

Universidad de Oviedo  
Departamento de Psicología

## **Tesis Doctoral**

**La Generación de Episodios Verbales Novedosos: La  
Emergencia de Intraverbales Complejas y Simétricas  
en Función del Aprendizaje de Intraverbales Simples y  
Tactos**

**Carlota Belloso Díaz**



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## 1. Introducción

La mayoría de los niños comienzan a responder preguntas en edades muy tempranas, entre el año y medio y los 2 años. Estas primeras preguntas se caracterizan por su simplicidad debido a que sus respuestas son, sistemáticamente, las mismas. Por ejemplo, los niños aprenden muy rápido a responder a su nombre, responder “Hola” cuando alguien les saluda o decir el sonido de un pequeño grupo de animales cuando se les pregunta; por ejemplo, “¿Cómo hace la vaca?” Este tipo de preguntas no requieren que el niño responda a una combinación de estímulos verbales. Simplemente los niños pueden responder correctamente atendiendo a un solo estímulo verbal; por ejemplo el estímulo “llamas” cuando responden su nombre o el estímulo “vaca” para responder “Muu”. Este fenómeno produce situaciones muy comunes en esta edad donde los niños responden de una forma automática cuando escuchan el estímulo verbal que provoca la respuesta a una pregunta. Por ejemplo, cuando un papá va caminando con su hijo de 2 años por el campo y ven una vaca, el papá dice “Mira, una vaca”, a lo que el niño responde rápidamente con “muuu”. En este ejemplo, la intención del papá no era que su hijo respondiera a “¿Cómo hace la vaca?”; sin embargo, la palabra “vaca” controla la respuesta “muuu”.

A medida que los niños desarrollan su lenguaje, van adquiriendo un repertorio cada vez más complejo para responder a preguntas que se complican cada vez más hasta llegar a la edad adulta. Después de que los niños aprenden a responder a preguntas sencillas como las expuestas anteriormente, es muy común observar cierto tipo de errores cuando se les presentan preguntas más complejas. Por ejemplo, Juan es un niño de 2 años que ha aprendido a responder correctamente a la pregunta “¿Cómo te llamas?” desde que tenía 17 meses. Un día jugando con su mamá y un teléfono, coge el teléfono y juega a que hace una llamada. Su mamá le pregunta “¿A quién llamas?”, a lo que él responde “Juan”. Es posible observar este tipo de error en los niños en un momento determinado de su desarrollo. Las respuestas erróneas se producen porque los niños todavía no han aprendido a responder preguntas atendiendo a la combinación de varios estímulos verbales. En el ejemplo anterior, Juan responde su nombre ante la pregunta que le hace su madre porque su respuesta “Juan” está bajo control específico de la palabra “llamas” y no está respondiendo a la combinación de los diferentes estímulos verbales que forman la pregunta “¿A quién llamas?” La mera exposición a preguntas de este tipo, a la corrección de las respuestas erróneas y, al elogio de las

respuestas correctas parece ser suficiente para que la mayoría de los niños vayan desarrollando cada vez repertorios más complejos para responder a preguntas.

Una vez que los niños son capaces de responder a preguntas atendiendo a la combinación de diferentes estímulos verbales, la mayoría de los niños comienzan a mostrar la capacidad de responder preguntas que no se les han enseñado de una forma incidental o directa. Esta capacidad parece ser crucial en el desarrollo cognitivo y del lenguaje de los niños y los adultos. Un ejemplo se puede observar cuando un niño de 6 años en una de sus clases de Conocimiento del Medio, aprende que la vaca, el perro y la oveja son mamíferos y que las características principales de los mamíferos son que nacen del vientre de la madre y maman cuando son crías. Tras este aprendizaje, el niño de 6 años es capaz de responder preguntas que no han sido enseñadas de una forma directa. Por ejemplo, pueden responder a preguntas como, “Dime tres mamíferos”, “¿Qué es la vaca/perro/gato?”, “¿Cómo se alimenta la vaca cuando es una cría?” o “¿De dónde nace el perro?” El desarrollo de esta capacidad permitirá a los niños acceder a informaciones cada vez más complejas y está muy relacionada con el desarrollo de otras habilidades (Sundberg y Michael, 2001), como las académicas y la comprensión del lenguaje en contextos sociales (Partington y Baley, 1993). La mayoría de los niños desarrollan esta capacidad sin aparente esfuerzo, simplemente exponiéndose a situaciones y contextos sociales y escolares donde otros adultos o compañeros les realizan preguntas y a la mera corrección cuando fallan. Sin embargo, a pesar de que la mayoría de los niños adquieren esta habilidad, no todos logran desarrollarla o muestran un desarrollo más lento que sus compañeros. Este déficit puede producir importantes problemas de aprendizaje en su edad escolar e incluso dificultades en el desarrollo de las interacciones sociales. El fenómeno de aprendizaje que está implícito en este ejemplo se denomina *emergencia de intraverbales* y es el objeto de estudio de esta tesis.

