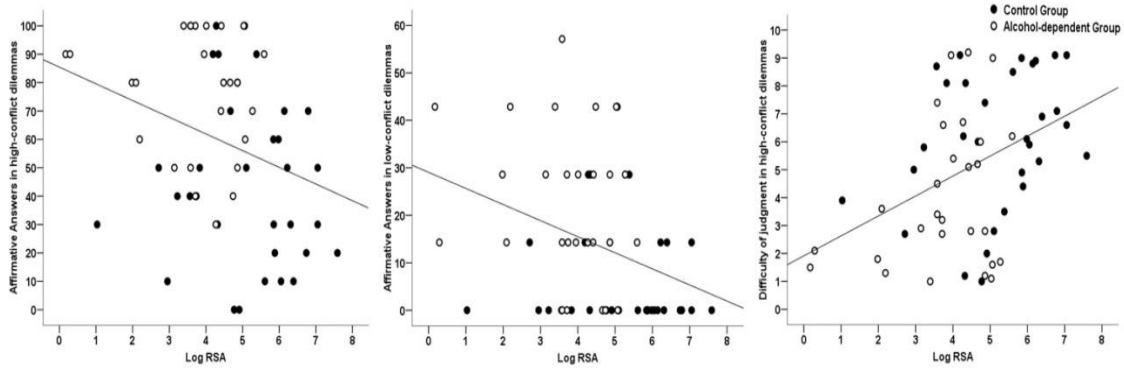


Figure 3. Scatterplot and regression lines for the relationship between log RSA and proportion of utilitarian choices in high and low-conflict moral dilemmas, and difficulty of judgment in high-conflict dilemmas.

4. Discussion

Alcohol-dependent individuals tend to endorse more utilitarian choices in personal moral dilemmas compared to healthy controls (Carmona-Perera et al., Under review; Khemiri et al., 2012). Here we unveil the psychophysiological concomitants of this behavior: whistle healthy controls showed decreased heart rate (HR) to the personal (emotionally salient) vs impersonal or non-moral scenarios, alcohol dependent individuals failed to modulate their heart rate responses as a function of the type of dilemma. Furthermore, in comparison to the healthy controls, the alcohol-dependent individuals showed a blunted cardiac responsiveness to the moral dilemmas. These deficits were not related to baseline differences in HR. In addition, utilitarian choices in personal dilemmas were associated with decreases in heart rate variability, nonetheless, this association did not hold in each group separately.

Stimulus-evoked reductions in heart rate are mainly associated with negatively

valenced emotions (Danko et al., 2011; Greenwald et al., 1989; Lang et al., 1993; Palomba et al., 2000). Therefore, we posit that the heart rate decreases shown by healthy controls in response to personal dilemmas reflects the engagement of negatively valenced emotions purportedly involved in the appraisal of moral violations (Rozin et al., 1999). Conversely, alcohol-dependent individuals exhibit problems to engage negatively valenced emotions during consideration of moral scenarios. This interpretation is in accordance with the somatic-marker theory of addiction, which postulates that addicted individuals have specific difficulties to generate and perceive the emotional signals (somatic-markers) attached to potential negative outcomes of decisions (Verdejo-García and Bechara, 2009; Verdejo-García et al., 2012). Our results are also consistent with the dual-process model of moral choice, which postulates that engagement of strong negative emotions tend to bias moral decision-making towards deontological choices (Greene, 2007; Greene et al., 2008). The ventromedial prefrontal cortex has been demonstrated as an essential brain region for the triggering of emotional responses during moral decision-making (Koenigs et al., 2007), and it is also involved in the decoding of negatively valenced emotions (Salloum et al., 2007).

Previous studies had highlighted the role of autonomic physiological responses during moral responses through the study of electrodermal activity (Moretto et al., 2010; Navarrete et al., 2012; Teper et al., 2011), however, our findings are the first to demonstrate blunted HR reactivity to moral dilemmas in alcohol-dependent-individuals. Specifically, healthy controls elicited an anticipatory HR response before moral decision-making, characterized by a biphasic response, and a subsequent HR increases during appraisal period, whereas this response pattern was substantially diminished in alcohol-dependent patients. This is in accordance with previous evidence in alcoholic patients about diminished cardiac responsiveness to emotional stimuli, and the inability

to be affected by mood (Jansma et al., 2000; Kornreich et al., 1998; Ryan and Howes, 2002). The somatic-marker theory of addiction (Verdejo-Garcia and Bechara, 2009) posits that these difficulties to generate somatic-markers would be associated altered decision-making in substance abusers. These findings provide support that this also occurred for moral decision-making. Specifically, our findings showed diminished heart rate responses elicited by personal moral scenarios. In view of the theoretical link between heart rate decreases and negative valence (Danko et al., 2011; Lang et al., 1993; Palomba et al., 2000) our results are in agreement with those obtained in mood induction studies, which demonstrate that induction of negative emotions significantly reduces utilitarian biases (Schnall et al., 2008; Van Dillen et al., 2012; Wheatley and Haidt, 2005), whereas positive emotions increase utilitarism (Pastötter et al., 2012; Valdesolo and DeSteno, 2006). These findings may pose important implications for alcohol-related interventions, which should focus on adequate appraisal of negative emotions to purportedly improve social cognition deficits.

This study holds important strengths and several worth commenting limitations. Strengths include a careful selection of alcohol-dependents and controls participants, excluding many confounders common in drug abuse research. The alcohol-dependent group excluded subjects with lifetime history of other drug use and co-morbid psychiatric disorders. The Alcohol-dependent participants were assessed after an abstinence period of 15 days verified by twice weekly urine analysis, and therefore we can avoid the changes in physiological activity during the first days of abstinence as well as the changes in moral judgments performance due to the immediate effect of alcohol. The main limitations include the non-matching of educational levels between the groups, the relatively small sample size and the lack of associations between moral choice and baseline physiological patterns within each group, in spite of previous evidence that heart

rate variability may strongly impact cognition-emotion integration (Lane et al., 2001; Thayer et al., 2009; Thayer and Lane, 2000). The discrepancy in years of education was controlled using ANCOVA models. These models were pertinent because years of education correlated with behavioral choice patterns. However, no study has found any relation between HRV and educative level. The sample size is similar to that reported in previous clinical studies of cognitive-affective deficits in alcohol-dependent individuals (Uekermann et al., 2007; Maurage et al., 2008), and it was enough powered to detect group differences on the heart rate concomitants of moral choice. Nonetheless, sample sizes within each group may have been short to detect the expected association in each group between heart rate variability and choice patters, perhaps due in part to reduced variability within each group. Future studies should further explore this association.

In summary, the results of this study indicate that the moral decision-making in alcohol-dependents is characterized by insensitivity to negative emotional consequences of personal moral violations, such that their moral behavior may be comparatively more guided by a cost-benefit approach that favors utilitarian choices. Specifically, they failed to modulate heart rate in response to personal dilemmas, showing an inability to decrease HR both prior decision-making and his post appraisal.

IV. DISCUSIÓN GENERAL, CONCLUSIONES Y PERSPECTIVAS FUTURAS

Capítulo 8

Discusión general, conclusiones y perspectivas futuras

1. Discusión General

A continuación se presenta una discusión general de nuestros hallazgos en relación con cada uno de los objetivos e hipótesis planteados en los cuatro trabajos que conforman esta tesis doctoral.

El objetivo principal de esta tesis doctoral fue investigar la toma de decisiones morales en la población drogodependiente, así como los correlatos psicológicos y psicofisiológicos asociados al patrón de respuesta Utilitarista vs. Deontológica. En su conjunto, el presente trabajo se estructura en dos ejes centrales, el primero consiste en investigar el patrón de respuesta y la dificultad de juicio ante los dilemas morales en la población drogodependiente, en concreto los pacientes dependientes a múltiples sustancias adictivas y los pacientes dependientes al alcohol, investigados en el primer y segundo estudio respectivamente. El segundo eje consiste en estudiar la contribución de las variables previamente asociadas al sesgo utilitarista, y se llevó a cabo en los dos últimos trabajos realizados en la población dependiente al alcohol. En concreto, en el tercer estudio se investigaron las variables psicológicas –la severidad de consumo, la impulsividad, el estrés, la ansiedad y el reconocimiento emocional–, y en el cuarto estudio las variables psicofisiológicas vinculadas a la experiencia de emociones aversivas y el control emocional, a través de la tasa cardiaca ante los dilemas y la variabilidad cardiaca en reposo.

Para ello, fue necesario un primer trabajo en el que se obtuvo una versión en español y abreviada de los dilemas morales de Greene (2001) llamada Brief Moral Decision-making Questionnaire (BrMoD). Además se probaron sus propiedades psicométricas en una población de 133 controles sanos, hallando una alta fiabilidad y validez, así como la capacidad para controlar las variables de confusión previamente

identificadas (género, edad, nivel educativo, nivel socioeconómico).

En cuanto al primer eje de estudio sobre la toma de decisiones morales, los resultados en los pacientes policonsumidores mostraron que, ante dilemas morales personales de alto conflicto emocional, las personas policonsumidoras llevan a cabo juicios morales utilitaristas que priorizan el bienestar global a pesar de dañar a una persona, y la dificultad que les supone tomar la decisión moral es menor que en los participantes no consumidores. Además observamos una asociación entre la gravedad del consumo de alcohol y el sesgo utilitarista en los dilemas personales. A partir de estos resultados procedimos a ampliar el estudio en los pacientes dependientes al alcohol, replicando en esta población el patrón utilitario específico para los dilemas morales personales, aunque en este caso se dio tanto en los de bajo como en los de alto conflicto emocional. También mostraron una menor dificultad percibida para emitir los juicios morales.

Respecto al segundo eje de estudio centrado en los factores predictivos del sesgo utilitarista en la población dependiente al alcohol, los resultados sobre las variables psicológicas mostraron que la deficiente codificación de las emociones de miedo y asco predecía significativamente el patrón de respuesta utilitarista en los dilemas personales, por encima del consumo de alcohol. En concreto, el deterioro en la decodificación del miedo fue el principal predictor de las respuestas utilitarias en los dilemas de alto conflicto, mientras que el déficit en la decodificación del asco fue el principal predictor para los dilemas de bajo conflicto. La contribución de la impulsividad y el estado de ánimo (depresión y ansiedad) no fue significativa. Finalmente, el último estudio centrado en la respuesta dinámica de la tasa cardiaca durante la toma de decisiones morales y la variabilidad cardiaca en reposo, demostró la contribución respectiva de la experiencia y

la regulación emocional en el sesgo utilitarista. En concreto, las personas dependientes al alcohol mostraron una respuesta disminuida de la tasa cardiaca durante la toma de decisiones morales. En cambio los participantes controles mostraron un patrón bien definido, caracterizado por una respuesta bifásica (aumento y descenso) previa al juicio moral y un posterior aumento durante la fase de evaluación de la respuesta emitida. Por otro lado, los controles sanos presentaron una disminución de la tasa cardiaca ante los dilemas personales vs. los dilemas impersonales o no morales, mientras que las personas dependientes al alcohol no modulaban la tasa cardiaca en función del tipo de dilema. Estos déficits no estaban relacionados con las diferencias basales en tasa cardiaca. Además, las opciones utilitarias en dilemas personales se asociaron con una disminución en la variabilidad cardiaca, sin embargo, esta asociación no se mantuvo en cada grupo por separado.

A continuación se exponen las implicaciones teóricas y clínicas que se derivan de estos resultados.

1.1. Implicaciones teóricas

Las implicaciones teóricas que se extraen de los cuatro estudios que forman la presente tesis doctoral contribuyen a aumentar el conocimiento en la toma de decisiones morales, explorando la contribución de la emoción y otras variables, como la impulsividad o el estado de ánimo, en el sesgo utilitarista. Además, el estudio de la toma de decisiones morales en la población drogodependiente, contribuye al avance en el conocimiento de los procesos adictivos y sus modelos explicativos.

El sesgo utilitarista ante los dilemas personales que muestran las personas policonsumidoras (Carmona-Perera et al., 2012), y dependientes al alcohol (Carmona-Perera et al., In press), en comparación con el patrón deontológico en los

controles sanos, es consistente con los trabajos previos en poblaciones con deterioro emocional, incluyendo los estudios en pacientes con daño frontal adquirido (Koenigs et al., 2007; Moretto et al., 2010), demencia frontotemporal (Gleichgerrcht et al., 2011; Mendez et al., 2005), psicopatía (Blair, 2007; Cima et al., 2010; Young et al., 2012), autismo (Buon et al., 2012; Moran et al., 2011), ansiedad (Starcke et al., 2011; Youssef et al., 2012), y el estudio en pacientes dependientes al alcohol (Khemiri et al., 2012). Las diferencias entre grupos específicas para los dilemas personales, aquellos que implican una alta carga emocional, indican el papel fundamental que juega la emoción en la toma de decisiones morales. Esta interpretación es consistente con la teoría del marcador somático de la adicción, que postula que las personas adictas tienen dificultades específicas para generar y percibir las señales emocionales (marcadores somáticos) unidos a los posibles resultados negativos de las decisiones (Verdejo-García & Bechara, 2009). Estos resultados también se enmarcan dentro de la teoría del Doble proceso de Greene (Greene, 2007, 2008). Mientras que en los controles sanos la emoción supera la evaluación cognitiva decantando los juicios morales personales hacia la respuesta deontológica y aumentando así la dificultad de juicio debido al conflicto moral emoción-cognición, en las personas drogodependientes los déficits emocionales favorecen el predominio del procesamiento cognitivo que genera respuestas utilitaristas y menor dificultad para decidir. Sin embargo los dilemas impersonales que no implican relevancia emocional, se encuentran liderados por mecanismos cognitivos, de manera que el déficit emocional de los pacientes drogodependientes no interfiere en la decisión, optando, al igual que los participantes no consumidores, por respuestas utilitaristas.

Tanto nuestros resultados (Carmona-Perera et al, In press), como los hallado por Khmiri (2012), muestran que el sesgo utilitarista observado en la población dependiente al alcohol se extiende a los dilemas personales de bajo conflicto o fáciles (96.3% de

consenso de respuesta deontológica y 4.5 s. de tiempo medio de respuesta en la población normal) y de alto conflicto o difíciles (consenso de respuesta deontológica = 55.6%; tiempo medio de respuesta = 10.2 s.) (Carmona-Perera et al., Under review a). Por tanto, la toma de decisiones morales de los pacientes dependientes al alcohol presenta una mayor alteración en comparación con los pacientes con daño frontal adquirido (Ciaramelli et al., 2007; Koenigs et al., 2007; Moretto et al., 2010) y los pacientes policonsumidores (Carmona-Perera et al., 2012), en los que el sesgo utilitarista solo aparece ante los dilemas personales de alto conflicto emocional. En esta línea, en los consumidores de varias sustancias, la severidad del consumo de alcohol se asocia con el sesgo utilitarista. La asociación entre la dependencia al alcohol y la toma de decisiones morales utilitaristas puede ser debida a los efectos neurotóxicos específicos del alcohol sobre el lóbulo frontal (Beck et al., 2012; Stephens & Duka, 2008), los cuales se asocian con un deterioro cognitivo-afectivo que podría contribuir a los déficits en el juicio moral. En esta línea, estudios previos han demostrado que el consumo de alcohol, en comparación con otros tipos de sustancias adictivas, conlleva daños más severos en la percepción y el procesamiento emocional (Foisy et al., 2005; Kornreich et al., 2003), incluyendo déficits en el reconocimiento facial emociones y la prosodia afectiva (Maurage et al., 2011; Uekermann et al., 2007; Uekermann, Daum, Schlebusch, & Trenckmann, 2005), así como la alteración emocional, pero no cognitiva de la empatía (Maurage et al., 2011). Además, estos déficits afectivos son predictivos de problemas interpersonales en la vida real (Kornreich et al., 2002).

En cuanto al estudio de los factores predictivos del sesgo utilitarista, nuestros resultados sugieren la contribución fundamental de la percepción y la experiencia emocional en los juicios morales utilitaristas de las personas dependientes al alcohol (Carmona-Perera et al., In press; Carmona-Perera et al., Under review b).

Respecto a la percepción de emociones se observó que la alteración en la decodificación del miedo y del asco contribuía a las decisiones utilitaristas ante los dilemas personales de bajo conflicto emocional en el caso del miedo, y de alto conflicto emocional en el caso del asco. Estos resultados se podrían explicar por la aversión que puede generar la percepción del miedo para llevar a cabo una violación moral a pesar de ser beneficiosa para el bienestar común, como ocurre en los escenarios de alto conflicto emocional (Crockett et al., 2010). Por el contrario, los dilemas personales de bajo conflicto, como causar daño de forma egoísta, podrían provocar repugnancia moral (Ugazio et al., 2012; Wheatley & Haidt, 2005). Además, los problemas en la decodificación de emociones se asocian con déficits en el condicionamiento aversivo (Borlikova et al., 2006; Stephens & Duka, 2008), lo que podría generar en las personas dependientes al alcohol una menor sensibilidad a las consecuencias emocionales negativas de las respuestas utilitaristas (Birbaumer et al., 2005; Gao et al., 2010). En este sentido, Marsh y Cardinale (2012) observaron que las personas con dificultades para identificar comportamientos que causan miedo en los demás, tienden a juzgar estas conductas como moralmente más aceptables, de manera que la comprensión de las consecuencias emocionales de la conducta se asocia con los juicios de moralidad, siendo relevantes en la comprensión de las relaciones interpersonales. De hecho, las relaciones interpersonales se basan en gran medida en nuestra capacidad para percibir las emociones de los demás (Riggio et al., 2003), por lo que el deterioro en la decodificación emocional de las personas con dependencia al alcohol puede contribuir a los problemas sociales que presenta esta población (Kornreich et al., 2002; Maurage et al., 2008). Nuestros datos también son consistentes con los estudios que asocian la inducción de emociones relacionadas con la evitación, como por ejemplo el miedo y el asco, con los juicios morales deontológicos (Harlé & Sanfey, 2010; Ugazio et al., 2012). La vinculación de la

experiencia emocional en la toma de decisiones morales se puede entender en el contexto del modelo del marcador somático de la adicción (Verdejo-García & Bechara, 2009), según el cual la integración del input socio-emocional es clave para orientar la toma de decisiones, y en concreto en el marco del modelo Doble proceso (Greene, 2007) que postula el dominio de la emoción en los juicios deontológicos.

El estudio centrado en los correlatos psicofisiológicos del patrón utilitarista a través del análisis de la tasa cardiaca, sugiere que las personas dependientes al alcohol presentan un déficit para experimentar emociones aversivas ante los dilemas personales. Los resultados mostraron que el grupo dependiente al alcohol presentaba una menor reactividad de la tasa cardiaca ante los dilemas morales, en concreto, una menor desaceleración cardiaca durante la consideración de los dilemas personales. La desaceleración cardiaca se asocia con la experiencia de emociones negativas (Danko, Gracheva, Boytsova, & Solovjeva, 2011; Greenwald, Cook, & Lang, 1989; Palomba, Sarlo, Angrilli, Mini, & Stegagno, 2000). De manera que la disminución de la tasa cardiaca mostrada por los controles sanos en respuesta a los dilemas personales, y no ante los dilemas impersonales y no morales, indica la participación de las emociones negativas en la evaluación de violaciones morales con relevancia emocional (Rozin, Lowery, Imada, & Haidt, 1999). Por el contrario, la incapacidad del grupo dependiente al alcohol para modular la tasa cardiaca en función del tipo de dilema, indica un deterioro a la hora de experimentar emociones negativas durante la toma de decisiones morales personales. Esta interpretación es conforme con el modelo del Doble Proceso de toma de decisiones morales, que postula que la participación de las emociones negativas tiende a sesgar la decisión moral con opciones deontológicas (Greene, 2007). Estos hallazgos también son consistentes con los estudios en pacientes alcohólicos que demuestran una disminución de la respuesta cardiaca ante estímulos emocionales, y la incapacidad para

modular la tasa cardiaca en función del estado de ánimo (Jansma, Breteler, Schippers, de Jong, & Van Der Staak, 2000; Ryan & Howes, 2002). La teoría del marcador somático de la adicción (Verdejo-García & Bechara, 2009) postula que las dificultades para generar las señales emocionales vinculadas a los resultados negativos de las decisiones, se asociarían con la alteración en la toma de decisiones de las personas drogodependientes. Nuestros resultados proporcionan apoyo a que esto también se daría en el caso de la toma de decisiones morales. Dado la asociación entre la disminución de la tasa cardiaca y la valencia negativa (Danko et al., 2011; Greenwald et al., 1989; Palomba et al., 2000) nuestros datos están de acuerdo con los estudios que demuestran que la inducción de emociones negativas reduce el patrón utilitarista ante los dilemas personales (Schnall et al., 2008b; Van Dillen et al., 2012; Wheatley & Haidt, 2005), mientras que las emociones positivas aumentan el utilitarismo (Pastötter et al., 2012; Valdesolo & DeSteno, 2006).