### **1.1. Definición de intraverbal**

Las intraverbales son operantes verbales caracterizadas por la emisión de una respuesta verbal después de la presentación de un estímulo verbal que no muestra una correspondencia punto-por-punto con la respuesta (Skinner, 1957). Ejemplos de intraverbales pueden ser responder “Blanco”, ante “¿De qué color es la nieve?”, responder “Tres”, ante “Uno, dos y...”, responder “Cerdo”, ante “Dime un animal de la granja” o responder “En Madrid”, ante “¿Dónde está el museo del Prado?” Las intraverbales son una parte muy relevante del lenguaje y están presentes en la mayoría de las interacciones sociales y en el desarrollo de la mayor parte de habilidades académicas (e.g., las tablas de multiplicar, categorizar los animales, nombrar las capitales de los países o citar los autores de obras literarias). Además, las intraverbales son componentes de habilidades verbales más complejas que están implicadas en el razonamiento.

### **1.2. Tipos de intraverbales**

Las intraverbales son operantes verbales complejas. Las relaciones intraverbales en el repertorio de cualquier adulto son el resultado de cientos de miles de reforzamientos bajo una gran variedad de contingencias inconsistentes y a menudo conflictivas. Muchas respuestas diferentes se producen bajo el control de un solo estímulo y, varios estímulos pueden producir una sola respuesta (Skinner, 1957). Existen diferentes tipos de intraverbales y podemos realizar una clasificación atendiendo al número de estímulos verbales antecedentes que controlan la respuesta (Axe, 2008). El repertorio intraverbal aparece en el desarrollo del lenguaje de los niños siguiendo un orden de menor a mayor complejidad en relación al estímulo antecedente. Las intraverbales más sencillas son aquellas que incluyen la emisión de cadenas de respuestas verbales. Por ejemplo, un niño de 20 meses puede responder “loba” cuando escucha a su madre cantar “Cinco lobitos, tiene la...”, también puede responder “Tres” ante el estímulo antecedente “Uno, dos y ...” o puede responder “¡Tás!” cuando su padre tapa su rostro mientras le dice “cu-cú”. Otro tipo de intraverbales simples son aquellas donde los niños solo necesitan responder a un estímulo antecedente relevante para dar una respuesta correcta. Por ejemplo, “¿Cuándo es tu cumpleaños?”, “¿Cómo hace el perro?” o “¿Cuál es tu nombre?” En este tipo de intraverbales el niño puede responder simplemente atendiendo a los estímulos verbales “cumpleaños”, “perro” o “nombre”, sin necesidad de atender al resto de estímulos verbales que, en este caso no

son relevantes. Denominaremos a este tipo de intraverbales como *intraverbales simples*. Definimos una intraverbal simple como aquella intraverbal que se basa en una relación de discriminación simple, es decir, cuya respuesta está bajo el control de un solo estímulo relevante.

Existe otro tipo de intraverbales, a las que denominaremos *intraverbales complejas*, y que se basan en una relación de discriminación condicional. Una discriminación condicional ocurre cuando la respuesta se produce bajo el control operante de un estímulo que se encuentra en presencia de otro estímulo contextual (Catania, 1998). Las discriminaciones condicionales están presentes en la mayor parte de las operantes verbales y determinan las respuestas verbales en función de la combinación de uno o varios estímulos discriminativos y contextuales. Por tanto, las intraverbales complejas son aquellas intraverbales cuya respuesta está bajo el control de la combinación de dos o más estímulos. Sundberg (2006<sup>a</sup>) se refiere a este tipo de operantes como *discriminaciones condicionales en las relaciones intraverbales*, donde un estímulo verbal altera el efecto evocativo de un segundo estímulo verbal y ambos evocan una respuesta intraverbal. Por ejemplo, cuando un niño responde “pelota”, “coche” o “muñeca” ante “¿Con qué juegas?”, está respondiendo a una intraverbal simple, ya que su respuesta está bajo el control de un solo estímulo relevante, en este caso, “juegas”. Sin embargo, cuando a un niño le preguntamos “¿Con qué juegas en la playa?” y “¿Con qué juegas en el parque?”, su respuesta está bajo control de dos estímulos relevantes “juegas” y “playa”/“parque”. Si ante la pregunta “¿Con qué juegas en la playa?” el niño responde “bañador”, “sombrija” o “toalla”; indicaría que el niño solo está respondiendo al estímulo “playa” y no al estímulo “juegas”. Por otro lado, si el niño responde “tobogán”, “iPad” o “coches”, indicaría que el niño está respondiendo solo al estímulo “juegas”. Solo cuando el niño responda a la combinación de “juegas” más “playa” y “juegas” más “parque” podrá responder “arena”, “cubo” y “pala” o, “tobogán”, “pelota” y “columpio” respectivamente. Es entonces cuando podemos decir que el niño está respondiendo a una intraverbal compleja.

### **1.3. Definición de emergencia de operantes verbales**

La emergencia de una operante verbal se produce cuando una operante aparece sin que se haya enseñado de una forma implícita, si no a partir del aprendizaje de otras operantes relacionadas (Pérez-González, 2015 y Barnes-Holmes, Barnes-Holmes y

Cullinan, 2000). Es decir, cuando una operante aparece sin que se haya enseñado con ayudas o correcciones.

Para demostrar la emergencia de relaciones verbales es necesario, en primer lugar, realizar una prueba inicial de las relaciones, sin utilizar ni reforzamiento ni correcciones a las respuestas, para asegurarnos de que la relación verbal no está presente. Una vez realizada la prueba inicial, se enseñan otras relaciones verbales relacionadas con las que queremos que emerjan. Finalmente, se repite la prueba inicial sin reforzamiento ni corrección. La aparición de las operantes verbales en la prueba final, después de haber enseñado otras operantes relacionadas, es la demostración de que se ha producido el fenómeno de emergencia.

#### **1.4. Definición de emergencia de intraverbales complejas**

La emergencia de una intraverbal compleja se produce cuando, una vez probado que la intraverbal compleja no está presente y, después de enseñar otras operantes verbales relacionadas, la persona responde correctamente a la intraverbal compleja en las pruebas finales.

Existen varias operantes que están relacionadas, en el sentido de que una puede emerger a partir de la otra. Por ejemplo, la discriminación y el tacto son operantes diferentes cuya relación ha sido demostrada ya que una de ellas puede emerger a partir de la otra (Horne y Lowe, 1996). Una discriminación consiste en una respuesta de selección ante un estímulo antecedente; en este caso se trata de una respuesta de selección ante un estímulo antecedente auditivo (Pérez-González, 2015). Un tacto (Skinner, 1957) se define como una operante verbal que se produce bajo el control de un estímulo no verbal y cuya relación esta mantenida por reforzamiento generalizado. Un ejemplo de este fenómeno se produce cuando un niño aprende a seleccionar la imagen de una mesa ante el estímulo verbal “mesa”, y la imagen de un sofá ante el estímulo verbal “sofá”. La mayoría de los niños que aprenden esta relación, luego son capaces de responder “mesa” cuando se les presenta la imagen de una mesa y, “sofá” cuando se les muestra la imagen de un sofá. En este ejemplo decimos que se ha producido la emergencia del tacto a partir del aprendizaje de la discriminación. Este fenómeno se puede dar a la inversa: cuando enseñamos al niño a nombrar las imágenes y probamos después la discriminación. Cuando esto ocurre, decimos que la discriminación ha emergido a partir del aprendizaje del tacto.