Además, nuestro estudio mostró que las personas con menor variabilidad cardiaca eran aquellas que presentaban más respuestas utilitaristas ante los dilemas personales y menor dificultad de juicio. Valores bajos en variabilidad cardiaca se interpretan como un índice de déficit en la regulación emocional (Thayer & Lane, 2000), y en la generación de respuestas emocionales (Appelhans & Luecken, 2006; Thayer & Lane, 2000). De manera que la asociación entre la variabilidad cardiaca en reposo y el patrón de respuesta utilitarista parece indicar un impacto de la regulación emocional en la toma de decisiones morales, vinculando la variabilidad cardiaca con las respuestas deontológicas, y su déficit con el sesgo utilitarista. Dado la asociación entre la variabilidad cardiaca y la generación de respuestas emocionales (Appelhans & Luecken, 2006; Thayer & Lane, 2000), estos datos apoyan de nuevo la hipótesis del marcador somático (Verdejo-García & Bechara, 2009).

En resumen, la aportación a nivel teórico que realizan los resultados de nuestros estudios apoyan el modelo del Marcador Somático (Verdejo-García & Bechara, 2009) en cuanto a modelo explicativo de la toma de decisiones en los procesos adictivos, así como el modelo del Doble Proceso, específico para la toma de decisiones morales. En su conjunto nuestros resultados indican que las personas dependientes al alcohol presentan una capacidad reducida para integrar la información social y afectiva que favorece el control cognitivo y la toma de decisiones morales utilitaristas ante los dilemas emocionalmente relevantes (Greene, 2007). Además, según la teoría del marcador somático de la adicción (Verdejo-García & Bechara, 2009) la afectación de la corteza prefrontal medial en la población drogodependiente, afectaría la generación de los marcadores somáticos asociados a las consecuencias aversivas de la conducta, guiando la toma de decisiones morales personales hacia opciones utilitaristas. Por tanto, nuestros datos realizan una contribución importante al debate Emoción vs. Cognición en los mecanismos explicativos de la conducta ética humana, enfatizando el rol de la emoción en la toma de decisiones morales a través de la vinculación de los déficits en la percepción y la experiencia de las emociones negativas con el sesgo utilitarista.

1.2. Implicaciones clínicas

Los resultados obtenidos en la presente tesis doctoral pueden suponer implicaciones clínicas importantes para la incorporación de la toma de decisiones morales al proceso de evaluación neuropsicológica y al proceso de intervención terapéutica, contribuyendo a reducir las conductas utilitaristas que estos llevan a cabo con el fin de conseguir la sustancia psicoestimulante.

1.2.1. Implicaciones en la evaluación neuropsicológica

La principal aportación que realizan nuestros resultados a la evaluación neuropsicológica

es la obtención de un cuestionario adaptado a la población española y de extensión breve que permite la evaluación de la toma de decisiones morales de manera válida y fiable. El cuestionario llamado Brief Moral Decision-making Questionnaire (BrMoD) contiene una selección de los ítems del cuestionario original de Greene (2001), realizada a través de un análisis Rasch. La metodología Rasch nos ha permitido depurar el instrumento original de Greene, es decir, reducir su longitud sin perder la medida del constructo en toda su extensión, homogeneizar la calidad de todos los ítems y eliminar aquellos en los que se puede reflejar la influencia de otras variables distintas al constructo de juicio moral (Tennant & Conaghan, 2007). Los resultados mostraron que el cuestionario BrMoD solventa los principales problemas de la batería original, cumpliendo con los siguientes criterios: i) duración breve, ii) propiedades psicométricas adecuadas (fiabilidad y validez de constructo), iii) estandarización de las puntuaciones en población control, iv) funcionamiento invariable en función del sexo, la edad, el nivel educativo y económico.

En cuanto la duración breve, la selección de 32 dilemas del conjunto de 60 dilemas Greene (2001) reduce la longitud del cuestionario casi a la mitad, minimizando así el potencial de la fatiga y los factores de distracción. Esta reducción significativa del tiempo de aplicación resulta fundamental en poblaciones clínicas, como en el caso de la población drogodependiente, dónde el tiempo medio de administración aumenta significativamente en comparación con la población normal.

Los buenos índices de fiabilidad y validez obtenidos nos permiten distinguir entre personas con nivel bajo, medio o alto de aplicación de un patrón utilitarista o deontológico en la toma de decisiones morales. Esta clasificación en función de las puntuaciones del cuestionario en una muestra de personas sanas, permite la posibilidad de comparar las puntuaciones concretas de otras poblaciones evaluadas en cada una de estas tres categorías con el objetivo de identificar alteraciones específicas. La baremación

e interpretación del cuestionario se ve facilitada por el funcionamiento invariable de los dilemas en los factores personales más comunes como el sexo, la edad, el nivel educativo y socioeconómico.

Por otro lado, los ítems que forman la categoría no moral funcionan como un elemento o escala de control sobre la capacidad de razonamiento lógico, entendido como un prerrequisito para la comprensión y el manejo de la información contenida en los dilemas del cuestionario. Aplicando el porcentaje mínimo obtenido en la muestra de 94% de respuestas lógicas correctas, se puede establecer un punto de corte de 7 ítems correctos para descartar la presencia de problemas de comprensión y razonamiento. Al estar formada por ítems que la población normal responde mayoritariamente de forma lógica, la categoría no moral se podría utilizar como un elemento para detectar la simulación en sujetos sometidos a procesos legales, como ocurre en personas con daño cerebral por accidentes de tráfico (Lange, Iverson, Brooks, & Rennison, 2010).

Además el hecho de disponer de un cuestionario estandarizado de dilemas morales permite disminuir la heterogeneidad en la aplicación de los dilemas, facilitando la comparación y replicación de resultados experimentales y la evaluación neuropsicológica (Cushman, 2008; Christensen & Gomila, 2012; Kahane & Shackel, 2010). Por consiguiente, el desarrollo del cuestionario BrMoD supone ventajas importantes tanto para la investigación, como para su aplicación fuera del contexto de laboratorio. En concreto sería de interés extender su uso a la práctica clínica en áreas que muestran alteraciones del juicio moral, como por ejemplo, las adicciones (Carmona-Perera et al., 2012; Khemiri et al., 2012) o el daño cerebral adquirido (Koenigs et al., 2007; Moretto et al., 2010). Otro ámbito de aplicación, es la selección de recursos humanos, y en especial de aquellas profesiones que pueden verse implicadas en dilemas morales como policías o bomberos (Gibson, 2003; Stahl & Cimorelli, 2012).

1.2.2. Implicaciones en la intervención terapéutica

Los hallazgos obtenidos en los tres estudios llevados a cabo en la población drogodependiente pueden tener implicaciones importantes en la rehabilitación de las personas con adicción al consumo de sustancias psicoadictivas, dado que los déficits en la toma de decisiones es un predictor de las recaídas en el consumo de alcohol y drogas (Allsop et al., 2000; Bechara & Damasio, 2002), y en concreto la toma de decisiones morales utilitaristas se relaciona con problemas de interacción social y con conductas antisociales que incluyen comportamientos ilegales, agresividad y violencia interpersonal (Cushman et al., 2006; Moll & de Oliveira-Souza, 2007; Moll et al., 2005; Young & Saxe, 2008). El patrón utilitarista y la menor dificultad para decidir que caracterizan los juicios morales personales de las personas dependientes a múltiples sustancias psicoactivas y al alcohol, podría ayudar a entender las violaciones morales que éstas llevan a cabo con el fin de conseguir droga, como por ejemplo conductas de robo o engaño a familiares, en las que la toma de decisiones morales se decanta hacia la elección utilitarista (conseguir droga) a pesar de infligir un conducta emocionalmente aversiva. La mejor comprensión de los juicios morales en drogodependencias es vital para promover la inclusión de terapias que tengan en cuenta el proceso de toma de decisiones morales dentro de las medidas de rehabilitación tradicionales.

La contribución de la percepción y experiencia emocional de las emociones negativas en la toma de decisiones morales que muestran nuestros datos, indica la necesidad de introducir estos procesos emocionales en la intervención terapéutica sobre el juicio moral, ya sea a través de la consideración de la emoción durante la resolución de dilemas morales (Lerkiatbundit, Utaipan, Laohawiriyanon, & Teo, 2006; Lind, 2005; Molewijk, Kleinlugtenbelt, Pugh, & Widdershoven, 2011; Molewijk, Kleinlugtenbelt, & Widdershoven, 2011), o bien con programas específicos para la mejora de la percepción y

experiencia emocional (Duric et al., 2002; Ekman, 2003; Kabat-Zinn, 2003, 2013; Lisetti & Nasoz, 2002; Zeng, Pantic, Roisman, & Huang, 2007).

En cuanto a la práctica clínica en la deliberación de dilemas morales teniendo en cuenta la emoción (Lerkiatbundit et al., 2006; Lind, 2005; Molewijk et al., 2011; Bert Molewijk et al., 2011) se propone a los participantes ponerse en el lugar del agente primario (dilemas personales) o secundario (dilemas impersonales) de la conducta aversiva, así como de la víctima de tal conducta, de manera que cada uno experimenta los distintos roles. A continuación, se evalúa de modo grupal los acontecimientos del dilema que generan la emoción y las cogniciones que la acompañan, tratando de encontrar la emoción más adecuada y la conducta más congruente con tal emoción para hacer frente a la situación que propone el dilema. Este proceso de reflexión emocional conjunta permite una mejor percepción de las emociones implícitas en el dilema moral, y también una mejor comprensión de la experiencia emocional (Johnson, Susan, Bradley, & Furrow, 2005; Molewijk et al., 2011; Palmer-Olsen, Gold, & Woolley, 2011). Un componente esencial de este tipo de intervención es el carácter grupal, que permite que las distintas personas puedan percibir y experimentar emociones diferentes ante el mismo dilema, explorar tales diferencias y aprender de ello. Sin embargo, para que la persona pueda reflexionar conjuntamente sobre las emociones, es necesaria la capacidad de prestar atención a la propia percepción y experiencia emocional, centrándose en las conductas deontológicas o utilitaristas que dan lugar. Por ello puede ser de gran interés, complementar la deliberación de dilemas morales con técnicas de intervención dirigidas a mejorar la percepción y la experiencia de emociones.

Respecto a la rehabilitación de la percepción de emociones, algunas intervenciones específicas, como por ejemplo el entrenamiento en el Reconocimiento de

Microexpresiones (Ekman, 2003; Matsumoto & Hwang, 2011) o los Sistemas Afectivos Multimodales (Duric et al., 2002; Lisetti & Nasoz, 2002; Zeng et al., 2007), pueden ser de utilidad para fomentar la decodificación emocional, así como la transferencia de estas capacidades emocionales a las decisiones de la vida real, incluyendo aquellas que implican un contenido moral, dado la asociación encontrada entre el déficit en la decodificación del asco y el miedo y la toma de decisiones utilitaristas.

Por otro lado, la alteración encontrada en la experiencia de emociones negativas de las personas drogodependientes ante los dilemas morales personales y la asociación entre la regulación emocional en línea base y las respuestas utilitaristas, podría trabajarse a través de la inclusión de la técnica de Mindfulness (Kabat-Zinn, 2003, 2013). Esta técnica fomenta la experiencia emocional a través de la atención plena al momento presente, permitiendo contemplar sin juzgar las propias emociones y las de los demás, tanto si resultan agradables como desagradables (Kabat-Zinn, 2009, 2013; Ma & Teasdale, 2004). También permite una mayor autorregulación, potenciando la toma de decisiones beneficiosas en lugar de las que se emiten de manera automática e inconsciente (Alfonso, Caracuel, Delgado-Pastor, & Verdejo-García, 2011; Black, Semple, Pokhrel, & Grenard, 2011; Ma & Teasdale, 2004), así como el incremento de los sentimientos de empatía y compasión (Aiken, 2006; Beddoe & Murphy, 2004; Birnie, Speca, & Carlson, 2010). Estudios recientes indican que la aplicación del Mindfulness resulta una herramienta útil para el tratamiento en las personas con dependencia a múltiples sustancias (Alfonso et al., 2011; Bowen et al., 2009; Breslin, Zack, & McMain, 2002; Witkiewitz, Marlatt, & Walker, 2005) y al alcohol (Garland, Boettiger, Gaylord, Chanon, & Howard, 2012; Garland, Schwarz, Kelly, Whitt, & Howard, 2012), demostrado una mejora de las funciones ejecutivas, la toma de decisiones, y la regulación emocional (Alfonso et al., 2011; Bowen et al., 2009; Hayes & Feldman, 2004).

En su conjunto, los hallazgos de esta tesis doctoral pueden suponer importantes implicaciones para la intervención terapéutica de las personas dependientes a sustancias adictivas, proponiendo la inclusión de técnicas centradas en el reconocimiento y la experiencia de emociones negativas para fomentar la toma de decisiones deontológicas y la mejora de las relaciones interpersonales.

2. Conclusiones

Las conclusiones derivadas de los cuatro estudios que constituyen la presente tesis doctoral son:

1- Las personas policonsumidoras y las personas dependientes al consumo de alcohol presentan una alteración en la toma de decisiones morales caracterizada por un patrón de respuesta utilitarista ante los dilemas morales emocionalmente salientes o personales. En concreto, estas personas llevan a cabo decisiones morales que priorizan el beneficio del colectivo a pesar de asumir una acción emocionalmente muy aversiva, y la dificultad que les supone tomar la decisión moral es menor que en los participantes no consumidores.

2- La toma de decisiones morales de los pacientes dependientes al alcohol presenta una mayor alteración en comparación con los pacientes policonsumidores y otras poblaciones con deterioros emocionales como por ejemplo pacientes con daño cerebral adquirido o demencia frontotemporal. En las personas dependientes al alcohol, el sesgo utilitarista se da tanto en los dilemas morales de alto conflicto emocional, como en los de bajo conflicto emocional, dónde el consenso de respuesta deontológica en la población normal es superior al 95% y el tiempo medio en dar la respuesta es menor a 5 segundos. En cambio, en las otras poblaciones citadas el sesgo utilitarista sólo aparece ante los dilemas personales

de alto conflicto emocional, aquellos que suscitan un mayor conflicto reflejado en el 55% de consenso de respuesta deontológica y los más de 10 segundos de media que ser requieren para responder.

3- La severidad del consumo de alcohol se asocia con el sesgo utilitarista. En los pacientes policonsumidores, el alcohol es la única sustancia que se correlaciona con el patrón utilitarista ante los dilemas personales de alto conflicto, lo que sugiere que el alcohol es la sustancia de mayor incidencia en la toma de decisiones morales utilitaristas, en comparación con los otros tipos de drogas.

4- Los déficits en el reconocimiento de las emociones de miedo y asco son aquellos que mejor predicen el sesgo utilitarista en los dilemas personales, incluso por encima de la severidad en el consumo de alcohol y descontando el efecto de la educación. En concreto, la decodificación del miedo es el principal predictor para las respuestas utilitarias en los dilemas de alto conflicto (bajo consenso y respuetas lentas) y la decodificación del asco para los dilemas de bajo conflicto (alto conseso y repuestas rápidas). Por el contrario, la contribución de la impulsividad, la depresión y la ansiedad no fue significativa.

5- Los pacientes dependietes al alcohol presentan un déficit en la experiencia de emociones negativas ante los dilemas morales con relevancia emocional o personales. En estas personas, la reactividad de la tasa cardiaca en respuesta a los dilemas morales se encuentra disminuida y no está modulada en función del tipo de dilema. En cambio, los participantes no consumidores mostraron una disminución de la tasa cardiaca específica para los dilemas personales de alto y bajo conflicto. Dado la asociación de la desaceleración cardiaca con la experiencia de emociones negativas, nuestros resultados sugieren la participación de las emociones negativas en la evaluación de los dilemas personales.

6- Niveles bajos en la variabilidad cardiaca se asocian con los juicios morales utilitaristas en los dilemas personales, indicando una posible contribución de la regulación emocional en la toma de decisiones morales.

7- El cuestionario Brief Moral Decision-making Questionnaire (BrMoD) es una herramienta útil para evaluar la toma de decisiones morales tanto a nivel de investigación como en otros ámbitos profesionales, por ejemplo en la clínica o en la selección de personal. Se trata de un cuestionario de extensión breve que reduce a la mitad el tiempo de aplicación requerido por el cuestionario original y presenta una alta fiabilidad y validez de constructo eliminando aquellos ítems que reflejan la influencia de variables distintas al constructo de juicio moral, como por ejemplo la edad, el género, el nivel educativo y socioeconómico. Además, su aplicación a una muestra amplia de la población control nos ha permitido obtener las puntuaciones estándar en la proporción de respuestas utilitaristas y dificultad de juicio ante cada tipo de dilema, permitiendo la posibilidad de comparar las puntuaciones obtenidas en otras poblaciones clínicas e identificar alteraciones específicas.

3. Perspectivas futuras

Los resultados de esta tesis doctoral abren nuevas perspectivas de investigación, entre las cuales destacamos las siguientes:

1- Debido a la predominancia del género masculino en las adicciones, nuestra muestra está compuesta únicamente por varones, no obstante, en posteriores estudios se debe determinar si es posible generalizar estos resultados a la población de mujeres.

2- Ampliar estos resultados a otras poblaciones, tanto en el ámbito de la

drogodependencia, incluyendo grupos de consumidores puros de sustancias específicas (p.e., cocaína o cannabis), como en otras poblaciones con alteraciónes emocionales y conductuales que incluyan conductas agresivas, como por ejemplo en el ámbito del maltrato.

3- El uso de medidas neuropsicológicas de control de impulsos e impulsividad, así como de marcas biológicas de los síntomas afectivos, como por ejemplo el nivel de cortisol en saliva, que permitan corroborar nuestros hallazgos en cuanto a los factores predictivos del sesgo utilitarista.

4- Explorar otras variables psicofisiológicas para una mejor comprensión de los mecanismos emocionales que subyacen la toma de decisiones morales en los pacientes drogodependientes.

5- Estudiar otros factores premórbidos que puedan contribuir a explicar la toma de decisiones morales en drogodependencias, como por ejemplo rasgos de personalidad psicopáticos, déficits atencionales o determinados neurotransmisores (p.e. serotonina, oxcitocina y vasopresina) y sus genes receptores.

6- Estudiar mediante técnicas de neuroimagen y conectividad funcional las áreas cerebrales y la conexión entre las mismas implicadas en el sesgo utilitarista encontrado en los pacientes policonsumidores y dependientes al alcohol.

7- Determinar si el patrón utilitarista que caracteriza los juicios morales personales de los consumidores era precedente al consumo de drogas o bien se produce como consecuencia del uso de droga. Para ello sería recomendable llevar a cabo el estudio de los factores genéticos citado anteriormente, así como estudios longitudinales que puedan responder a esta pregunta.

8- Explorar la capacidad de los juicios morales utilitaristas en los dilemas

hipotéticos del cuestionario para predecir conductas utilitaristas que se asocian a la drogodependencia en la vida real, como por ejemplo conductas de robo para conseguir droga. Así mismo, sería de especial interés conocer las implicaciones de la toma de decisiones morales en el proceso de rehabilitación, a través del estudio de parámetros clínicos como la adherencia al tratamiento, las recaídas o la interacción social.

9- Aplicar los avances en el conocimiento de la moral en la intervención terapéutica de las adicciones, proponiendo nuevas estrategias de tratamiento dirigidas a hacer frente a la alteración en la toma de decisiones morales, y estudiando su efectividad para disminuir el patrón de respuesta utilitarista y favorecer la mejoría clínica.