### **1.5. Estudios empíricos sobre intraverbales**

Existen dos vías de investigación diferenciadas en el estudio de las intraverbales. Por un lado, existe un grupo de investigadores que han estudiado diferentes procedimientos para enseñar directamente diferentes tipos de intraverbales. La enseñanza directa de intraverbales tiene como principal objetivo enseñar a niños con dificultades de aprendizaje a responder preguntas. Se han estudiado diferentes procedimientos que han mostrado resultados en la enseñanza directa de las intraverbales: (a) procedimientos basados en la mediación de compañeros (e.g., Bell, Young, Salzberg y West, 1991; Kamps, Barbetta, Leonard y Delquadri, 1994; Kamps, et al., 2002; Krantz, Ramsland y McIannahan, 1989), (b) procedimientos basados en la transferencia de control de estímulos a partir de ecoicas, tactos o conducta textual (e.g., Braam y Poling, 1993; Finkel y Williams, 2001; Luciano, 1986; Miguel, Petursdottir y Carr, 2005; Partington y Baley, 1993; Sundberg y Sundberg, 1990; Vignes, 2007; Watkins, et al., 1989), (c) procedimientos basados en el video-modelado (e.g., Ayres y Langone, 2005; Sherer, et al., 2001) y (d) otro tipo de procedimientos (e.g., Greer, Yuan y Gautreaux, 2005; Kisamore, Carr y LeBlanc, 2011; Sautter, LeBlanc, Jay, Goldsmith y Carr, 2011).

Existe una segunda vía de investigación en intraverbales más reciente. El objetivo de este grupo de investigadores se centra en el análisis de las variables que pueden influir y facilitar la emergencia de repertorio intraverbal. Dentro de este grupo se diferencian dos vías principales de investigaciones: (a) la investigación de la emergencia de intraverbales basadas en relaciones de categorización (e.g., Braam y Polin, 1983; Chase, Johnson y Sulzer-Azaroff, 1985; Partington y Baley, 1993; Petursdottir, Carr, Lechago y Almason, 2008; Sundberg y Sundberg, 1990; Vignes, 2007; Watkins, et al., 1989) y (b) la investigación de emergencia de intraverbales basadas en relaciones de equivalencia de estímulos (Carp y Petursdottir, 2012; May, Hawkins y Dymond, 2012; Pérez-González, García-Asenjo, Williams y Carnerero, 2007; Pérez-González, Herszlikowitz y Williams, 2008; Pérez-González, Salameh y García-Asenjo, 2014; Petursdottir y Hafliðadóttir, 2009; Petursdottir, Ólafsdóttir y Aradóttir, 2008; Polson y Parsons, 2000).

### **1.5.1. Estudios de emergencia de intraverbales basadas en relaciones de categorización**

La investigación sobre la emergencia de intraverbales basadas en relaciones de categorización tiene como objetivo identificar procedimientos eficaces tanto para enseñar a responder ejemplares de una categoría de forma directa como para producir la emergencia de nuevas respuestas intraverbales de categorización no enseñadas directamente (Braam y Poling, 1983; Miguel, Petursdottir, Carr y Michael, 2008; Chase, Johnson y Sulzer-Azaroff, 1985; Partington y Bailey, 1993; Petursdottir, Carr, Lechago y Almason, 2008; Sundberg y Sundberg, 1990; Vignes, 2007; Watkins et al., 1989). Es decir, el objetivo se centra en identificar las variables que hacen que después de enseñar a un niño a responder “gato”, “perro” y “vaca” ante “Dime un animal”, el niño sea capaz de responder; por ejemplo, “oveja” o “conejo” ante la misma instrucción sin que se le haya enseñado directamente.

Watkins et al. (1989) enseñaron a niños con dificultades de aprendizaje intraverbales simples de adjetivos utilizando un procedimiento de transferencia de control del tacto a la intraverbal (color, tamaño y textura). Después enseñaban intraverbales simples cuyas respuestas eran diferentes ejemplares de animales, juguetes, ropa, muebles y ropa del hogar (e.g.; “Dime algunos animales”). Además, enseñaron a los niños a responder intraverbales con respuestas múltiples; por ejemplo, ante la instrucción verbal, “Dime un caballo” el niño debía responder “caballo grande/marrón/suave”. Los resultados de este trabajo mostraron la efectividad del uso de procedimientos de transferencia de control del tacto a la intraverbal para enseñar directamente tanto intraverbales simples como intraverbales con repuestas múltiples, pero ninguno de los participantes mostró la emergencia de nuevas intraverbales de categorización. Por otro lado, este trabajo mostró que después de aprender intraverbales con respuestas múltiples los niños no respondían correctamente ante las pruebas de tectos múltiples (e.g., los niños podían responder “caballo marrón” ante, “Dime un caballo”, pero cuando se les mostraba la imagen del caballo marrón no respondían “caballo marrón”).