10- La obtención de pruebas de toma de decisiones morales que aborden dilemas específicos para cada población clínica, adaptando el contenido de los dilemas de forma que describan escenarios lo más similares posibles a los dilemas a los que se enfrentan en la vida real.

11- Incluir las técnicas de realidad virtual inmersivas en la simulación de los dilemas morales, dando capacidad de movimiento y sonido en tiempo real. De esta manera, los participantes tendrían que decidir entre llevar a cabo o omitir la conducta aversiva, en lugar de dar una respuesta oral afirmativa o negativa. Además la realidad virtual permitiría incluir personas con lazos afectivos con el participante como los personajes vinculados en los dilemas. El uso de la realidad virtual podría ser de interés tanto en la evaluación de la toma de decisiones morales como en las medidas de rehabilitación.

DOCTORADO INTERNACIONAL

Summary, conclusions, and future perspectives

1. Summary

This thesis consists of eight chapters that are grouped into four sections: introduction; justification and objectives; submitted and published studies; general discussion, conclusions, and future perspectives.

The introductory section consists of two chapters, the first deal with moral decision-making, and the second deal with drug addiction. In chapter 1, we present the moral decision-making approach, including the study of utilitarian vs. deontological moral choice pattern, the main findings in healthy volunteers and clinical populations, and the research about neural basis and theoretical models. We also show the main moral judgment assessment tool using moral dilemmas. In Chapter 2 we address introductory concepts of drug and alcohol dependence and the somatic marker model of addiction. We also describe the main neuropsychological alterations in drug abusers, specially emotional and executive functions impairments, and finally we present the firsts findings on moral decision-making.

The second section consists of chapter 3 where we justify the execution of this thesis, as well as, its main objective and specific objectives, and hypothesis.

The third section consists of four chapters complied of four empirical studies, in the first we obtained a short-extension and validated questionnaire to assess moral decision-making, and in the other three studies we explore moral decision-making and its predictor factors in drug abusers. Chapter 4 is dedicated to obtain a shortened standardized questionnaire based on the original set of Greene's moral dilemmas (2001), an extensive length instrument developed in Anglophone population. Once we adapted the instrument to Spanish population, and reduced the number of items through Rasch analysis, the new version was validated in a sample of 133 healthy controls. Results

showed adequate reliability and construct validity, indicating that the shortened questionnaire is a good tool for assessing moral decision-making in research or professional fields.

Chapter 5 consists of a study to explore moral-decision making in polysubstance-dependent individuals under residential treatment in a therapeutic community. These patients had a mixed drug-consumption pattern, including several drugs, such as cannabis, cocaine, heroin, amphetamines, methadone, ecstasy, benzodiazepines, and alcohol. This study demonstrate faulty moral judgment in polysubstance-dependent individuals, who endorsed a higher proportion of utilitarian choices, compared to non-drug using controls, in scenarios with emotional salience (e.g., to kill one person to save a group of people). These choices were also perceived as less difficult than controls participants. Utilitarian pattern is specific for personal moral dilemmas, as they do not occur in other dilemma categories which imply less emotional salience, showing the key role of emotion in moral decision-making. Moreover, severity of alcohol use correlated with the proportion of utilitarian judgments in personal dilemmas, pointing alcohol as a substance with high incidence in moral decision-making.

Chapter 6 consists of a study conducted on alcohol-dependent individuals to investigate the psychological predictors of utilitarian biases in personal moral choices. Specifically we assessed the predictive effects of severity of alcohol use, impulsivity, anxiety and depressive symptoms, and emotional recognition. The results demonstrated that individuals with alcohol dependence exhibit utilitarian biases and less difficulty to choose emotionally-aversive harms to an individual in personal dilemmas. Thus, our findings replicate the prior finding in alcohol-dependent patients. Furthermore, we showed that deficient decoding of fear and disgust predicts utilitarian bias in personal

dilemmas, over and above the impact of total alcohol consumption, while, impulsivity, anxiety and depressive symptoms were not significant predictors of moral decision-making. In other words, this study reveals that defective fear and disgust decoding are key predictors of utilitarian pattern in alcohol-dependent individuals.

Chapter 7 consists of a research of the psychophysiological correlates in alcohol-dependent individuals during moral decision-making indexed by heart rate. Our findings demonstrate that alcohol-dependents showed a blunted cardiac responsiveness to the moral dilemmas in comparison with healthy controls. Specifically, they did not modulate heart rate in response to personal dilemmas, showing an inability to decrease heart rate (index as aversive emotional experience), both prior decision-making and his post appraisal. These deficits were not related to baseline differences in heart rate. In addition, utilitarian choices in personal dilemmas were associated with decreases in heart rate variability, nonetheless, this association did not hold in each group separately, thus is needed further research in future studies. In conclusion these findings showed that the moral decision-making in alcohol-dependents is characterized by insensitivity to negative emotional consequences of personal moral violations.

Fourth section consists of chapter 8, where we jointly discuss the findings obtained in the four empirical studies explained above, and we also present its theoretical and clinical implications. Finally we present the conclusions and future research perspectives which can be extracted from this thesis.

2. Conclusions

Based on the results from the 4 studies reported and discussed in this thesis, we can conclude the following:

1- Polysubstance and alcohol dependent individuals showed an alteration in moral decision-making, characterized by utilitarian bias when they confronted with emotionally salient or personal dilemmas. Specifically, polysubstance and alcohol dependent individuals endorsed choices that maximize aggregate welfare in spite of assume an emotional aversive behaviour, and they found these decisions easier to make in comparison with non-abuser participants.

2- Alcohol-dependent patients showed severe moral decision making alteration in comparison with polyssubstance-dependents and other populations with impaired emotional processing, such as brain acquired damage or frontotemporal dementia. The utilitarian bias observed in alcohol-dependents emerged both in high-conflict and low-conflict personal dilemmas, where deontological agreement in community sample is over 95% and response latencies shorter than 5 seconds. By contrast, in the other clinical samples the utilitarian bias emerged only in high-conflict dilemmas, which elicit higher conflict as was reflected with 55% deontological agreement and more than 10 seconds of response latencies.

3- Severity of alcohol use is associated with utilitarian bias. Polysubstance-dependent patients showed only a significant correlation between utilitarian pattern in high-conflict personal dilemmas and severity of alcohol use. This suggests that alcohol, compared to other drug classes, has a greater incidence in moral decision-making.

4- The deficient decoding of fear and disgust is the best predictor of utilitarian choices in personal dilemmas, over and above the impact of total alcohol consumption and years of education. Specifically, fear decoding emerged as the main predictor of utilitarian choices for high-conflict dilemmas (low inter-subject agreement and longer responses latencies), whereas disgust decoding emerged as the main

predictor for low-conflict dilemmas (high inter-subject agreement and shorter response latencies). By contrast, impulsivity, depression and anxiety symptoms had not a significant contribution.

5- Alcohol-dependent patients were characterized by insensitivity to negative emotions experience during personal emotionally salient dilemmas. Alcohol-dependents showed a blunted cardiac responsiveness to the moral dilemmas, and failed to modulate heart rate as function of the type of dilemma. Conversely, non-abusers showed specific decreased heart rate to the personal dilemmas, both high and low conflict. Since reductions in heart rate are associated with negatively valenced emotions, our results suggest the involvement of negative emotions in emotionally relevant moral decision-making.

6- Decreases in heart rate variability were associated with utilitarian moral judgments in personal dilemmas, indicating that emotional regulation could contribute to the moral decision-making.

7- The Brief Moral Decision-Making Questionnaire (BrMoD) is a useful tool for assessing moral decision-making in research or professional fields, such as clinical assessment or personnel recruitment and selection. BrMoD reduced the length of the original questionnaire by almost half, and holds adequate reliability and construct validity since were removed the items those reflect confounders factors, such as gender, age, education and socioeconomic level. In addition, standardized scores obtained in a large community sample allow for the comparison of scores from other clinical populations to identify specific alterations.

3. Future perspectives

The results obtained in this thesis open new possibilities for future research, among

which we highlight the following:

1- Due to the predominance of male gender in the addictions, our sample is composed only of men, even if, future studies should determine whether it is possible to generalize these results to the women population.
2- To extend these results to pure consumer groups of a specific substance (e.g. cocaine or ccannabis), as well as to other clinical samples with emotional deficits and behavioral disturbances including aggression, such as violence against women's field.
3- To use neuropsycological measures of impulse control and impulsivity, as well as biological marks of affective disturbance such as salivary cortisol, that could allowing to corraborate our results about predictor factors of utilitarian bias.
4- To explore alternative psychophysiological variables for a better understanding of the emotional mechanisms underlying moral decision making in drug adictions.
5- To examine other premorbid factors that may also account for the moral decision-making in addictions, such as psychopathic personality traits, attentional deficits or alterations in certain neurotransmitters (e.g. serotonin, oxytocin and vasopressin) and its receptor genes.
6- To study, by fuctional neuroimagin and connectivity techniques, the brain areas and its connections involved in the utilitarian bias observed in polysubstance and alcohol-dependent patients..
7- To determine whether utilitarian pattern that characterizes personal moral judgments of drug abusers, was preceding drug abuse or occurs as a result of this. For this reason, it would be advisable to conduct longitudinal studies that can answer this question.
8- To explore the ability of utilitarian moral judgments emerged from dilemmas

questionnaire to predict utilitarian behaviors in the real live associated with drug addictions, such as theft in order to get drugs. In addition, it would be interesting to know the impact of moral decision-making on the rehabilitation process, through the study of clinical measures, such as treatment adherence, relapse or social interaction.

9- To apply morality knowledge on rehabilitation intervention for drug addictions, inlcuding new treatment methods to address moral decision-making, and testing its effectiveness to reduce utilitarian bias and promote clinical improvement.

10- To obtain moral decision-making instruments to address specific and relevant dilemmas for each potential clinical population. It would be interesting to adapt moral dilemmas content, describing the scenarios as much similar as the dilemmas that each person deal in their real life.

11- To include inmersive virtual reality techniques that simulates moral dilemmas, giving the opportunity of movement and sound in real time. Thus, the participant have to choice between acting or abstaining from aversive behaviour, rather than give an affirmative or negative oral answer. Virtual reality also allows to include well-liked persons for each participant as dilemmas characters. The use of virtual reality could be interesting for both assessment and for rehabilitation of moral decision-making.

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ANEXOS

CON ARTÍCULOS PUBLICADOS Y EN REVISIÓN

ANEXO I

Journal of Clinical and Experimental Neuropsychology

Brief moral decision-making questionnaire: a Rasch-derived short form of the Greene dilemmas

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Running head: Brief moral decision-making questionnaire

Brief moral decision-making questionnaire: a Rasch-derived short form of the Greene dilemmas

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ABSTRACT

In this study we developed the Brief Moral Decision-Making Questionnaire (BrMoD) as a standardized brief form of the dilemmas compiled by Greene. An initial Rasch analysis was conducted over responses to 60 dilemmas to retain the most appropriate items. The psychometric properties of the 32-item brief instrument were determined in a community sample of 133 individuals using analyses from both the Classical Test Theory and Rasch model. The BrMoD showed appropriate construct validity and reliability. Differences between dilemma categories proposed by Greene were observed in the BrMoD by measuring the difficulty of decisions and response times of the participants. In addition, there was no differential item functioning by the demographic variables. Therefore, the BrMoD is a good tool for assessing moral decision-making in research or professional fields.

Key words: Moral decision-making; Short-form; Rasch analysis; Construct validity; Reliability

INTRODUCTION

Moral decision-making reflects the appropriateness of our own and others' behaviors against the social views of right and wrong, thus establishing social behavior on a continuum ranging from prosocial acts to aggressive and violent behaviors (Moll, Zahn, Oliveira-Souza, Krueger, & Grafman, 2005). Our moral decisions can be classified as utilitarian or deontological; utilitarian decisions entail endorsement of an emotional aversive action in favor of communitarian well-being (e.g., smothering a baby to save a group of individuals during wartime) whereas deontological decisions involve refusal to cause harm despite the advantages it would bring in terms of costs-benefits (e.g., deciding not to smother the baby although this implies the death of a greater number of individuals).

The most common method to assess moral decisions is through moral dilemmas scenarios. A moral dilemma is a hypothetical scenario that generates a moral conflict, and then requires the individual to decide whether s/he would accept or refuse to take the utilitarian action. The response decision biases (whether acceptance rates are high or low) allows the classification of individuals based on predominantly utilitarian or deontological patterns. The battery of dilemmas by Greene (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001) is currently the most widely used in experimental studies on moral decision-making (Cushman & Greene, 2011; Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008; Greene, Nystrom, Engell, Darley, & Cohen, 2004; Koenigs et al., 2007). The battery consists of 60 scenarios classified into three main categories: non-moral, impersonal-moral and personal-moral (see dilemmas in http://wjh.harvard.edu/ ~ mcl / materials / Greene-CogLoadSupMats.pdf). Non-moral dilemmas involve a rational decision without moral content. For example, in the "Train or Bus" dilemma, one must decide whether to travel by train or bus, given certain time constraints. The impersonal-moral dilemmas involve indirect and not serious bodily harm, inducing a low emotional salience. For example, the "Standard Trolley" dilemma posits flipping a switch to turn a train away from five individuals but towards one person. By contrast, personal-moral dilemmas involve high emotional salience, inflicting directly a severe physical harm to a person or specific group in order to save a greater number of people. Personal dilemmas are further divided into low and high-conflict dilemmas based on response times and degree of consensus (Greene et al., 2004; Koenigs et al., 2007). An example of high-conflict would be the "Smothering Baby" dilemma. An example of low-conflict is the "Architect" dilemma in which participants must decide (whether or not) to push a "bullying boss" off a building knowing that the rest of the office would think he fell by accident. In low-conflict dilemmas, the response time is significantly

lower than in high-conflict dilemmas, whereas the utilitarian answers consensus is significantly greater (Koenigs et al., 2007). Notably, the application of this battery of moral dilemmas has shown substantial sensitivity to detect social decision-making problems in a range of clinical groups relevant to neuropsychological research and practice, including acquired brain injuries (Koenigs et al., 2007; Moretto, Làdavas, Mattioli, & di Pellegrino, 2010), frontotemporal dementia (Gleichgerrcht, Torralva, Roca, Pose, & Manes, 2011; Mendez, Anderson, & Shapira, 2005; Mendez & Shapira, 2009), psychopathy (Blair, 2007; Cima, Tonnaer, & Hauser, 2010; Young, Koenigs, Kruepke, & Newman, 2012), drug addictions (Carmona-Perera, Verdejo-García, Young, Molina-Fernández, & Pérez-García, 2012; Khemiri, Guterstam, Franck, & Jayaram-Lindström, 2012), autism (Buon et al., 2012; Gleichgerrcht et al., 2012, Moran et al., 2011), and anxiety (Youssef et al., 2012).

The Greene's battery of dilemmas has therefore demonstrated sensitivity and discriminant validity to assess moral decision-making in clinical populations in neuroscientific research. However, the fact that it was not originally designed as a clinical assessment tool has raised a number of concerns related to its applicability outside the laboratory context (Abarbanell & Hauser, 2010; Cushman, 2008; Christensen & Gomila, 2012; Hauser, Cushman, Young, Kang-Xing Jin, & Mikhail, 2007; Kahane & Shackel, 2010). First, the administration time of the full battery of 60 dilemmas is too long to make feasible its application to clinical settings (Carmona-Perera et al., 2012; Greene et al., 2004). Second, its psychometric properties have not been firmly established (Christensen & Gomila, 2012, Hauser et al., 2007). Third, several studies have showed that individual differences in demographic variables (Abarbanell & Hauser, 2010; Fumagalli et al., 2010; Navarrete, McDonald, Mott, & Asher, 2012) and discrepancies in stimuli presentation (Cushman, 2008; Christensen & Gomila, 2012) can significantly impact on decision

patterns. Both inter-rater variability and heterogeneity of applications hamper the opportunity to compare and replicate the findings from different studies or to use the dilemmas for clinical assessment purposes (Cushman, 2008; Christensen & Gomila, 2012, Hauser et al., 2007; Kahane & Shackel, 2010). Consequently, the development of a standardised questionnaire measure based on the original dilemmas and able to control the previously identified confounding variables have important advantages for neuropsychological research and practice.

Possible methodologies to obtain a standardized version of the Greene battery of dilemmas include joint measurement models encompassed in the Item Response Theory, particularly the Rasch model (1980). This model provides an adequate framework to revamp the moral dilemmas battery and make it both more feasible for application to clinical populations and more psychometrically robust and resistant to the impact of extraneous variables. Rasch analysis is the most frequently applied method in health sciences to reduce questionnaires without diminishing its psychometric properties (Blanchin et al., 2011). Rasch analysis offers statistic criteria such as calibration and item fit that can be used for deleting redundant items and low quality items that contain harmful elements for construct validity. It also provides statistical proofs of construct unidimensionality, a requirement to use an overall score based on the sum of the item responses. Rasch analysis provides statistic indexes of reliability and suitability for the particular sample being evaluated. This method checks the presence of differential item functioning (DIF) or an item bias among the sample groups, for example, age, gender or economic status (Tennant & Conaghan, 2007). Statistical information provided by the Rasch analysis allows us to refine the instruments, shorten their length without losing the measure of the constructs in its entirety, standardize the quality of all items and eliminate those that reflect the influence of other variables distinct from constructing moral judgments.

We conducted two consecutive studies in order to (1) develop a shortened version of the original set of dilemmas based on the principles of Rasch analysis, and (2) test the psychometric properties of this shortened version and to what extent this version addresses the methodological limitations associated with the original set of dilemmas. We hypothesized that a calibration of items will be helpful for retaining appropriate items in a shortened form. Second study aimed to determine psychometric properties of this brief questionnaire in a community sample. We hypothesize that this abbreviated moral dilemmas questionnaire (i) will have sound reliability in accordance to both Rasch model and Classical Test Theory parameters, (ii) will have adequate criterion validity by differentiating the distinct types of moral dilemmas in terms of the proportion of affirmative responses, decision difficulty and time response, and (iii) will be low impacted by typical confounders such as gender, age, education and socioeconomic level.

METHOD

The inclusion criteria were aged over 18 years old and to have at least a primary school education to ensure reading comprehension. Exclusion criteria include not having current or past diagnoses of substance abuse or dependence, and the absence of clinically significant psychiatric symptoms. The Interview for Research on Addictive Behaviour (IRAB; Verdejo-García, López-Torrecillas, Aguilar de Arcos & Pérez-García, 2005) was used to assess compliance with drug abuse criterion, and the Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 2000) was used to assess compliance with psychiatric symptoms criterion. This study was approved by the Ethics Committee of the University of Granada. The participants were informed of the study conditions and signed an informed consent form.

STUDY 1. Development of a Brief Moral Decision-Making Questionnaire (BrMoD)

Participants and procedure

One hundred and seventy two undergraduate students participated in this study. Participants were recruited from the schools of education and health sciences of the University of Granada (Spain) between April 2009 and June 2009. Eighteen participants were excluded due to drug dependence or clinically significant psychiatric symptoms; therefore, the final sample was composed of 154 participants (120 women and 34 men). The mean age of participants was 21.51 years (SD = 5.22) and the mean years of education were 16.80 years (SD = 1.97). The moral decision-making assessment was administered in groups of 20 participants that performed the dilemmas in paper-and-pencil format with no time limits. The mean duration of administration was of 45 minutes.

Instrument and variables

Participants filled out the battery of 60 dilemmas compiled by Greene (Greene et al., 2001) adapted to Spanish population. This version showed adequate psychometric properties in a community sample (Cronbach's alpha = .71 and Spearman Brown coefficient = .76; Carmona-Perera, Verdejo-García & Pérez-García, 2009). The Dependent measure was the proportion of affirmative responses to the dilemmas. Affirmative answers were considered “utilitarian” for moral dilemmas and “logical” for non-moral dilemmas.

Analysis

Separate Rasch analyses were conducted on two sets of dilemmas (20 non-moral and 40 moral) in order to calibrate the items. Calibration is a process for locating items on a Rasch scale according to their probability of being responded positively (logically on the scale of non-moral dilemmas and in a utilitarian manner for moral dilemmas). Generally, items are distributed in positions ranging from -3 (a greater probability of a positive response) to +3 (less probability)

(Tesio, 2003). Rasch analyses were performed with RUMM2030 software (RUMM Laboratory Pty. Ltd., Perth, Australia).