Partington y Baley (1993) estudiaron el efecto de enseñar a niños de preescolar de desarrollo típico a nombrar ejemplares de una misma categoría (e.g., “Dime algunos juguetes”). Para enseñarlo utilizaron un procedimiento de transferencia de control del tacto a la intraverbal. Este estudio mostró la eficacia de los procedimientos de enseñanza directa de intraverbales basados en la transferencia de control de estímulos

pero los niños no mostraron la emergencia de nuevas respuestas intraverbales. En su Experimento 2, Partington y Baley enseñaron a los niños a tactar tanto el nombre del objeto que se les presentaba como la categoría a la que pertenecían. Por ejemplo, ante la imagen de un plátano los niños debían responder “un plátano y una fruta”. Este procedimiento tampoco influyó en la producción de la emergencia de nuevas intraverbales de categorización.

Miguel, Petursdottir y Carr (2008) realizaron una réplica del estudio de Partington y Baley (1993) y mostraron los mismos resultados. Además, evaluaron la influencia de la enseñanza de repertorio de escucha en la emergencia de nuevas intraverbales de categorización. Enseñaron a los niños a seleccionar los estímulos cuando se les pedía el ejemplar y la categoría. La enseñanza de repertorios de escucha no mostró un incremento en la emergencia de las nuevas intraverbales de categorización. Petursdottir, Carr, Lechago y Almason (2008) estudiaron el efecto de la enseñanza de repertorio de escucha, igualdad a la muestra, tactos e intraverbales simétricas en la emergencia de intraverbales de categorización. Este estudio mostró, una vez más, que la enseñanza de repertorios de escucha no dan lugar a la emergencia de intraverbales.

En resumen, los estudios que han analizado el efecto de la enseñanza de repertorios de escucha, tactos, intraverbales con respuestas múltiples y respuestas de igualdad arbitraria en la emergencia de nuevas intraverbales de categorización no han mostrado la emergencia de las intraverbales de categorización en niños con dificultades de aprendizaje ni en niños de desarrollo típico de preescolar.

### **1.5.2. Estudios de emergencia de intraverbales basadas en relaciones de equivalencia de estímulos**

La principal característica de la equivalencia de estímulos es la emergencia de nuevas relaciones de control discriminativo. La equivalencia de estímulos se define a través de sus propiedades (Sidman, 1994): (a) la reflexividad, (b) la simetría, (c) la transitividad y (d) la equivalencia. Por ejemplo, para producir una equivalencia de estímulos es necesario enseñar la relación entre dos estímulos A y dos estímulos B (donde A1 va con B1 y A2 va con B2), después es necesario enseñar la relación entre dos estímulos B y dos estímulos C (donde B1 va con C1 y B2 va con C2). La equivalencia de estímulos se produce cuando después de este aprendizaje, la persona es capaz de mostrar las propiedades de: (a) reflexividad (responder A1 ante A2 y B1 ante

B2), (b) simetría (responder, por ejemplo, A1 ante B1 y B1 ante C1), (c) transferencia (responder, por ejemplo, C1 ante A1) y (d) equivalencia (responder, por ejemplo, A1 ante C1).

Los estudios sobre equivalencia de estímulos se han centrado en el análisis de las respuestas basadas en selección frente a las respuestas basadas en topografía (Polson y Parsons, 2000). Hall y Chase (1991) sostienen que las respuestas basadas en la selección son predominantes en los estudios sobre equivalencia de estímulos (e.g., Kelly, Green y Sidman, 1998; Saunders y Spradlin, 1993), mientras que las respuestas basadas en topografía predominan dentro de los estudios sobre conducta verbal. Los estudios sobre discriminaciones condicionales y equivalencia de estímulos y los estudios sobre conducta verbal no se han influido mutuamente. Debido a que la equivalencia de estímulos y las discriminaciones condicionales forman la base a partir de la cual se desarrollan una gran parte de operantes verbales complejas, es muy importante realizar investigaciones que ayuden a unir los hallazgos aportados por ambas ramas para enriquecerse mutuamente. Una de las vías de investigación que se abre a partir de esta premisa es la emergencia de intraverbales basadas en relaciones de equivalencia (Carp y Petursdottir, 2012; May, Hawkins y Dymond, 2012; Pérez-González, García-Asenjo, Williams y Carnerero, 2007; Pérez-González, Herszlikowicz y Williams, 2008; Pérez-González, Salameh y García-Asenjo, 2014; Petursdottir, Ólafsdóttir y Aradottir, 2008; Polson y Parsons, 2000). Por ejemplo, cuando aprendemos a responder “Madrid”, ante “Dime la capital de España” (Relación AB) y “el Prado”, ante “Dime un museo de Madrid” (Relación BC), la mayor parte de los adultos son capaces de responder “España”, ante “Dime el país de Madrid” (Relación BA de simetría), “Madrid”, ante “Dime la ciudad del Prado” (Relación CB de simetría), “el Prado”, ante “Dime un museo de España” (Relación AC de transitividad) y “España”, ante “Dime el país del Prado” (Relación CA de equivalencia). La emergencia de todas estas intraverbales complejas se produce dentro de una relación de equivalencia de estímulos. Aunque la mayor parte de los adultos muestran este tipo de emergencias, parece que los niños de desarrollo típico y las personas con dificultades de aprendizaje tienen dificultades para producirlas. El objetivo de las investigaciones sobre la emergencia de intraverbales basadas en relaciones de equivalencia de estímulos es analizar los procedimientos que facilitan la emergencia de las relaciones de simetría, transitividad y/o equivalencia en las relaciones intraverbales.