STUDY 2. Psychometric properties of the BrMoD Questionnaire and capacity to address previously identified confounding variables

Participants and procedure

One hundred and thirty three individuals (72 women and 61 men) participated in this study. Participants were recruited from community and leisure centers (e.g., singing choirs, sport clubs or traditional dances) between May 2010 and June 2011 using flyers-based advertisement and word-of-mouth communication. The average age was 37.90 (SD = 14.04) with a range of 19-69 years. The educational level ranged between 9 and 20 years of education with an average of 17.29 (SD = 2.90). For socioeconomic status, 16.36% of the sample was at a low level, 64.40% at an average level and 19.24% at the highest level. The brief moral decision-making questionnaire (BrMoD) was administered individually through a computer implementation. Each administration lasted approximately 20 minutes.

Instrument and variables

We used the Brief Moral Decision-Making Questionnaire (BrMoD) derived from the battery of moral dilemmas by Greene (Greene et al., 2001) in study 1. (See table 2 for a description of 32 dilemmas in the BrMoD). The items were presented in a counterbalanced order across three consecutive computer screens. On the first screen, the description of the dilemma appeared. The second screen asked the participant whether he would perform the proposed action and recorded the response time. On the last screen, the participant was asked to indicate the degree of subjective difficulty to decide, on a scale of 1 (low difficulty) to 10 (high difficulty). Each screen

continued with no time limit as the participants read and responded to the dilemmas. The dependent variables of the study 2 were the participant's responses to the 32 dilemmas. For Rasch analyses, affirmative and negative responses, coded as 1 and 0, were respectively introduced, whereas for the remainder of analysis, the proportion of affirmative answers for each type of dilemma was considered. Consistent with previous studies (Greene et al., 2004; Koenigs et al., 2007) the average difficulty to decide and mean time response were used as the dependent variables to discriminate between personal low and high-conflict personal dilemmas.

Analysis

We applied the analyses included under both the traditional Classical Test Theory, and the modern Item Response Theory. Initially, descriptive analyses were applied to determine the demographic profile of the participants. A Rasch analysis was subsequently applied to dichotomous responses of the items to determine the fit of the short questionnaire to the Rasch model and those psychometric characteristics of the instrument that this type of analysis provided. Subsequently, reliability was analyzed using Cronbach and Spearman Brown's *alpha* coefficients. Subsequently, repeated mean ANOVA analyses were conducted to examine differences in the dependent variables in terms of the dilemma types. Finally, performance in the task of moral dilemmas was analyzed in terms of differences in the demographic variables using ANOVA tests. The analyses were performed with SPSS (IBM SPSS Statistics, Somers, New York) and RUMM2030 (RUMM Laboratory Pty. Ltd., Perth, Australia) programs.

RESULTS

STUDY 1. Development of a Brief Moral Decision-Making Questionnaire (BrMoD)

Reduction of non-moral dilemmas

As non-moral dilemmas assess logical reasoning ability, our criterion was to ensure the exclusion of items that were less likely to be answered in a logical manner. Then, just the eight items that were located above zero on the Rasch scale were retained. These items, that were the most frequently answered in a logical manner for the sample, constitute a true control subscale absolutely free from the possibility of responses influenced of variables outside of the "logical reasoning" construct. These items maintain the structure of the original battery because one-half of them were of the reverse type, i.e., the logical response is "no", and have to be coded as positive.

Reduction of moral dilemmas

Criterion for excluding moral items was their location at both ends of the Rasch scale, in which the consensus of deontological (items near +3) or utilitarian responses (items near -3) was greater than 95%. This high consensus indicated that the two possible response options were too unbalanced to propose a real dilemma to the subject. Sixteen of the forty items were excluded. In examining all these items, five of them belonged to the impersonal category, were located consecutively at the end of the deontological pole, and it is noteworthy that were of fundamentally economic content. From the personal category, only three items were removed and were those that did not meet the criterion of invariance among groups required to fit the Rasch model. These findings support that excluding these items prevents the subjects' economic levels from influencing their responses and those that did not fit the Rasch model. Finally, the Brief Moral Decision-Making Questionnaire (BrMoD) based on Greene's dilemmas was composed of 24 moral items, in which 8 were in the impersonal category, 6 in the personal low emotional conflict category and 10 in the high conflict category, including a control scale consisting of 8 non-moral items. These dilemmas are showed in the table 2.

STUDY 2. Psychometric properties of the BrMoD Questionnaire and capacity to address previously identified confounding variables

The psychometric properties according to the Rasch model

The overall fit and unidimensionality of the questionnaire. Table 1 shows the results of the conducted Rasch analyses. In the first analysis, all 32 BrMoD dilemmas were included with the results of the item-trait interaction indicated by a statistically significant chi-square value; therefore, overall, the questionnaire did not meet the fit criteria for the Rasch model. This result suggests that the included dilemmas corresponded to more than one latent construct. This result makes sense because the questionnaire consisted of moral and non-moral dilemmas; therefore, the subsequent Rasch analyses were performed, including responses only to the moral type of items. The results (see Analysis 2 in Table 1) indicated that this battery of dilemmas showed a good fit to the Rasch model (a non-significant chi-square). Subsequently, a review of the unidimensionality of the moral dilemmas was undertaken, which indicated that all included items were useful in evaluating a single coherent capacity, i.e., a component of the identical construct. The method used to study unidimensionality, described by Tennant and Pallant (2006) as the preferred and most rigorous method, consisted of performing a principal component analysis of the residuals and included defining two subsets of items according to the positive or negative sign for each item in the first component (Smith & Miao, 1994). A fit to the Rasch model was then performed separately for each subset, and the forecast of the location of the subjects was obtained for each and was compared with a paired *t*-test. The criterion used to accept or reject unidimensionality was the percentage of *t*-tests that fell outside a 95% confidence interval and did not exceed 5% of the total (Tennant & Conaghan, 2007).

(Insert table 1 about here)

A Rasch analysis cannot be applied to non-moral items because, unsurprisingly, they are too easy and homogeneous for scaling (Styles & Andrich, 1993). Two (Train or Bus and Computer) were answered affirmatively by 100% of the sample, and the remaining six (Standard Turnips, Scheduling, Reversed Turnips, Investment Offer, Broken CVR and New Job) were affirmatively answered by more than 94% of the participants.

Reliability. After confirming that the sample data fit the model, one could obtain other parameters on the quality of the items and entire questionnaire. Reliability from the perspective of the Rasch model was indicated by the Person Separation Index (PSI). This index measured the ability of the BrMoD moral dilemmas to discriminate among individuals in the sample based on the amount of the construct they possessed, i.e., their degree of moral judgment. A value of 0.8 was acceptable because it allowed us to separate individuals into three levels (low, medium or high) with a confidence level of 95% (Fisher, 1992).

Construct validity. The construct validity and coverage for proper measurement was determined. The calibration or location of the items on the Rasch scale allowed us to observe that they were distributed over a wide range from -4.1 (an item with high probability of utilitarian type response) to +5.05 (an item with high probability of ethical type response), as shown in Table 2.

(Insert table 2 about here)

The construct validity of the test was empirically verified and determined whether the location of the items corresponded to the theoretical postulates. It was noted that at the extreme negative sign, all items were impersonal and centered among those of high conflict, and on the positive extreme, the items were of low-conflict with no overlap among the three types of dilemmas. This

distribution reflected the existence of a continuum from the utilitarian pole (the negative end of the scale) to the deontological pole (the positive end). The construction of the continuum was performed as a function of the utilitarian response probability of each item, as determined by the Rasch analysis. This structure corresponded closely with the categorization of dilemmas encountered by Greene (2004) and Koenings (2007) and demonstrated the validity of the BrMoD construct. Regarding covering the continuum, both Table 2 and Figure 1 show that the items covered the entire space without leaving large gaps, which enabled an accurate measurement of the entire moral judgment construct.

Targeting. The third parameter of the Rasch analysis was the appropriateness of the item set to measure the moral judgment of the sampled participants. Therefore, we compared the average of the sample localization shown in Table 1 (mean = -.28, SD = .57) with the value .0, at which the Rasch analysis located the mean of the items by default. The closeness between two means indicated the suitability of the items to measure the amount of this construct in all participants. Furthermore, we graphically confirmed the person-item map (Figure 1) and observed that there was a good match between the distribution of participants (the upper section of Figure 1) and items (the bottom of Figure 1) in the construct. On the positive end of the scale, we observed the two items least likely to be answered in a utilitarian manner (Infanticide and Country Road), and because of their significant deviation from the location of the sample, these items could be useful in detecting individuals whose positive responses indicated that they differed greatly from what was socially expected in these two cases.

(Insert figure 1 about here)

Differential Item Functioning (DIF). The Rasch analysis determined whether there were biases because of any item that behaved invariably in the different groups identified in the sample, for example, in men and women. For this analysis, sex, age (categorized in groups of 18 to 27, 28 to 37, 38 to 47 and older than 48), education (primary, secondary and tertiary) and economic level (low, medium and high) were introduced to investigate whether any items showed DIF among different levels defined in each group. An ANOVA of person-item deviation residuals with person factors and class intervals as factors was run using the RUMM2030 software. No DIF was observed by any factor, thus supporting the construct validity of the shortened set of dilemmas.

Psychometric properties according to the classical test theory

Reliability. The three dependent variables showed good reliability as measured by the internal consistency coefficient Cronbach alpha (Affirmative Responses = .78, Difficulty in deciding = .75 and Response Time = .73). There was also a good reliability with these variables as indicated by the split-half coefficient of the Spearman Brown analysis (.76, .67 and .70, respectively).

Construct validity. We determined the ability to discriminate the categories of dilemmas by an ANOVA, which showed significant differences among the various categories of dilemmas depending on the main dependent variable proportion of positive responses F (3,396) = 967.88, MSE = 429.18, $p < .001$. Pairwise comparisons showed significant effects in all contrasts, with the high-conflict personal dilemmas obtaining less answer consensus with 44.69% of the utilitarian responses (Figure 2 a).

The comparison between the personal high and low emotional conflict dilemmas showed greater decision difficulties F (1,132) = 613.67, MSE = 1.96, $p < .001$ and higher response times F (1,132) = 91.75, MSE = 238.34, $p < .001$ for high-conflict dilemmas (Figure 2 b and 2 c).

(Insert figure 2 about here)

The influence of socio-demographic variables (gender, age, educational level and socioeconomic status) in moral decisions-making. The ANOVA analyses for the dependent variable proportion of positive responses did not significantly differ by gender F (3,393) = .16, MSE = 649.63, p = .219, age F (9,387) = .94, MSE = 392.69, p = .462, education F (6,351) = .56, MSE = 245.66, p = .671 or socioeconomic status F (6,303) = 1.49, MSE = 688.19 , p = .216. For the decision difficulty and response time variables in personal dilemmas, no significant differences were observed in either with the value of $p < .05$ in any demographic variable analyzed.

DISCUSSION

We report two consecutive studies directed to (1) obtaining a shortened standardized questionnaire based on the original set of Greene's moral dilemmas (2001) through the use of Rasch analyses, and (2) testing the psychometric properties of this questionnaire, and its ability to control previously identified confounding variables. In our first study we obtained a Rasch-derived Brief Moral Decision-making Questionnaire (BrMoD). In our second study we demonstrated that the BrMoD questionnaire has adequate psychometric properties and correctly addresses the main limitations associated with the Greene's original battery.

The selection of 32 dilemmas from the set of 60 Greene dilemmas (2001) using a Rasch analysis reduced the length of the questionnaire by almost half, thus minimizing potential fatigue and distraction factors. Regarding psychometric properties, the questionnaires demonstrated

good reliability and construct validity in both classical and modern test theories. A Rasch analysis allowed us to define the moral judgment construct as a continuous function of the items probability to be answered in a utilitarian manner. Between the extremes of the continuum, consisting of utilitarianism and deontology, the three categories in the order of "impersonal and personal dilemmas of high or low personal conflict" were correctly graded. The calibration of the dilemmas on the Rasch scale indicated an underlying pattern in which impersonal items were more easily answered in a utilitarian manner than personal dilemmas. The ability of the continuum to differentiate between personal and impersonal dilemmas was consistent with the dual-process hypothesis (Greene et al., 2004; 2008), in which impersonal dilemmas are leaded by cognitive mechanisms, whereas personal dilemmas evoke an aversive emotional response that generates a deontological decision against causing harm. In turn, discrimination on the continuum between personal dilemmas of high and low-conflict allows the adjustment of the level of utilitarianism, thus situating the dilemmas of low-conflict at an ethical extreme in which most individuals choose to reject aversive action. Specifically, only those individuals who have a more utilitarian pattern answer affirmatively answer to low-conflict dilemmas, whereas the percentage of utilitarian and deontological options in high-conflict dilemmas is practically divided in the normal population. The ability of the questionnaire to discriminate between the three types of moral dilemmas may allow clinicians and researchers to profile different patterns of performance based on the moral gradient. Construct validity is further supported by invariable operation of the dilemmas regardless of the influence of potential demographic confounders, such as sex, age, educational level or socioeconomic status. Further evidence of construct validity is offered by the discrimination of the three moral dilemma categories using affirmative responses, and the difficulty of decision and response times to differentiate between the two

subtypes of personal dilemmas. The latter two variables were used for the validation of the instrument but were not a component of the proposed assessment with the standardized BrMoD application.

Regarding score standardization, the unidimensionality of the brief questionnaire allowed us to obtain a valid overall score of moral decision-making through the BrMoD. The adjustment of these moral dilemmas to the Rasch model indicated the overall score of the BrMoD is an interval level measure (Tennant et al., 2004), which offers significant advantages over ordinal measures obtained with instruments that do not fit the Rasch model.. Therefore, the overall scores are appropriate for later parametric analyses which are more robust than the non-parametric indicated for ordinal scores (Polit & Beck, 2004, p. 484).

Non-moral category is used as an element or level of control over the ability of logical reasoning and is understood as a prerequisite for examining the understanding and management of the information contained in all set of dilemmas. Applying the minimum 94% percent of correct logical answers obtained in the sample, one can set a cut-off of 7 correct items to eliminate problems of understanding and reasoning. Because the questionnaire consists of items that a normal population mainly responds to logically, it could be used as a test for detecting malingering in subjects undergoing legal processes, such as in individuals with brain damage from traffic accidents (Lange, Iverson, Brooks, & Rennison, 2010).

Following the criteria to ensure methodological rigor in the abbreviation of questionnaires (Smith, McCarthy, & Anderson, 2000), the BrMoD was separately tested in two independent samples. The initial selection of 32 dilemmas from 60 Greene's scenarios was based on a student sample highly biased towards women and high educational level, and this may stand

as a limitation. However, the second study was conducted in a community sample more representative of the general population, and the questionnaire showed similar robustness when dealing with even males and females ratios, and more heterogeneous age and education distributions. The 32 dilemmas included in the BrMoD measure a wide range of the moral judgment constructs (from -4.1 to +5.05 on the Rasch scale). In the present research, we have not replicated the psychometric properties of the BrMoD to other independent samples, as suggested by Smith (2000). However, in future studies, validation of the BrMoD in different clinical populations is proposed, specifically in terms of its potential uses. The BrMoD obtains adequate rates of reliability and construct validity for both the traditional and Rasch models, to which the BrMoD fits, showing unidimensionality, adequate coverage of the construct and targeting of the sample, thus making it a useful tool for evaluating moral decision-making.

In conclusion, the BrMoD is a shortened standard version of the original set of Greene's moral dilemmas with demonstrated reliability, validity and ability to control the most relevant limitations of the original experimental version. These properties make it a suitable instrument for use in broader research or professional fields.

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Table 1. Results of Rasch analyses applied to 133 participants responses to determine the fit and psychometric properties of the Brief Moral Decision-Making questionnaire (BrMoD)

Analysis	Item-trait interaction	Item Fit residual	Person Fit residual	Reliability	Unidimensionality
	χ^2 (*p*)	Mean (SD)	Mean (SD)	PSI	Significant t-test at CI 95%
All 32 items	122.17 (.000)	-.16 (1.16)	-.33 (.71)	.78	Non applicable
24 moral items	83.79 (.161)	-.29 (.94)	-.28 (.57)	.80	3.76% (5/133)

χ^2: Chi square value; PSI: Person Separation Index; CI: Confidence Interval.

Table 2. Item location order for moral dilemmas of the Brief Moral Decision-Making questionnaire (BrMoD).

Dilemma Category	Item content description	Location	SE	Item Fit Residual	χ^2	*p*
Impersonal	Standard Trolley	-4.10	.44	-.17	1.11	.775
	Guarded Speed Boat	-3.23	.33	.25	1.71	.634
	Environmental Policy A2	-3.22	.32	-.55	5.83	.120
	Environmental Policy B2	-3.15	.32	-.87	4.49	.213
	Environmental Policy A1	-2.86	.29	.42	.77	.857
	Standard Fumes	-2.67	.28	.48	.87	.834
	Environmental Policy B1	-2.28	.25	2.19	6.19	.103
	Vaccine Policy	-1.43	.22	.75	3.84	.279
Personal	Lifeboat Modified	-1.07	.21	-.36	.61	.895
High-conflict	Vaccine Test	-1.04	.21	-.64	5.02	.171
	Euthanasia	-0.99	.21	-.78	2.45	.484
	Lawrence of Arabia	-0.85	.21	-1.04	3.98	.264
	Ecologists	-0.35	.21	-1.85	5.19	.158
	Vitamins	.22	.21	.73	6.17	.104
	Sophie's Choices	.41	.21	-.18	1.24	.743
	Sacrifice	1.26	.23	-2.31	8.19	.042
	Footbridge	1.31	.23	.21	8.30	.040
	Crying Baby	1.56	.24	-1.57	6.34	.100

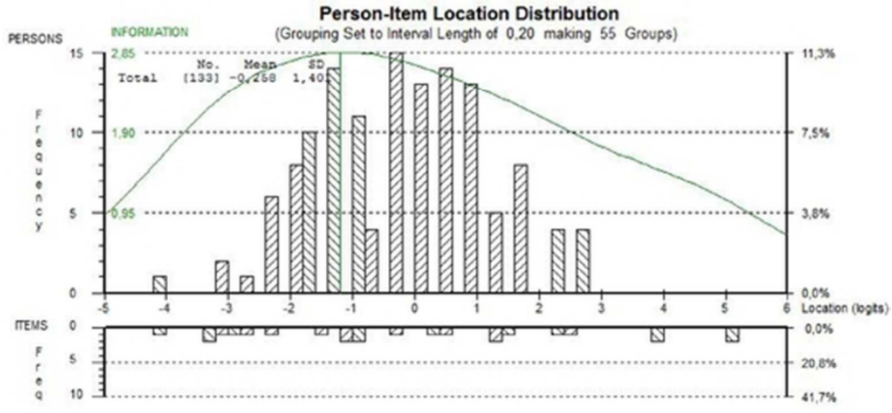
Personal	Transplant	2.23	.28	.26	6.71	.082
Low-conflict	Plane Crash	2.41	.30	-.69	1.28	.734
	Architect	3.83	.48	-.94	1.14	.776
	Smother for Dollars	3.91	.50	-.10	1.69	.639
	Infanticide	5.04	.81	-.14	.35	.950
	Country Road	5.05	.81	-.13	.34	.952

SE: Standard error; χ^2: Chi square value

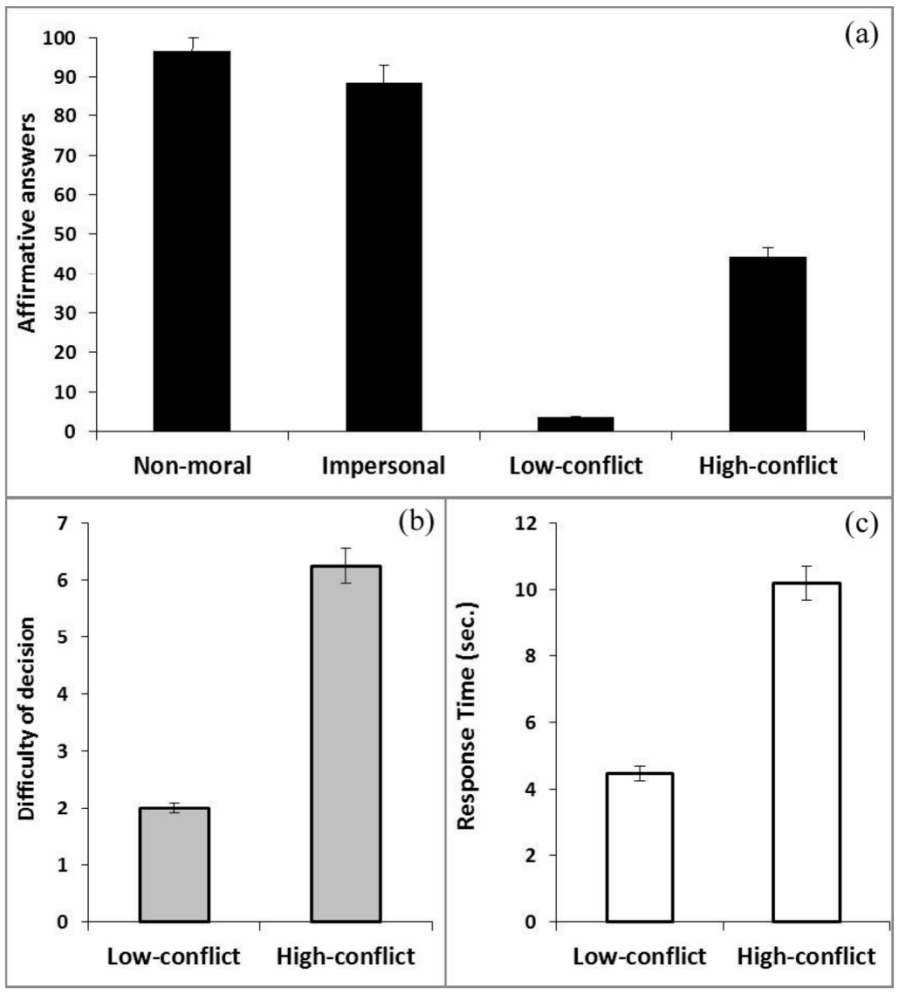
Figure Captions

Figure 1. Distribution of item (lower half) and person locations (upper half) along the judgment construct. Grouping is set to interval length of .20.