Pérez-González et al. (2008) enseñaron, a niños de desarrollo típico de entre 5 y

6 años, las intraverbales A-B; por ejemplo, “Dime la ciudad de Argentina”-“Buenos Aires” (donde A1 es “Argentina” y B1 es “Buenos Aires”) y las intraverbales B-C; por ejemplo, “Dime el parque de Buenos Aires”-“El Botánico” (donde B1 es “Buenos Aires” y C1 es “El Botánico”). En el Experimento 1 enseñaron las relaciones A-B y B-C y después probaron la emergencia de las relaciones B-A (e.g., “Dime el país de Buenos Aires”-“Argentina”, C-B (e.g., “Dime la ciudad del Botánico”-“Buenos Aires”), AC (e.g., “Dime el parque de Argentina”-“El Botánico”) y C-A (e.g., “Dime el país del Botánico”-“Argentina”). La mayoría de los niños no mostraron la emergencia de las intraverbales; la simetría B-A y la equivalencia C-A solo la mostró uno de los cinco participantes. En el Experimento 2, Pérez-González et al. (2008) estudiaron el efecto de enseñar intraverbales simples en la emergencia de las relaciones B-A, C-B, A-C y C-A. Por un lado, enseñaron a los niños a responder ante “Dime un país/una ciudad/un parque” (Ejemplares) y ante “¿Qué es Argentina/Buenos Aires/El Botánico?” (Categorías). Este estudio mostró que enseñar las intraverbales simples (tanto los Ejemplares como las Categorías), facilita la emergencia de las intraverbales complejas en niños de desarrollo típico de 5 a 6 años. Carp y Petursdóttir (2012) replicaron el estudio de Pérez-González et al. (2008) con niños de entre 6 y 7 años. Tres de los nueve participantes mostraron la emergencia de las intraverbales complejas antes de la enseñanza de los Ejemplares y las Categorías. Cuatro niños mostraron la emergencia después de la enseñanza de los Ejemplares y las Categorías y dos niños no mostraron la emergencia de las intraverbales complejas.

Otro grupo de investigaciones se han centrado exclusivamente en el análisis de variables que influyen en la emergencia de intraverbales simétricas, intraverbales basadas en relaciones de simetría (May, Hawkins y Dymond, 2012; Pérez-González, García-Asenjo, Williams y Carnerero, 2007; Pérez-González, Salameh y García-Asenjo, 2014; Petursdóttir y Haflidadóttir, 2009; Petursdóttir, Ólafsdóttir y Aradóttir, 2008). Pérez-González et al. (2007) enseñaron a niños con dificultades de aprendizaje a responder intraverbales del tipo, “Dime el opuesto de” para después probar la emergencia de las intraverbales simétricas. Por ejemplo, enseñaban a los niños a responder “frío” ante, “Dime el opuesto de caliente”. Después probaban la emergencia de la intraverbal simétrica, “Dime el opuesto de frío”. Ningún participante mostró la emergencia de intraverbales simétricas hasta que se les enseñó directamente a responder la intraverbal simétrica con algunos sets de estímulos.