Figure 2. Proportion of affirmative answers (a), difficulty of decision mean (b), and average time response in seconds (c) in function of dilemma category for the 133 community sample in the Brief Moral Decision-Making questionnaire (BrMoD).



Distribution of item (lower half) and person locations (upper half) along the judgment construct. Grouping is set to interval length of .20.
45x23mm (300 x 300 DPI)



Proportion of affirmative answers (a), difficulty of decision mean (b), and average time response in seconds (c) in function of dilemma category for the 133 community sample inmthe Brief Moral Decision-Making questionnaire (BrMoD).
157x174mm (300 x 300 DPI)

ANEXO II

Drug and Alcohol Dependence 126 (2012) 389–392

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Short communication

Moral decision-making in polysubstance dependent individuals

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ABSTRACT

Background: Moral judgments depend on the integration of complex cognitive and emotional processes. Addiction is associated with core deficits in both cognitive and emotional processing, which may jointly lead to utilitarian biases in moral decision-making.
Methods: We assessed 32 polysubstance dependent males and 32 non-drug using controls using a previously validated moral judgment task, including non-moral scenarios, and moral dilemmas that were either high in emotional salience ("personal scenarios") or low in emotional salience ("impersonal scenarios").
Results: Polysubstance dependent individuals endorsed more utilitarian choices for personal dilemmas (e.g., smothering a baby to save a group of hidden people during wartime). These choices were also perceived as less difficult. Severity of alcohol use correlated with the proportion of utilitarian judgments.
Conclusion: Polysubstance dependent individuals show a more utilitarian pattern of moral decision-making for personal moral scenarios.

1. Introduction

Moral judgments depend on the integration of complex cognitive and emotional processes (Cushman et al., 2006; Young et al., 2007). Recent work in moral psychology and neuroscience suggests that impairments in these processes lead to systematic biases in moral judgments (Méndez et al., 2005; Koenigs et al., 2007). For example, patients with focal lesions to the ventromedial prefrontal cortex are more likely to deliver utilitarian moral judgments for moral scenarios that are high in emotional content (e.g., it is morally permissible to smother a baby to save a group of hidden people during wartime; Koenigs et al., 2007; Moretto et al., 2010). According to dual-process models of moral cognition (e.g., Greene et al., 2008), a prepotent emotional aversion to harming an innocent individual (the deontological response) competes with a utilitarian cost–benefit analysis to maximize aggregate welfare. When scenarios elicit a sufficiently robust emotional response, deontological moral judgment tends to prevail. In the current study, we test the hypothesis that, in polysubstance dependent individuals, the inability to integrate cognitive and emotional inputs for appropriate decision-making (Bechara et al., 2000) lead to systematic biases in moral judgments.

Addiction, and, in particular, polysubstance dependence, is associated with core deficits in higher cognitive processes and emotional skills, and with real-life difficulties related to social interaction (Leeman et al., 2009; Volkow et al., 2011) and illegal behavior (Verdejo-García et al., 2006, 2007; Yechiam et al., 2008). Recent research has revealed deficits in emotional processing, including in emotion regulation and emotion perception, in polysubstance abusers (Aguilar de Arcos et al., 2005, 2007; Fernández-Serrano et al., 2010). For example, polysubstance abusers tend to outweigh immediate rewards over negative future outcomes and to act impulsively (Verdejo-García et al., 2007, 2008). Polysubstance dependent individuals also show defective decoding of moral emotions like anger or disgust (Fernández-Serrano et al., 2010), reduced reactivity to emotionally competent stimuli (Aguilar de Arcos et al., 2005), and poor affective-based decision making, due to a failure to trigger bodily markers signaling negative outcomes (Bechara et al., 2002).

Recent research on polysubstance dependence has also revealed enduring anatomical abnormalities in a key region for social and moral cognition, the medial prefrontal cortex (Tanabe et al., 2009). Polysubstance abusers show long-term reductions of gray matter volume in the medial prefrontal cortex (Franklin et al., 2002;

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Tanabe et al., 2009), and abnormal activation of this region during the extraction of empathic information from social vignettes (Kim et al., 2010).

Do polysubstance dependent individuals show utilitarian biases in moral judgments? We predicted that polysubstance dependent individuals would deliver more utilitarian moral judgments as a direct result of their cognitive-emotional deficits in decision-making.

2. Methods

2.1. Participants

We tested 32 polysubstance dependent individuals and 32 control participants. Polysubstance dependent individuals were recruited during residential treatment in a therapeutic community. Selection criteria for polysubstance dependent individuals consisted for the following: (i) meeting the DSM-IV criteria for substance dependence (see Table 1 for descriptive scores on substance dependence diagnoses and drug use parameters); (ii) minimum abstinence duration of 30 days before testing, confirmed by weekly urine analyses; (iii) not having history of head injury or neurological disorders; and (iv) the absence of clinical diagnosis of comorbid Axis I or Axis II disorders – as assessed by clinical interviews conducted by the treatment center staff (four participants were excluded due to diagnosis of personality disorders, and one participant due to comorbid mood disorder). Selection criteria for control participants consisted of the following: (i) the absence of current or past diagnoses of substance abuse or dependence; (ii) not having history of head injury or neurological disorders; and (iii) the absence of history of psychiatric disorders. To minimize the impact of any alcohol or drug use in the control group, we included only control participants who reported having used any illegal drugs no more than 5 times during their lifetime; furthermore, we allowed current alcohol consumption only at levels below 10 standard units per week (mean alcohol use in the control group: 9.34 units per month).

The polysubstance dependent and control groups were matched on sex and ethnicity; all participants were European-Caucasian males. The groups also showed similar distributions for handedness (four left-handed subjects in the polysubstance group and one left-handed subject in the control group, $\chi^2 = 2.58$, $p > 0.1$), socioeconomic status (70.4% of polysubstance dependents and 81.3% of controls had middle socioeconomic status, $\chi^2 = 2.58$, $p > 0.1$), and levels of religiosity (89% of polysubstance dependents and 79% of controls were religious – all Catholics, $\chi^2 = 1.21$, $p > 0.1$), which is known to impact moral judgment (Pyysiäinen and Hauser, 2010). The groups did differ in age; mean ages for the polysubstance dependent and control group were 33.56 years (SD = 6.81) and 26.03 years (SD = 10.05), respectively ($t = 3.30$, $p < 0.002$). However, age did not significantly correlated with moral decision-making and therefore it was not further considered in subsequent analyses. The groups also differed in education; mean education for the polysubstance dependent and control group were 14.31 years (SD = 1.57), and 16.06 years (SD = 1.76), respectively ($t = 3.96$, $p < 0.001$). Education significantly correlated with moral decision-making, and was therefore used as a covariate in all subsequent analyses.

2.2. Instruments

2.2.1. Interview for research on addictive behavior (Verdejo-García et al., 2005). This semi-structured interview focuses on patterns of use for different classes of drugs, including typical amount per month and duration of use.

2.2.2. Structured clinical interview for DSM-IV (SCID; First et al., 1994). We used the substance abuse and dependence subscale to obtain diagnoses related to substance use.

2.2.3. Moral judgment task (Greene et al., 2001). Participants read and responded to 60 hypothetical scenarios. Participants' responses consisted of reporting whether they would perform ("yes") or refuse to perform ("no") an action. Participants also reported the subjective difficulty of the decision. As in prior work, scenarios were categorized as either impersonal (not emotionally salient) or personal (emotionally salient). In addition, personal scenarios were classified as either low-conflict (easy) versus high-conflict (difficult; Koenigs et al., 2007). Thus, scenarios fell into four categories: (1) non-moral scenarios, (2) impersonal moral scenarios, (3) personal moral low-conflict scenarios, and (4) personal moral high-conflict scenarios.

For all moral scenarios, Affirmative Answers represent utilitarian judgments: the participant endorses an emotionally aversive action (e.g., to kill someone) in order to maximize aggregate welfare (e.g., to save more people). For example, a utilitarian choice could involve throwing a dying into the sea to keep a lifeboat full of people afloat. By contrast, negative answers represent non-utilitarian or deontological judgments: the participant rejects the harmful action at the expense of the greater good.

The main dependent measures were the proportion of *Affirmative Answers* and the perceived level of *Difficulty* for each of the four categories of scenarios. In the case of moral scenarios, Affirmative Answers represent utilitarian moral judgments, i.e., endorsing an emotionally aversive action to maximize aggregate welfare. Difficulty reflects the mean score of difficulty ratings, ranging from 1 (low difficulty) to 10 (high difficulty).

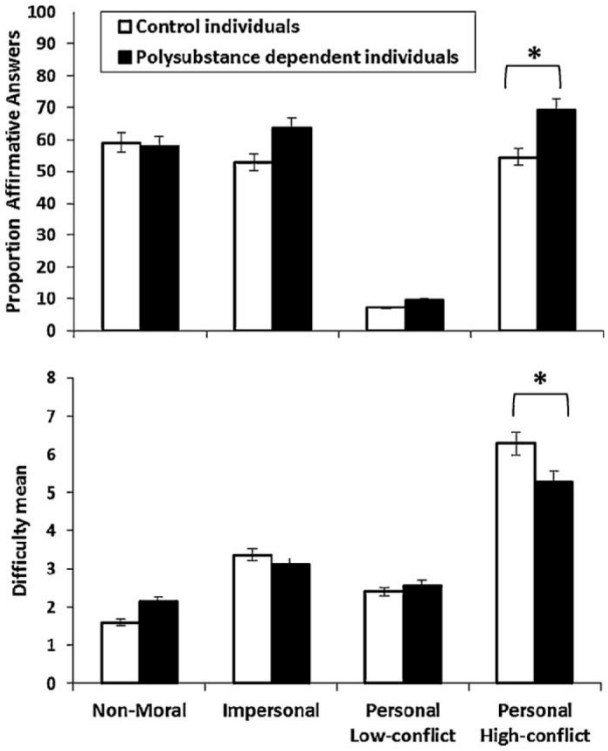

Fig. 1. Proportion of Affirmative Answers and Difficulty across scenario categories, for polysubstance dependent individuals and controls.

We used a Spanish version of this instrument, adapted through back-translation procedure, which holds adequate psychometric properties (Cronbach's alpha = 0.71; Carmona-Perera et al., 2009).

2.3. Procedure

The study was approved by the Ethical Committee for Research in Humans of the University of Granada. All participants read the research protocol and signed an informed consent form before inclusion in the study. Polysubstance dependent individuals were initially screened by the clinical staff for fulfillment of inclusion criteria, including urine tests to confirm abstinence, and then assessed in a single session including the toxicological interview and the moral dilemmas battery. Controls were recruited through advertisements placed in community centers in the same geographical area.

3. Results

The main hypothesis was tested, using a 2 (Group: Polysubstance dependent individuals vs. Control) × 4 (Category of dilemma) mixed-effects ANCOVAs of the two dependent variables (Affirmative Answers and Difficulty). Years of education were entered as covariate in these analyses. Results showed a significant Group × Category interaction on the index of Affirmative Answers [$F(3, 2.328) = 3.441$, $p < 0.018$].

Planned t-tests showed that this interaction was driven by significant differences between polysubstance users and controls on personal moral high-conflict dilemmas [$t = -2.555$, $p < 0.013$]; polysubstance dependent individuals endorsed a higher proportion of Affirmative Answers (Fig. 1). We found no significant differences between groups on the other three categories (all $p > 0.05$).

For Difficulty, a Group × Category interaction emerged as well [$F(3, 1.962) = 3.510$, $p < 0.017$]. Planned t-tests revealed that

Table 1
Descriptive scores of substance dependent diagnoses, and amount and duration of use of each drug, in polysubstance dependent individuals.

Substance	Ever used (proportion)	DSM-IV diagnosis (proportion)	Drug use parameters, mean (SD)	
			Quantity	Duration (years)
Alcohol	96.34%	44.46%	140.26 (185.01) units/month	15.03 (5.56)
Cocaine	85.28%	65.63%	42.69 (65.13) g/month	9.03 (6.97)
Cannabis	77.83%	15.63%	17.03 (22.65) g/month	8.25 (6.91)
Ecstasy	52.91%	3.13%	586.96 (1107.29) mg/month	2.80 (5.27)
Heroin	40.73%	25%	208.24 (527.12) mg/month	3 (5.21)

Note: g, grams; mg, milligrams.

polysubstance dependent individuals trended toward judging personal moral high-conflict dilemmas as less difficult [$t = 1.920$, $p < 0.059$] (see Fig. 1). We found no significant differences between groups on the other three categories (all $p > 0.05$).

We also conducted Spearman correlation analyses to test the association between patterns of drug use and the dependent variables. A significant correlation emerged between the severity of alcohol use and Affirmative Answers for personal moral high-conflict dilemmas ($r = 0.408$; $p = 0.043$).

4. Discussion

The current study demonstrates that polysubstance dependent individuals deliver more utilitarian moral judgments in response to personal moral scenarios, which are high in emotional content. Polysubstance dependent individuals not only delivered a greater proportion of utilitarian judgments but also perceived these decisions as less difficult.

According to dual-process models of moral cognition, utilitarian choices are more readily endorsed by individuals who show reduced ability to integrate social-emotional inputs (Greene, 2007; Greene et al., 2008). Polysubstance dependent individuals are characterized by emotional blunting, abnormal triggering of emotional signals during outcome anticipation, and poor affective regulation (Aguilar de Arcos et al., 2005; Bechara et al., 2002; Payer et al., 2011). These deficits may therefore underlie the utilitarian pattern of their moral judgments. Nonetheless, future work should explore other explanatory accounts including impaired inhibition and impulsivity (Leeman et al., 2009) or degraded representations of social values (Moll et al., 2005).

The current analyses revealed a correlation between utilitarian moral judgments and severity of alcohol use. Previous studies have shown that alcohol use (compared to other drug classes) disproportionately damages emotion perception (Foisy et al., 2005; Korneich et al., 2003). Chronic alcohol dependent individuals show deficits in emotional processing, including impaired appraisal of facial emotions and affective prosody (Maurage et al., 2011a; Uekermann et al., 2005, 2007) and impaired emotional but not cognitive empathy (Maurage et al., 2011b). Notably, these affective deficits are predictive of real-life interpersonal problems (Korneich et al., 2002). We note, however, that the specificity of the link between alcohol use and utilitarian moral judgment should be interpreted with caution, given the mixed sample of polysubstance abusers in the current study.

We also note that the current conclusions apply specifically to a sample of polysubstance dependent individuals who were referred to residential treatment due to inability to achieve treatment goals in a naturalistic setting. Therefore, the patients in the current study may have been more likely to show emotional blunting and decision-making deficits that impact moral judgment. Although the consumption patterns of the sample are representative of users demanding addiction treatment in the European Union (EMCDDA Annual Report, 2010), future work should target broader groups of substance abusers. It is also important to note that future studies should control for important confounders or moderators of moral judgment in this population, including IQ, impulsivity or depression levels, which were not assessed and stand as a limitation of our study.

The utilitarian pattern observed in the current sample of polysubstance dependent individuals deviated from standard response patterns in not only the current control sample (Carmona-Perera et al., 2009) but also the control groups from two previous studies (Koenigs et al., 2007; Ciaramelli et al., 2007). Polysubstance dependent individuals scored more than 1 standard deviation above the means reported by these previous studies. Future research should investigate whether this utilitarian response pattern reflects a premorbid trait or a consequence of drug dependence. In any case, the current finding may yield important clinical implications. For example, novel interventions directed to improve cognition–emotion integration may contribute to correct the utilitarian biases of these individuals, thus fostering prosocial behavior (Crockett et al., 2010).

The present study provides initial clues about moral decision-making in polysubstance dependent individuals from a cognitive neuroscience perspective. In sum, the current findings indicate that polysubstance dependent individuals are more prone to deliver utilitarian choices when confronted with moral dilemmas, and find these decisions easier to make.

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Contributors

M. Pérez-García, A. Verdejo-García and M. Carmona-Perera designed the study and conducted statistical analysis. A. Molina-Fernández and M. Carmona-Perera collected the data. A. Verdejo-García, L. Young and M. Carmona-Perera wrote the first draft. All the authors contributed to the main content and provide critical comments on the final draft.

Conflict of interest

None declared.

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ANEXO III

Alcoholism: Clinical and Experimental Research

Impaired decoding of fear and disgust predicts utilitarian moral judgment in alcohol-dependent individuals

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Keyword:	Moral decision-making, Utilitarian judgments, Alcohol-dependent individuals, Emotional face recognition, Fear and disgust decoding
Category:	other - consequences of drinking - human < CONSEQUENCES OF DRINKING - HUMAN, social harm < CONSEQUENCES OF DRINKING - HUMAN
Abstract:	Background: Recent studies of moral reasoning in patients with alcohol use disorders have indicated a 'utilitarian' bias, whereby patients are more likely to endorse emotionally aversive actions in favor of aggregate welfare (e.g., throwing a dying person into the sea to keep a lifeboat of survivors afloat). Here we investigate the underlying psychological and neuropsychological processes. Methods: Alcohol-dependent individuals (n=31) and healthy comparison participants (n=34) completed a validated moral judgment task, as well as measures of impulsivity, mood symptoms (anxiety and depression), and emotional face recognition. Results: Alcohol-dependent individuals were more likely to endorse utilitarian choices in personal moral dilemmas compared to controls, and rated these choices as less difficult to make. Hierarchical regression models showed that poorer decoding of fear and disgust significantly predicted utilitarian biases in personal moral dilemmas, over and above alcohol consumption. Impulsivity and mood symptoms did not predict moral decisions.

	Conclusions: These findings suggest that impaired fear and disgust decoding contributes to utilitarian moral decision-making in alcohol-dependent individuals.

Impaired decoding of fear and disgust predicts utilitarian moral judgment in alcohol-dependent individuals

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ABSTRACT

Background: Recent studies of moral reasoning in patients with alcohol use disorders have indicated a 'utilitarian' bias, whereby patients are more likely to endorse emotionally aversive actions in favor of aggregate welfare (e.g., throwing a dying person into the sea to keep a lifeboat of survivors afloat). Here we investigate the underlying psychological and neuropsychological processes.

Methods: Alcohol-dependent individuals (n=31) and healthy comparison participants (n=34) completed a validated moral judgment task, as well as measures of impulsivity, mood symptoms (anxiety and depression), and emotional face recognition.

Results: Alcohol-dependent individuals were more likely to endorse utilitarian choices in personal moral dilemmas compared to controls, and rated these choices as less difficult to make. Hierarchical regression models showed that poorer decoding of fear and disgust significantly predicted utilitarian biases in personal moral dilemmas, over and above alcohol consumption. Impulsivity and mood symptoms did not predict moral decisions.

Conclusions: These findings suggest that impaired fear and disgust decoding contributes to utilitarian moral decision-making in alcohol-dependent individuals.

Key words: Moral decision-making, utilitarian judgments, alcohol-dependent individuals, emotional face recognition, fear and disgust decoding.

INTRODUCTION

Alcohol dependence is characterised by the persistent use of alcohol in the face of physical, psychological, and social consequences for oneself and close others (American Psychiatric Association and others, 2000). Alcohol-dependent individuals show deficits on decision-making tasks due in part to their impaired ability to attach emotional value to decision prospects (i.e., 'myopia for the future') (Fernández-Serrano et al., 2010; Park et al., 2010). Recent work has targeted these decision-making deficits in the domain of moral cognition (De Oliveira-Souza and Moll, 2009; Moran et al., 2012). Typically, participants are instructed to choose between a utilitarian option (i.e., harming one person to save a greater number of people) and a deontological option (i.e., refusing to harm someone and thus allowing a greater number of people to die). Alcohol-dependent individuals have been shown to endorse utilitarian options in response to moral dilemmas (Khemiri et al., 2012). Furthermore, among polysubstance users, severity of alcohol use predicts the degree of utilitarian bias (Carmona-Perera et al., 2012). Together, these prior studies reveal a link between alcohol use and utilitarian moral judgment. This link may be due to the specific neurotoxic effects of alcohol on frontal lobe function (Beck et al., 2012; Stephens and Duka, 2008), associated with co-morbidities and cognitive-affective deficits that contribute to moral judgment deficits. The primary aim of the current study was to identify key predictor variables of moral judgment deficits in alcohol dependence.

Prior work has explored moral judgment deficits. For example, studies have identified traits associated with impaired moral cognition, including antisociality and impulsivity (Bartels and Pizarro, 2011; Marsh et al., 2011). Induction of negative emotional states, such as disgust, has also been shown to reduce utilitarian bias choice in healthy individuals (Harlé and Sanfey, 2010; Schnall et al., 2008; Ugazio et al.,

2012), while patients with focal damage to brain regions that support emotional responding tend to endorse utilitarian moral judgments to a greater extent (Koenigs et al., 2007; Moretto et al., 2010). Moreover, depression and anxiety levels in non-clinical samples are positively also associated with utilitarian choice (Bartels and Pizarro, 2011; Starcke et al., 2011; Youssef et al., 2012). Notably, alcohol-dependent patients exhibit depression and anxiety (Lai et al., 2012), impulse control problems (Mitchell et al., 2005; Stephens and Duka, 2008), poor emotion regulation and emotional expression recognition (Foisy et al., 2007; Uekermann and Daum, 2008).

This study aimed first to replicate the prior finding that alcohol-dependent patients show a utilitarian bias and second to determine which psychological and neuropsychological factors previously associated with utilitarian bias (severity of alcohol use, impulsivity, mood symptoms and cognitive-affective processes) predict moral judgments in alcohol-dependent patients. First, we hypothesised that alcohol-dependent individuals would deliver more utilitarian moral judgments on personal (emotionally salient) moral scenarios. Second, since utilitarian moral judgments of moral personal scenarios have been previously associated with impulsivity, altered mood states and decoding affective deficits that are closely linked to alcohol dependence problems (Foisy et al., 2007; Lai et al., 2012; Stephens and Duka, 2008) we also hypothesized that high impulsivity, negative mood elevations, and poor affective decoding would significantly predict utilitarian choices in alcohol-dependent individuals. Specifically, based on our previous neural findings linking emotional processing with moral judgment (Koenigs et al., 2007; Verdejo-Garcia et al., 2012), we expected poor affective decoding to be the most significant predictor of utilitarian choices in alcohol-dependent individuals.

MATERIALS AND METHODS

Participants

Alcohol-dependent individuals (n = 31) and healthy control individuals (n = 34) participated in the study. The two groups did not differ significantly in terms of gender, age, handedness, socioeconomic status (see Table 1). All participants were of European-Caucasian origin. The alcohol-dependent group reported significantly fewer years of formal education ($t_{(63)}$ = 5.63, p < 0.001); therefore, this variable was entered as a covariate in all subsequent analyses.

Alcohol-dependent individuals were recruited from the detoxification unit of Nostra Senyora de Meritxell Hospital between October 2010 and June 2011. All subjects met DSM-IV criteria for alcohol dependence and did not meet criteria for abuse or dependence of other substances, with the exception of nicotine. For eligibility, participants needed to have been abstinent for at least 15 days (mean 2.56 month, SD= 3.44), as confirmed by urine analyses performed approximately every three days , and not have comorbid diagnoses of Axis I or Axis II disorders, assessed by clinical reports. Controls were recruited from the community through word-of-mouth communication. The main criterion for inclusion in the control group was the absence of significant alcohol use patterns, defined as fewer than 10 standard units of alcohol per week, taking a glass of whisky or other liquor to equal one unit, and a glass of wine or beer to equal 0.5 units. All participants scored at least 27 (i.e. normal cognitive state baseline) on the Spanish version of the Mini mental state examination (MEC; Lobo et al., 1979).

Insert table 1 about here

Instruments

- *Interview for Research on Addictive Behavior,* IRAB (Verdejo-García et al., 2005). This instrument evaluates the average amount of alcohol consumption per month and the duration of use in years. A combined quantity x duration variable was calculated for total alcohol consumption (i.e. alcohol units over lifetime) to illustrate group differences in alcohol exposure, despite the relative similarity in duration of alcohol use.
- *Barratt Impulsiveness Scale*, BIS-11 (Patton et al., 1995); Spanish version (Oquendo et al., 2001). This scale was used as a measure of impulsive personality traits. Participants were asked to rate a set of impulsivity manifestations on frequency: never or rarely, occasionally, often and always or almost always (scoring from 0 to 4). The main dependent variable was the total impulsivity score, and three subscale scores: cognitive, motor, and non-planning impulsiveness.
- *Hamilton Depression and Anxiety Rating Scales* (Hamilton, 1969, 1960); Spanish version (Ramos-Brieva and Cordero Villafáfila, 1986). These scales assess depression and anxiety symptoms. The interviewer assigns a score between 0 and 4, depending on frequency and intensity of symptoms (maximum depression and anxiety scores are 52 and 56, respectively). In addition, the anxiety scale can assess psychic and somatic anxiety separately. We used depression and anxiety total scores and anxiety partial scores (psychic and somatic) as dependent variables.
- *Facial Expressions of Emotion: Stimuli and Tests,* FEEST (Young et al., 2002). This cognitive-affective decoding task assesses recognition of facial emotional expressions. Participants must identify which emotion (anger, disgust, fear,

happiness, sadness and surprise) best describes the facial expression displayed. A set of 60 faces was presented, in random order, for 5 seconds each; there was no time limit for responding. The number of correct identifications for each emotion (ranging from 0 to 10) was collected as a dependent measure.

- *Moral Judgment task* (Greene et al., 2001). We used 32 hypothetical dilemmas selected in a prior work through Rasch analysis (Carmona-Perera et al., In press). The Spanish version was derived through back-translation, and its psychometric properties were adequate in an independent community sample (Cronbach's alpha = 0.78, Spearman Brown coefficient = 0.76; (Carmona-Perera et al., In press). Participants chose if they *would perform* ("yes") or *refuse to perform* ("no") an action to resolve each moral dilemma. Participants also rated the subjective difficulty of the decision using a Likert scale ranging from 1 (very low) to 10 (extreme). For moral dilemmas, affirmative answers ("yes") were considered 'utilitarian'. Dilemmas were classified into three types: non-moral dilemmas in a control condition (involving a cost-benefit decision without moral or emotional content; n = 8), moral-impersonal (involving a moral decision of low emotional salience; n = 8), and moral-personal (moral decisions of high emotional salience; n = 16). Personal dilemmas were further classified as low-conflict (shorter response latencies and high inter-subject agreement) versus high-conflict (longer responses latencies and low inter-subject agreement) (Koenigs et al., 2007). The dependent variables were the proportion of affirmative choices, the difficulty rating, and the decision latencies, for each of the dilemma categories.

Procedure

Participants provided written informed consent, before completing two individual test sessions lasting 1 h each. In the first session, we administered the assessments of drug use, impulsivity, mood and emotional decoding. In the second session, we administered the moral judgment task, in a computerised format. Individual dilemmas were presented over three phases on successive screens: the first screen described the scenario; the second screen prompted the response; the third screen prompted the difficulty rating on a Likert scale (with no time limits imposed).

Data analyses

Performance differences on the moral judgment task were compared between groups using a series of 2 (Group) × 4 (Type of dilemma) mixed-model ANCOVAs, with years of education entered as a covariate, on the three dependent measures (affirmative choices, difficulty ratings, and decision latencies). Significant Group × Type of dilemma interactions were decomposed using t-tests on each of the four dilemma categories. Additional analyses were conducted to determine the influence of education, by comparing two subsets (n = 20) matched on education. Group differences in emotion recognition, impulsivity, depression and anxiety were tested using univariate ANCOVAs (with years of education entered as a covariate).

To analyse the predictive capacity of the different psychological variables on utilitarian moral judgments, hierarchical multiple regression analyses were performed. The hierarchical regression approach was chosen to estimate the relative increase in the percentage of explained variance (and the statistical significance of the prediction change) provided by each of the consecutive sets of predictors. The four sets of predictors were entered in reverse sequence relative to our hypothesis: affective decoding measures were included last. Therefore, the affective decoding set had to

increase the percentage of variance explained by the other predictors to attain significant. We included the dependent measures from the moral judgment task that showed significant group differences: proportion of affirmative (utilitarian) judgments for high-conflict dilemmas, proportion of affirmative (utilitarian) choices for low-conflict dilemmas, and self-reported difficulty assessments for high-conflict dilemmas. The predictor variables were the socio-demographic and psychological variables that elicited significant group differences, which were grouped on five theoretically-driven sets and introduced in this order: i) years of education, ii) total alcohol consumption (composite estimate of amount and duration of alcohol use), iii) impulsivity (BIS-impulsivity total score), iv) mood (combined Hamilton depression and anxiety score), v) emotional decoding (number of hits in the decoding of facial expressions of fear and disgust). To determine the differential contribution of each set of predictors, we estimated the R^2 change associated with the entrance of each new set and its statistical significance.

RESULTS

Group differences

Table 2 shows descriptive statistics and between-group comparisons for the psychological variables. The alcohol-dependent group showed significantly higher levels of impulsivity, depression and anxiety, and significantly poorer recognition of fear and disgust compared to control participants, controlling for the effect of education. We found no significant differences in the perception of expressions of sadness, happiness, surprise and anger. Cohen's d coefficients for the group differences exceeded 1, indicating large effect sizes (Zakzanis, 2001).

Insert table 2 about here

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On the moral dilemmas task, a significant Group (Alcohol-dependent individuals vs. Healthy controls) × Category of dilemma interaction was observed for affirmative (utilitarian) answers ($F_{(3, 186)} = 10.32$, $p < 0.001$]. The main effects for Group ($F_{(1, 62)} = 6.26$, $P = 0.015$) and Dilemma category ($F_{(3, 186)} = 11.37$, $p < 0.001$) were also significant. The alcohol-dependent group was more likely to endorse utilitarian options for low-conflict personal dilemmas ($t_{(63)} = -5.23$, $p < 0.001$) and high-conflict personal dilemmas ($t_{(63)} = -4.35$, $p < 0.001$). No significant differences were observed on the non-moral scenarios ($t_{(63)} = 1.95$, p = 0.064), or impersonal dilemmas ($t_{(63)} = 0.08$, $p = 0.936$).

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A significant Group × Category interaction also emerged for the Difficulty ratings [$F_{(3, 186)} = 6.56$, $p = 0.003$], such that the alcohol-dependent group reported lower difficulty on the high-conflict dilemmas ($t_{(63)} = 3.07$, $p = 0.003$), but not the other three categories (non-moral, $p = 0.467$; impersonal, $p = 0.163$; low-conflict, $p = 0.565$). No significant main effects were found for Group ($F_{(1, 62)} = 2.01$, $p = 0.162$] or Dilemma category ($F_{(3,186)} = 1.79$, $p = 0.150$].

In addition, no significant Group × Category interaction was observed for decision latencies ($F_{(3, 186)} = 0.55$, $p = 0.648$]. The main effects for Group and Category were also non-significant ($p > 0.05$).

Additional analysis was conducted to further examine the influence of education. We selected subgroups from the alcohol-dependent group and healthy control group, that did not differ on years of education (AD subgroup, n = 20, mean = 14.84, SD = 1.80; HC subgroup n = 20, mean = 15.30, SD = 2.08) ($t_{(37)}$ = 0.73; p = 0.468). These matched subgroups nevertheless showed significant differences in utilitarian responding for personal moral dilemmas (low-conflict, $t_{(37)}$ = -3.24, p = 0.003; high-conflict, $t_{(37)}$ = -2.89, p = 0.006). These groups also differed on difficulty ratings for high-conflict dilemmas ($t_{(37)}$ = 2.47, p = 0.018). We found no significant differences between subgroups on the other three categories (all $p > 0.05$).

Moral decision-making predictors

The regression model for utilitarian choices for high-conflict personal dilemmas showed significant effects of the first and second blocks that entered the education and total alcohol consumption variables. Impulsivity and mood variables did not significantly improve the prediction level. However, inclusion of the emotional decoding block, including fear and disgust recognition, did significantly add to the model (see Table 3 for regression values). The global model predicted 23.8% of total variance and the best individual predictor was the fear recognition score, which was inversely correlated to utilitarian choices (β = -0.311, p = 0.018).

For utilitarian choices on low-conflict personal dilemmas, the blocks of education and total alcohol consumption were significant predictors of utilitarian choices. Impulsivity and mood variables were not significant predictors. Entering the block of emotional decoding variables again significantly increased the predictive value, with 27.7% of total variance explained in the global model. Total alcohol consumption (β = 0.354, p = 0.026) and disgust recognition (β = -0.252, p = 0.072) were the variables

that were individually significant predictors. Total alcohol consumption was positively correlated with utilitarian choices, while disgust recognition correlation was inversed.

For difficulty ratings on the high-conflict personal dilemmas, none of the blocks was significantly predictive.

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Insert table 3 about here

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DISCUSSION

This study aimed both to replicate prior work revealing utilitarian bias in alcohol-dependent individuals, and to determine the predictors of this bias, e.g., severity of alcohol use, impulsivity, mood symptoms and emotional decoding. Our findings demonstrate a utilitarian bias on personal moral scenarios in individuals with alcohol dependence. In addition, alcohol-dependent individuals rated these decisions as less difficult, compared to controls. Critically, poor recognition of facial expressions of fear and disgust predicted utilitarian bias on personal moral dilemmas, over and above the impact of total alcohol consumption and years of education. Specifically, impaired fear decoding emerged as the main predictor of utilitarian choices for *high-conflict* dilemmas, whereas impaired disgust decoding emerged as the main predictor of utilitarian choices for *low-conflict* dilemmas. Although future work is required to explore these effects, we suggest that the perception of fear in specific individuals may lead to an aversion to harming those individuals even when doing so may lead to saving other people, as in high-conflict scenarios (Crockett et al., 2010). On the other hand, low-conflict scenarios (e.g., causing harm for selfish benefit) may trigger moral disgust (Ugazio et al., 2012; Wheatley and Haidt, 2005).

Notably, impulsivity and mood symptoms were not significant predictors of moral decision-making, although they differed significantly between groups. Nevertheless, future work should use neuropsychological measures of impulse control or biological markers of affective disturbance such as salivary cortisol (Dallman, 2005).

The current demonstration of utilitarian responding in alcohol-dependent individuals is consistent with prior work, including a previous study in a Swedish sample (Khemiri et al., 2012). The utilitarian bias observed in the current sample also appears to be broader than the pattern observed in our prior work in a polysubstance-dependent group (Carmona-Perera et al., 2012), in which the bias emerged only high-conflict personal dilemmas. In the current sample, utilitarian bias extended to low-conflict personal dilemmas, which elicit deontological judgments in healthy subjects and even patients with impaired emotional processing (Koenigs et al., 2007; Moretto et al., 2010). Thus, the current sample of alcohol-dependent individuals appears to show relatively severe cognitive-affective deficits (Foisy et al., 2007; Stephens and Duka, 2008; Uekermann and Daum, 2008).

These findings are also consistent with prior evidence showing that alcohol-dependent individuals are impaired in their decoding of fear and disgust (Foisy et al., 2007; Uekermann and Daum, 2008). In the current study, these decoding deficits emerged as the key predictors of utilitarian choice on a subset of moral dilemmas. Poor emotional decoding is typically associated with deficits in aversive conditioning (Borlikova et al., 2006; Stephens and Duka, 2008) and may render alcohol-dependent individuals less sensitive to the emotional consequences (e.g., causing personal harm) of utilitarian responding (Birbaumer et al., 2005; Gao et al., 2010). Indeed, individuals with difficulty identifying fear-inducing behaviours tend to judge these behaviours as more morally acceptable (Marsh and Cardinale, 2012). More generally, interpersonal

interactions are based in large part on our ability to perceive other emotions (Riggio et al., 2003); thus, emotional decoding deficits in alcohol dependence may lead to social impairments observed in this population (Kornreich et al., 2002; Maurage et al., 2008).

The present research can be understood in the context of dual-process models of moral judgment; alcohol-dependent individuals show reduced ability to integrate social-emotional inputs and therefore endorse utilitarian moral judgments (Greene, 2007). As such, the current results are also consistent with the proposed role of emotion in deontological judgments (Schnall et al., 2008; Van Dillen et al., 2012; Wheatley and Haidt, 2005). More specifically, the successful induction of avoidance-related emotions (e.g., disgust or fear) may lead to deontological moral judgments (Harlé and Sanfey, 2010; Ugazio et al., 2012). Furthermore, according to the somatic-marker theory of addiction, the medial prefrontal cortex is the key brain region for generating and integrating emotional signals (somatic-markers), which arise in anticipation of the affective and social consequences of different courses of action (e.g., utilitarian vs. deontological), crucially guiding decision-making (Verdejo-García and Bechara, 2009).

We should acknowledge that our two groups were not closely matched for background education. We therefore included this variable as a covariate in our analyses, although, given some of the caveats raised about the use of ANCOVA (Grove and Meehl, 1996; Wallet et al, 2006), we also note that our group effects were substantiated both in the ANOVA models without the covariate term included, and in the sensitivity analysis using subsets matched for education. Our regression models also directly investigated any influence of education, with the psychological variables entered after education. We think the correlation with alcohol consumption reflects a consequence of alcoholism, but other explanations are possible, and future work should explore alternative premorbid factors including, especially, psychopathic traits (Bartels

and Pizarro, 2011; Harensky et al, 2009) or altered attentional control (Van Dillen et al., 2012), which may also partially account for these findings. In sum, our study not only replicates the association between alcohol dependence and utilitarian moral judgment but also reveals that defective fear and disgust decoding are key predictors of utilitarian choices in personal moral dilemmas. These findings have important clinical implications, given that poor decision-making is a well-validated predictor of alcohol and drug relapse (Allsop et al., 2000; Bechara and Damasio, 2002). Furthermore, the impairments in fear and disgust recognition could be related to clinical observations in alcohol-dependent individuals, such as the lack of disgust of vomit, and poor personal hygiene (Hazelton et al., 2003; Johnson et al., 2008). Specific interventions directed at improving emotional decoding as well as transferring these emotional capacities into real-life decisions, for example the Micro Expression Training Tool (Ekman, 2003; Matsumoto and Hwang, 2009), and Multimodal Affective Systems (Duric et al., 2002; Lisetti and Nasoz, 2002; Zeng et al., 2009) may prove useful.

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Figure legends

Figure 1. Proportion of affirmative answers and difficulty of judgment across scenario categories, for alcohol-dependent individuals and controls.

Table legends

Table 1. Descriptive scores for the sociodemographic and alcohol use characteristics of alcohol-dependent individuals and healthy control individuals.

Table 2. Descriptive scores, univariate analyses of covariance (ANCOVAs), and effect sizes on the psychological variables for alcohol-dependent group and control group.

Table 3. Multiple hierarchical regression models of the association of education, total alcohol consumption, impulsivity, mood and emotional decoding with moral judgments performance.

Table 1.

	Alcohol-dependent Mean (SD) / Proportion	Control Mean (SD) / Percentage	t / χ^2	*p*-value
Age	52.06 (6.48)	48.77 (10.66)	*-1.49	0.141
Educational level (years)	13.74 (1.98)	17.12 (2.75)	*5.63	0.000
Handedness			**1.42	0.889
Right handed	87.1%	88.2%		
Left handed	12.9%	11.8%		
Socioeconomic level			**0.02	0.492
Low	25.8%	14.7%		
Middle	64.5%	70.6%		
High	9.7%	14.7%		
Quantity alcohol per month (units)	565.79 (462.26)	21.38 (12.50)	*-6.87	0.000
Duration alcohol consumption (years)	26.50 (8.53)	20.66 (9.67)	*-2.55	0.013
Total alcohol consumption (units)	188026.78 (167376.61)	5076.99 (4358.61)	*-6.38	0.000

*Note: Socioeconomic status was collected from clinical history reported by clinical staff; *Value of Student's t; **Value of chi-squared χ^2.*

Table 2.

	Alcohol-dependent Mean (SD)	Control Mean (SD)	*F*-value	*p*-value	Cohen's *d*
Impulsivity (total)	51.77 (15.71)	28.38 (10.69)	32.66	0.000*	1.76
Cognitive	15.77 (4.58)	11.35 (4.14)	9.84	0.003*	1.02
Motor	17.87 (7.69)	8.09 (3.99)	27.07	0.000*	1.62
Non-planning	18.03 (7.41)	9.59 (5.88)	19.22	0.000*	1.27
Depression	12.32 (8.88)	2.12 (2.32)	27.68	0.000*	1.61
Anxiety (total)	15.32 (12.46)	3.56 (3.95)	18.86	0.000*	1.30
Somatic	6.71 (5.76)	1.62 (2.26)	13.69	0.000*	1.19
Psychic	8.61 (7.61)	1.94 (2.39)	18.08	0.000*	1.21
Emotional Perception (total)	43.13 (5.69)	50.03 (5.52)	11.85	0.001*	1.23
Anger	7.09 (1.99)	8.18 (1.59)	2.17	0.146	0.60
Disgust	6.58 (1.84)	8.62 (1.58)	9.69	0.003*	1.19
Fear	4.32 (2.21)	6.65 (2.39)	10.30	0.002*	1.01
Happiness	9.71 (0.46)	9.85 (0.44)	1.19	0.280	0.32
Sadness	7.35 (2.27)	7.53 (1.79)	0.01	0.910	0.09
Surprise	8.52 (1.52)	9.18 (1.34)	1.61	0.210	0.46

*Note: For the Emotional Perception Task, we obtained the number of correct identifications for each emotion (ranging 0–10), and the sum score of total correct identifications (ranging 0–60); * p-value < 0.05.*

Table 3.

	Education R^2 change (p-value)	Tot Alcohol R^2 change (p-value)	Impulsivity R^2 change (p-value)	Mood R^2 change (p-value)	Em Decod R^2 change (p-value)	Full model R^2 adjusted -value)	Main Contributors (p-value)
Variable 1	0.119 (0.005)*	0.075 (0.020)*	0.005 (0.551)	0.018 (0.655)	0.107 (0.017)*	0.238 (0.002)*	Fear Rec (0.018)*
Variable 2	0.122 (0.005)*	0.143 (0.001)*	0.000 (0.941)	0.015 (0.543)	0.077 (0.042)*	0.277 (0.001)*	Tot Alcohol (0.021)* Disgust Rec (0.072)
Variable 3	0.044 (0.096)	0.006 (0.554)	0.000 (0.993)	0.033 (0.354)	0.013 (0.677)	-0.017 (0.554)	

Variable 1; Proportion of utilitarian choices in high-conflict personal dilemmas; Variable 2; Proportion of utilitarian choices in low-conflict personal dilemmas; Variable 3; Mean of judgment difficulty in high-conflict personal dilemmas; Tot Alcohol, Total Alcohol Consumption; Em Decod, Emotional Decoding; Fear Rec, Fear Recognition; Disgust Rec, Disgust Recognition; * p-value < 0.05.*

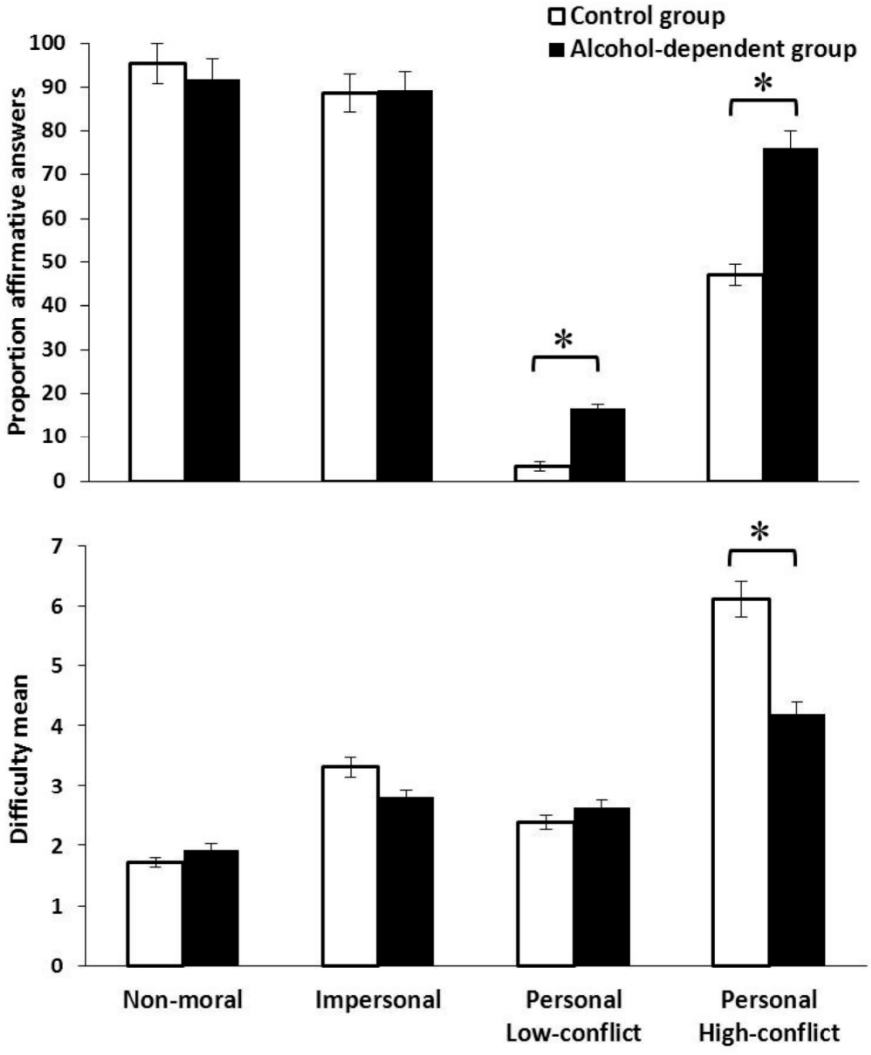

Figure 1. Proportion of affirmative answers and difficulty of judgment across scenario categories, for alcohol-dependent individuals and controls.
153x185mm (300 x 300 DPI)

ANEXO IV

Word count: 3921

Heart rate correlates of utilitarian moral decision-making in alcoholism

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Abstract

Background: Recent studies of moral reasoning in patients with alcohol use disorders have indicated a 'utilitarian' bias, whereby patients are more likely to endorse emotionally aversive actions in favor of aggregate welfare (e.g., to kill a person in order to save a group of people). The aim of the present study was to examine psychophysiological correlates of this tendency indexed by heart rate.

Methods: The sample was composed by 31 alcohol-dependent individuals and 34 healthy controls without alcohol use disorders. Electrocardiogram was recorded at rest and during execution of a validated moral judgment task, including non-moral scenarios, and moral dilemmas that were either high in emotional salience ("personal scenarios") or low in emotional salience ("impersonal scenarios").

Results: Alcohol-dependent individuals showed a blunted response to moral dilemmas . Furthermore, healthy controls displayed decreased heart rate to the personal vs. impersonal or non-moral scenarios, while alcohol-dependent individuals failed to differentiate dilemmas in terms of heart rate both prior decision-making and its post appraisal. These deficits were not related to baseline differences in Heart Rate.

Conclusion: Our findings indicate that alcohol-dependent individuals failed to engage emotional aversive reactions to personal moral violations in terms of heart rate response.

Keywords: Moral decision-making; Emotion; Heart rate; Alcohol-dependent individuals.

1. Introduction

The somatic-marker model of addiction posits that addicted individuals exhibit problems to raise and process the emotional signals that normally guide adaptive decision-making (Verdejo-García and Bechara, 2009). When decision-making is framed in the context of moral judgment this notion is reminiscent of the dual-process model (Greene, 2007; Greene et al., 2008). This model posits that the surge of negative emotional states during consideration of personal moral dilemmas tend to foster deontological choices (i.e., refuse to harm someone regardless of its beneficial implications for societal well-being). However, in absence of these emotional signals moral decision-making is more likely to be approached from a cost-benefit analysis which favors utilitarian choices (i.e., smothering a baby to save a group of people during wartime). Recent studies demonstrate that alcohol-dependent individuals compared to non-alcohol using controls tend to endorse more utilitarian choices when faced with personal moral dilemmas (Carmona-Perera et al., Under review; Khemiri et al., 2012). In addition, they rate these utilitarian choices as less difficult to make (Carmona-Perera et al., Under review). Because the utilitarian choice patterns specifically emerge in response to personal emotionally salient dilemmas, and because difficulty ratings can be viewed as a proxy of the degree of emotional burden involved, we have proposed that the utilitarian choice patterns of alcohol-dependent subjects are associated with deficits to raise negative emotions during consideration of moral dilemmas. However, this notion has not been yet been tested using physiological recordings during moral judgment.

In order to evaluate the physiological concomitants of emotional responses, we assessed the heart rate (HR) response evoked by moral dilemmas. HR changes are considered to be an indicator of the valence dimension of emotion, since HR tend to

decrease under the experience of negative emotions and to increase when we experience positive ones (Greenwald et al., 1989; Lang et al., 1993). Accordingly, evidence show significant HR decreases in response to a plethora of unpleasant stimulus, including the reading of emotional drama texts (Danko et al., 2011; Lacey and Lacey, 1970) or the passive viewing of unpleasant pictures and films (Lang et al., 1993; Palomba et al., 2000). Blunted HR reactivity to emotional stimuli has been demonstrated in alcohol dependent-individuals compared to healthy participants (Kornreich et al., 1998; Ryan and Howes, 2002). Moreover, HR reactivity has shown to be less significantly impacted by mood states in alcohol users, since it is not correlated with levels of sadness, distress or irritation after negative mood induction (Jansma et al., 2000). Therefore, personal dilemmas should induce HR decreases in normal controls, but in agreement with the somatic-marker theory of addiction and the dual-process model of moral decision-making, this response may be attenuated in alcohol-dependent individuals.

In addition to examine HR responses to moral dilemmas, we also explored whether the emotional deficits proposed to relate to utilitarian choices were associated with general physiological deficits in baseline conditions, when no task is present. In particular, Heart Rate Variability (HRV), and especially Respiratory Sinus Arrhythmia (RSA), have been demonstrated to be reliable indices of emotional regulation (Thayer and Lane, 2000). Reduced HRV-RSA is interpreted as a physiological correlate of deficient generation of emotional responses (Appelhans and Luecken, 2006; Thayer and Lane, 2000). In its neuro-visceral integration model, Thayer and Lane interpreted HRV (especially vagal-mediated high frequency or RSA) as an index of attentional-emotional regulation related to tonic inhibitory influences from the prefrontal cortex to subcortical structures. The reduced HRV is then interpreted as a disregulation of this inhibitory network. This would suggest lower effects of emotion on regulation of cognitive

processing, and may therefore be relevant for moral decision-making. Accordingly, previous evidence have shown that variations in baseline HRV or RSA are associated with performance in emotion regulation and cognitive control tasks (Lane et al., 2001; Thayer et al., 2009; Thayer and Lane, 2000) and with adequate integration of prefrontal-subcortical systems in the linkage between peripheral physiology and cognitive control (Thayer et al., 2012).

In summary, this study is aimed to test whether autonomic nervous system responses to moral dilemas indexed by heart rate contribute to explain utilitarian choice patterns in alcohol-dependent individuals. We hypothesized that alcohol dependent individuals would display: (i) reduced cardiac reactivity to the moral dilemmas, specifically a less pronounced HR deceleration during personal moral dilemmas, and (ii) reduced RSA at baseline, which would correlate with more utilitarian choices in personal dilemmas.

2. Methods

2.1. Participants

Thirty one alcohol-dependent individuals and 34 non-alcohol using controls participated in this study. Alcohol-dependent individuals were recruited as they commenced psychosocial treatment at the Addicted Behaviors Unit of Nostra Senyora de Meritxell Hospital (Andorra). We initially screened 43 participants between October 2010 and June 2011. Of them, we excluded 9 participants because they did not meet inclusion criteria. The inclusion criteria were defined as follows: (i) meeting DSM-IV criteria for alcohol dependence; (ii) absence of comorbid dependence of other drugs (excluding nicotine); (iii) maintained abstinence at least 15 days before testing, confirmed by twice weekly urine analyses; (iv) not having history of head injury or neurological disorders;

(v) not having current comorbid diagnoses of Axis I or Axis II disorders, assessed by clinical reports; and (vi) the absence of severe cognitive impaired caused by dementia. Compliance with inclusion criteria was assessed using the Structured Clinical Interview for DSM-IV (SCID-I; First, 2007) to diagnose alcohol dependence and exclude any other substance dependence disorder. All participants also completed the Millon Clinical Multiaxial Inventory III (MCMI-III; Millon and Davis, 1997) and the Symptom Check List, Revised (SCL-90-R; Derogatis, 1977) to provide information on personality disorders and psychopathological symptoms. To screen the presence of severe cognitive impairment we used Mental State Examination (MMSE, Folstein et al., 1975; Spanish version from Lobo et al., 1979), excluding participants who rates below normal baseline score (27; Folstein et al., 1975). Data regarding patterns of quantity and duration of drugs use, including typical amount per month, duration of use and total alcohol consumption (lifetime amount), was collected using the Interview for Research on Addictive Behavior (IRAB; Verdejo-García et al., 2005).

Controls were recruited through snowball communication among adults from the same geographical area as patients, during the same period of time. Additional selection criteria for control participants was the absence of current or past diagnoses of substance abuse or dependence, excluding past or current social drinking (less than ten standard units per week) and nicotine. Four control participants were excluded due to alcohol abuse and one participant due to cannabis use. For technical reasons HR-data were not available for three participants from the control group; Also, HRV were not available for three controls and three alcohol-dependents.

Alcohol-dependent individuals and controls did not differ on sex and ethnicity (all participants were European-Caucasian males). The groups also did not differ significantly in terms of age [mean ± standard deviation (SD); alcohol-dependents

52.06±6.48; controls 48.77±10.66; $p = 0.141$], handedness (alcohol dependents 87.1% right handed and 12.9% left handed; controls 88.2% and 11.8%, respectively; p = 0.889) and socioeconomic level (64.5% of alcohol-dependents and 70.6% of controls had middle socioeconomic status, $p = 0.492$). The groups differed in years of education [alcohol dependents 13.74±1.98; controls 17.12±2.75; $p < 0.001$], and therefore this variable was included as a covariate in all subsequent analyses.

In the alcohol-dependent group, the mean amount of alcohol use was 565.80 (SD = 462.26) units/month, the mean duration of alcohol consumption was 26.50 (SD = 8.53) years, and the mean duration of abstinence was 11 weeks. In the control group, the mean alcohol use was 21.38 (SD = 12.50) units/month and the mean duration of consumption in years was 20.66 (9.67). From these data, we calculated the lifetime alcohol consumption (the product of mean amount × duration), which in the alcohol-dependent group was of 188027 units/lifetime (SD = 167377) and in controls was of 5077 units/lifetime (SD = 4359).

2.2. Instruments and procedure

This study was conducted according to the principles expressed in the Declaration of Helsinki. The protocol assessment was approved by the Ethics Committee for Human Research of the University of Granada and the Ethics Committee for Clinical Research of Nostra Senyora de Meritxell Hospital. All participants signed an informed consent before testing. The assessment was conducted individually in two sessions that lasted approximately one hour each. In the first session, participants were administered the clinical measures of addictive behavior, other psychiatric disorders and cognitive impairment. The moral decision-making task was administered in a second session. The

instruments included in this research belong to a more extensive evaluation protocol aimed at studying neuropsychological functions in alcoholism.

Moral decision-making were evaluated by 32 hypothetical dilemmas selected by Rasch analyses from Greene's moral dilemmas (Greene et al., 2001). The battery of dilemmas was adapted to Spanish language through a back-translation procedure, and its psychometric properties were tested in an independent community sample and found to be satisfactory (Cronbach's alpha = 0.78, Spearman Brown coefficient = 0.76; Carmona-Perera et al., Under review). In agreement with previous studies, we used four categories of dilemmas: non-moral dilemmas (involve non-moral decisions, e.g. buy a new camera or to have your old camera repaired for the same price; n = 8), impersonal moral dilemmas (involve non-emotional salient moral decisions, e.g. to turn a trolley away from five people, but toward one person; n = 8), and personal moral dilemmas (involve emotional salient moral decisions; n = 16), which were further divided into low-conflict, easy dilemmas (characterized by shorter decision latencies and high inter-subject response agreement, e.g. push a person off a bridge to stop a trolley from hitting five people), and high-conflict, more difficult dilemmas (characterized by longer decision latencies and lower levels of response agreement, e.g. smothering a baby to save a group people; Koenigs et al., 2007). Each dilemma had to be answered with ''yes'' or ''no'' and assessed the subjective difficulty of the decision on a scale ranging from 1 (low difficulty) to 10 (high difficulty). In the case of moral dilemmas, the answer ''yes'' indicates a utilitarian judgment which endorsed an emotionally aversive behaviour for a higher societal well-being (e.g. to kill someone to save more people), while "no" indicate a deontological judgment which rejects the harmful action despite the aggregate welfare. The whole battery of dilemmas was administered in a computerized format. Each item consisted of three consecutive prompts: 1) description

of the scenario, 2) a question whether or not to execute the proposed action, and 3) the subjective difficulty question. The dilemmas were presented in a counter-balanced order across participants. The inter-trial interval between dilemmas was of 10 s, during which we used a blank screen to facilitate participants to return their psychophysiological responses to baseline. Participants were sitting in front of a computer screen in a quiet and dimly lit room. They read and responded without pre-established time limits, pressing "next" to advance from the reading to the decision screen, "yes" or "no" to advance from the decision to the difficulty judgment screen, and a number ranging from 1 to 10 to advance to the next dilemma. The Percentage of Affirmative answers and mean score of Difficulty of judgment ratings for each type of dilemma were collected as main dependent measures for behavioral data.

2.3. Psychophysiological Data Acquisition and Analyses

Heart Rate (HR) and Heart Rate variability (HRV) were used as dependent psychophysiological variables. For this purpose, the electrocardiogram (ECG) was continuously recorded at rest (baseline) and during performance on the moral decision-making test. During the 5 min baseline, participants were asked to sit still, not to speak, and maintain their eyes open. ECG was recorded at a sampling rate of 2000 Hz through a Biopac MP150 (Biopac Systems Inc., USA). Electrodes (Ag/AgCl) were placed according to Einthoven's II derivation attaching them to the participant's right and left ankles and wrist of the non-dominant hand. The ECG raw signal was processed using the software AcqKnowledge 3.8.1, allowing R-spike detection and quantification of R–R intervals (in ms). Inter-beat interval data were edited for artifacts using linear interpolation.

For baseline, Respiratory Sinus Arrhythmia (RSA), a vagal-based measure of heart rate variability in the high frequency range (from 0.12 to 0.40 Hz), was extracted using CMetX software (Allen et al., 2007). The moral decision-making task was synchronized to the physiological recoding by event marking in association to the behavioral responses. This allow for the differential analysis of the different phases of trials. In such a way, each dilemma was divided in three time periods: i) presentation (from the onset of the dilemma in the computer screen to the time the participant press "next"), ii) decision (from the presentation of the dilemma question and the participant response), and iii) appraisal (from the presentation of the difficulty of judgment question and the subject's response). In order to extract the HR response patthern (ΔHR) to each experimental phase we obtained the 0.5 s by 0.5 s HR values expressed as differential scores with respect to mean HR obtained during the 5 s pre-dilemma. . The first 4 s (8 values) of each experimental period were computed as the analysis intervals. For all participants the comprised time for each period was at least 4 seconds, thus, the analized ΔHR intervals were recoded in all participants, including the fastest answers.

Data were analyzed using SPSS (IBM SPSS Statistics, Somers, New York). In order to examine between group HRV differences in the resting condition we conducted Univariate Analysis of Variance ANOVA, including as dependent variable Log RSA. In addition, we performed parametric Pearson correlations between log HRV and moral decision making behavioral data (affirmative answers and difficulty ratings). To test whether the HR response pattern to the trials phases (presentation, decision and appraisal) differed as a function of dilemma subtype and group, we used 2(3x4x8) ANOVA, with a between-subject factor (group) and the three repeated-measures factors: experimental phase (presentation, decision and appraisal), dilemma category

(non-moral, impersonal, low-conflict and high-conflict) and HR response pattern (8 HR values). The Huynh-Feldt epsilon correction was applied for the adjustment of the degrees of freedom in the repeated measures factors. Results are reported with the original degrees of freedom and the corrected *p* values.

3. Results

3.1. Heart Rate response

A significant HR response change was observed [main effect of response pattern: $F(7, 420) = 32.22$, $p < 0.001$, $\eta^2 = 0.35$] which differed as a function of group [interaction effect: $F(7, 420) = 4.36$, $p = 0.016$, $\eta^2 = 0.07$]. Although the HR response was significant in the two groups, the effect was greater in the control [$F(7, 210) = 26.18$, $p < 0.001$, $\eta^2 = 0.47$] than in the alcohol-dependent group [$F(7, 210) = 7.72$, $p = 0.001$, $\eta^2 = 0.20$]. In the control group the HR increases during the presentation phase exhibited an increase and a posterior decrease during the decision phase (i.e. a biphasic response) and increases again during the appraisal phase (see Figure 1). A similar but blunted response was observed in the alcohol-dependent participants (see Figure 2).This pattern lead to a decrease in HR during the course of the experiment [main effect of phase: $F(2, 120) = 17.03$, $p < 0.001$, $\eta^2 = 0.22$].

(Insert Figure 1 about here)

There were significant differences between the types of dilemmas [main effect effect of type of dilemma: $F(3, 180) = 5.86$, $p < 0.001$, $\eta^2 = 0.09$] which differed as a function of group [interaction effect: $F(3, 180) = 5.06$, $p = 0.003$, $\eta^2 = 0.08$]. Significant differences between the different types of dilemmas were found in the control group

[F(3, 90) = 8.07, $p < 0.001$, $\eta^2 = 0.21$] but not in the alcohol-dependent group [F(3, 90) = 0.31, $p = 0.787$, $\eta^2 = 0.01$]. For the three experimental phases, low and high-conflict personal dilemmas were associated with reduced HR levels compared to non-moral and impersonal dilemmas in the control group (see Figure 2). Furthermore, the effect of the types of dilemmas is dependent of the experimental phase (interaction effect: F(6, 360) = 2.41, $p = 0.034$, $\eta^2 = 0.04$) as differences between dilemmas increases progressively during the course of the experiment [F(3, 180) = 3.27, $p = 0.05$, $\eta^2 = 0.05$ for presentation, F(3, 180) = 5.75, $p = 0.001$, $\eta^2 = 0.09$ for decision, and F(3, 180) = 8.94, $p < 0.001$, $\eta^2 = 0.13$ for appraisal]. Finally, the experimental phase also modulated the group × response pattern interaction [triple interaction effect: F(14, 840) = 3.26, $p = 0.019$, $\eta^2 = 0.05$]. The interaction group × response pattern was statistically significant for presentation [F (7, 420) = 7.03, $p = 0.003$, $\eta^2 = 0.11$], and appraisal [F (3, 58) = 4.53, $p = 0.021$, $\eta^2 = 0.07$] but not for the decision phase [F (7, 420) = .90, $p = 0.416$, $\eta^2 = 0.02$]. The inclusion of mean baseline HR as a covariate did not change these results.

(Insert Figure 2 about here)

3.2. Heart Rate Variability

Univariate ANOVA analysis to test HRV differences at baseline revealed that the alcohol-dependent group displayed significantly lower HRV (Mean = 3.78; SD = 1.37) than the control group (Mean = 5.15; SD = 1.48) in log RSA [F(1, 57) = 13.49, $p = 0.001$, $\eta^2 = 0.19$]. Pearson's correlations in the overall sample showed that utilitarian answers were significantly associated with reduced log RSA in low (r = -0.34; $p = 0.008$) and high-conflict (r = -0.31; $p = 0.019$) personal dilemmas, whereas no significant correlations were found for non-moral and impersonal dilemmas (see

Figures 3a and 3b). Moreover, difficulty of judgment in high-conflict scenarios was positively correlated with increased log RSA (r = 0.42; $p < 0.001$) (see Figure 3c). However, correlations calculated separately within each group did not reach significance neither for controls (low conflict: r = -0.12, high conflict: r = -0.10), or alcohol-dependent participants (low conflict: r = -0.13, high conflict: r = -0.10). Difficulty of judgment in high-conflict dilemmas was marginally associated with log RSA both in the control (r = 0.35, $p = 0.053$) and the alcohol-dependent groups (r = 0.32, $p = 0.096$).

(Insert Figure 3 about here)

4. Discussion

Alcohol-dependent individuals tend to endorse more utilitarian choices in personal moral dilemmas compared to healthy controls (Carmona-Perera et al., Under review; Khemiri et al., 2012). Here we unveil the psychophysiological concomitants of this behaviour: whistl healthy controls showed decreased heart rate (HR) to the personal (emotionally salient) vs impersonal or non-moral scenarios, alcohol dependent individuals failed to modulate their heart rate responses as a function of the type of dilemma. Furthermore, in comparison to the healthy controls, the alcohol-dependent individuals showed a blunted cardiac responsiveness to the moral dilemmas. These deficits were not related to baseline differences in HR. In addition, utilitarian choices in personal dilemas were associated with decreases in heart rate variability, nonetheless, this association did not hold in each group separately.

Stimulus-evoked reductions in heart rate are mainly associated with negatively valenced emotions (Danko et al., 2011; Greenwald et al., 1989; Lang et al., 1993;

Palomba et al., 2000). Therefore, we posit that the heart rate decreases shown by healthy controls in response to personal dilemmas reflects the engagement of negatively valenced emotions purportedly involved in the appraisal of moral violations (Rozin et al., 1999). Conversely, alcohol-dependent individuals exhibit problems to engage negatively valenced emotions during consideration of moral scenarios. This interpretation is in accordance with the somatic-marker theory of addiction, which postulates that addicted individuals have specific difficulties to generate and perceive the emotional signals (somatic-markers) attached to potential negative outcomes of decisions (Verdejo-García and Bechara, 2009; Verdejo-García et al., 2012). Our results are also consistent with the dual-process model of moral choice, which postulates that engagement of strong negative emotions tend to bias moral decision-making towards deontological choices (Greene, 2007; Greene et al., 2008). The ventromedial prefrontal cortex has been demonstrated as an essential brain region for the triggering of emotional responses during moral decision-making (Koenigs et al., 2007), and it is also involved in the decoding of negatively valenced emotions (Salloum et al., 2007).

Previous studies had highlighted the role of autonomic physiological responses during moral responses through the study of electrodermal activity (Moretto et al., 2010; Navarrete et al., 2012; Teper et al., 2011), however, our findings are the first to demonstrate blunted HR reactivity to moral dilemmas in alcohol-dependent-individuals. Specifically, healthy controls elicited an anticipatory HR response before moral decision-making, characterized by a biphasic response, and a subsequent HR increases during appraisal period, whereas this response pattern was substantially diminished in alcohol-dependent patients. This is in accordance with previous evidence in alcoholic patients about diminished cardiac responsiveness to emotional stimuli, and the inhability to be affected by mood (Jansma et al., 2000; Kornreich et al., 1998; Ryan and

Howes, 2002). The somatic-marker theory of addiction (Verdejo-Garcia and Bechara, 2009) posits that these difficulties to generate somatic-markers would be associated altered decision-making in substance abusers. These findings provide support that this also occurred for moral decision-making. Specifically, our findings showed diminished heart rate responses elicited by personal moral scenarios. In view of the theoretical link between heart rate decreases and negative valence (Danko et al., 2011; Lang et al., 1993; Palomba et al., 2000) our results are in agreement with those obtained in mood induction studies, which demonstrate that induction of negative emotions significantly reduces utilitarian biases (Schnall et al., 2008; Van Dillen et al., 2012; Wheatley and Haidt, 2005), whereas positive emotions increase utilitarism (Pastötter et al., 2012; Valdesolo and DeSteno, 2006). These findings may pose important implications for alcohol-related inteventions, which should focus on adequate appraisal of negative emotions to purportedly improve social cognition deficits.

This study holds important strengths and several worth commenting limitations. Strengths include a careful selection of alcohol-dependents and controls participants, excluding many confounders common in drug abuse research. The alcohol-dependent group excluded subjects with lifetime history of other drug use and co-morbid psychiatric disorders. The Alcohol-dependent participants were assessed after an abstinence period of 15 days verified by twice weekly urine analysis, and therefore we can avoid the changes in pshysiological activity during the first days of abstinence as well as the changes in moral judgments performance due to the immediate effect of alcohol. The main limitations include the non-matching of educational levels between the groups, the relatively small sample size and the lack of associations between moral choice and baseline physiological patterns within each group, in spite of previous evidence that heart rate variability may strongly impact cognition-emotion integration

(Lane et al., 2001; Thayer et al., 2009; Thayer and Lane, 2000). The discrepancy in years of education was controlled using ANCOVA models. These models were pertinent because years of education correlated with behavioral choice patterns. However, no study has found any relation between HRV and educative level. The sample size is similar to that reported in previous clinical studies of cognitive-affective deficits in alcohol-dependent individuals (Uekermann et al., 2007; Maurage et al., 2008), and it was enough powered to detect group differences on the heart rate concomitants of moral choice. Nonetheless, sample sizes within each group may have been short to detect the expected association in each group between heart rate variability and choice patters, perhaps due in part to reduced variability withing each group. Future studies should further explore this association.

In summary, the results of this study indicate that the moral decision-making in alcohol-dependents is characterized by insensitivity to negative emotional consequences of personal moral violations, such that their moral behavior may be comparatively more guided by a cost-benefit approach that favors utilitarian choices. Specifically, they failed to modulate heart rate in response to personal dilemmas, showing an inability to decrease HR both prior decision-making and his post appraisal.

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Fig.1. Example of Heart Rate response (ΔHR) recoded in a control participant during the high-conflict dilemma called "crying baby", where the participant have to accept or refuse smothering a baby to save a group of people.

Fig.2. Heart rate response (ΔHR) during the three experimental phases (presentation, decision and appraisal), as a function of dilemma category and group.

Fig.3. Scatterplot and regression lines for the relationship between log RSA and proportion of utilitarian choices in high (a) and low-conflict (b) moral dilemmas, and difficulty of judgment in high-conflict dilemmas (c).

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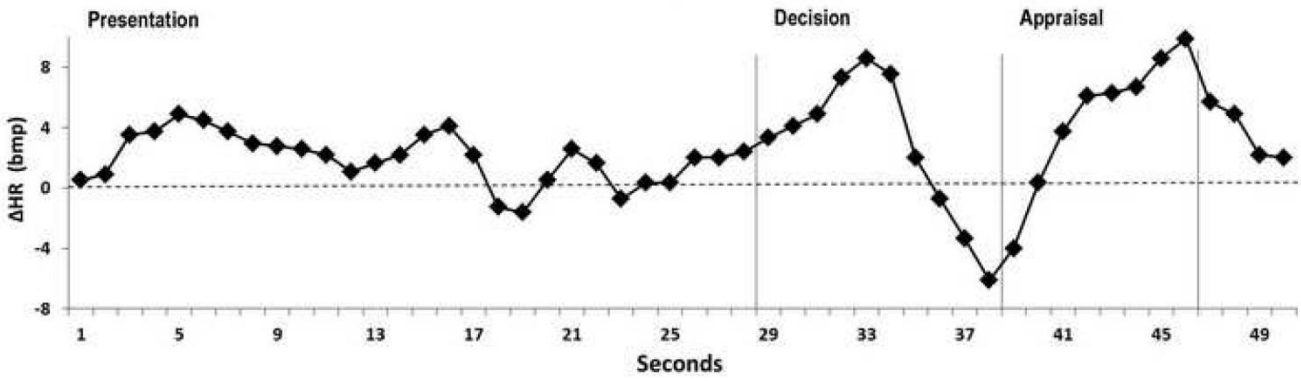

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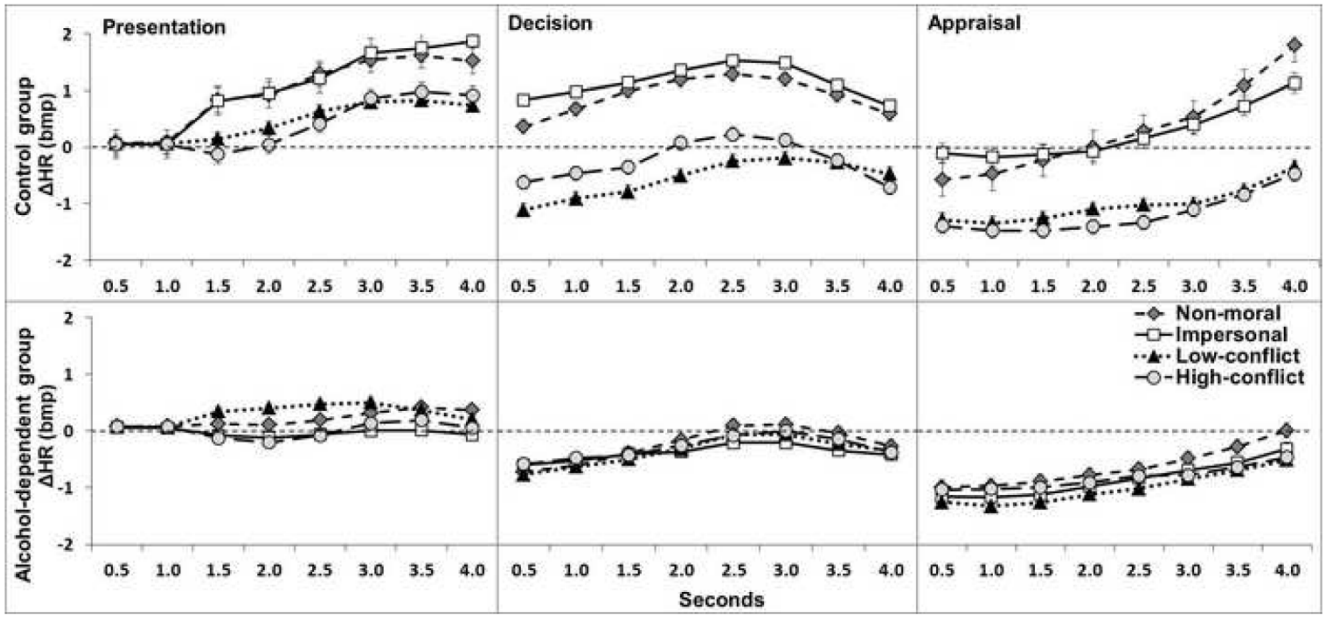

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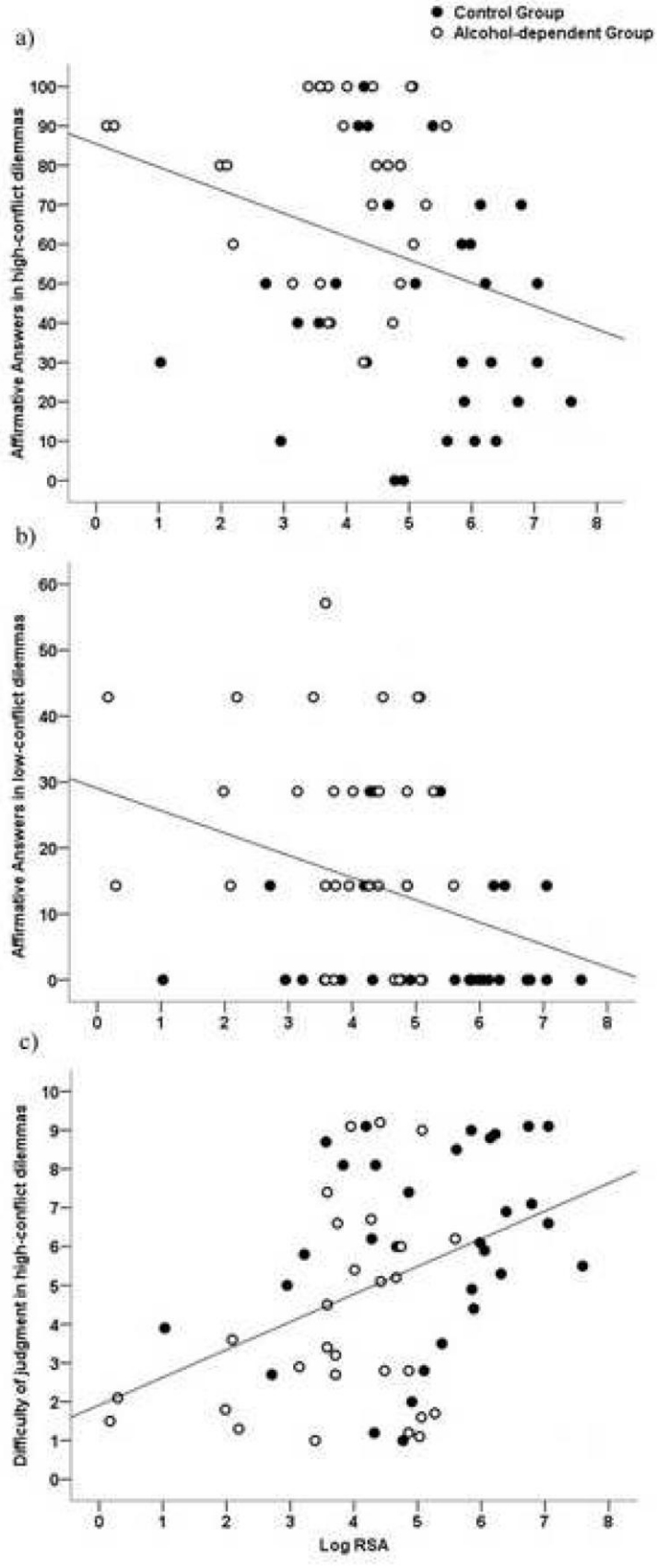

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Contributors

M. Pérez-García, A. Verdejo-García and M. Carmona-Perera designed the study. G. Reyes-Del Paso and M. Carmona-Perera designed psychophysiological data acquisition and conducted the process of data and statistical analysis. M. Carmona Perera collected the data. G. Reyes-Del Paso, A. Verdejo-García, and M. Carmona-Perera developed a first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflicts of interest

The authors have no conflicts of interest to declare.

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