Petursdottir et al. (2008) analizaron el efecto de la enseñanza de repertorio de escucha y tactos en la emergencia de intraverbales simétricas. Los participantes eran niños de 4 y 5 años de habla islandesa. Las intraverbales probadas eran del tipo, “¿Qué significa –palabra en español?” y, “¿Cómo se dice (nombre islandés) en español?” Este estudio mostró que la enseñanza de tactos tiene más influencia en la emergencia de intraverbales que la enseñanza de repertorio de escucha. Aún así, la emergencia de las nuevas intraverbales no se produjo de una forma consistente en todos los participantes ni en todos los grupos de estímulos estudiados. Petursdottir y Haflidadóttir (2009) enseñaron a dos niñas de 5 años de habla islandesa repertorio de escucha con palabras en italiano, tactos en italiano, la intraverbal nativo-extranjero (e.g., ¿Qué es-palabra en islandés-en italiano?) o la intraverbal extranjero-nativo (e.g., “¿Qué significa-palabra en italiano?”). Después probaban la emergencia de todas las demás relaciones. La enseñanza de repertorio de escucha no produjo la emergencia de ninguna de las relaciones intraverbales en ninguna de las participantes. La enseñanza de tactos produjo la emergencia de la intraverbal nativo-extranjero en una de las dos participantes, pero no produce la emergencia de la intraverbal extranjero-nativo en ninguna de las participantes. La enseñanza de la intraverbal extranjero-nativo no produjo la emergencia de la intraverbal simétrica nativo-extranjero en ninguna participante. La enseñanza de la intraverbal nativo-extranjero produjo la emergencia de la intraverbal simétrica extranjero-nativo en una de las dos participantes. Con estos resultados queda claro que la emergencia de intraverbales simétricas no se produce de una forma inmediata en niños de desarrollo típico, lo que supone que es necesario utilizar procedimientos específicos que faciliten la emergencia de este tipo de relaciones. Con los estudios analizados parece claro que los repertorios de escucha no influyen en la producción de la emergencia de nuevas intraverbales. Por otro lado, parece que la enseñanza de tactos tiene mayor influencia en la emergencia de este tipo de relaciones en algunos niños.

### **1.6. Hipótesis de partida de la tesis**

Los estudios previos sobre la emergencia de intraverbales han permitido identificar variables que facilitan o no facilitan la emergencia de intraverbales. Sin embargo, en el momento en el que inicié mi tesis, quedaban muchas cuestiones pendientes en relación a qué tipo de enseñanzas eran necesarias para producir de una forma sistemática la emergencia de intraverbales. Las hipótesis de partida de mi tesis fueron las siguientes:

- 1) Supongo que la emergencia de intraverbales es un proceso que se desarrolla a partir del aprendizaje de habilidades previas y, que la falta de esta habilidad no viene determinada por la edad o por cuestiones vinculadas a problemas del desarrollo. Por lo tanto, conocer qué habilidades es necesario enseñar para producir la emergencia de los diferentes tipos de intraverbales, nos permitirá conocer qué hacer cuando esta habilidad no está presente.
- 2) Existen diferentes tipos de intraverbales, por lo que entiendo que para producir la emergencia de cada tipo de intraverbal es necesario enseñar diferentes habilidades en cada caso.
- 3) Dado que en la emergencia de intraverbales complejas es necesario que la persona responda a la combinación de al menos dos estímulos, considero que enseñar a responder operantes con dos estímulos antecedentes, al menos, es necesario para producir la emergencia de este tipo de intraverbales.

Los supuestos de partida de la tesis nos permitirán identificar qué tipo de aprendizajes de operantes facilitan ciertos tipos de emergencias de intraverbales. Este conocimiento permitirá producir la emergencia de intraverbales cuando no esté presente en el repertorio a través del aprendizaje de las operantes identificadas como facilitadoras de la emergencia.

### **1.7. Impacto social de la investigación sobre intraverbales**

En el momento en el que se iniciaron los estudios de esta tesis no existía ningún estudio en el que se investigara de forma directa qué tipo de variables influyen en la emergencia de intraverbales. La emergencia de intraverbales es una habilidad de lenguaje complejo que no está presente en el repertorio de los niños a edades tempranas (e.g., Pérez-González, Herszlikowicz y Williams, 2008; Pérez-González, Salameh y García-Asenjo, 2014; Petursdottir, Ólafsdóttir y Aradottir, 2008) y que no se desarrolla en la mayoría de los niños con graves dificultades de aprendizaje, como el autismo (e.g., Briton y Fijiki, 1994; Charlop, 1986; Prizant y Duchan, 1981; Schreibman, 1998). Los niños con dificultades de aprendizaje son capaces de aprender a responder a intraverbales sencillas cuando se les enseña de una forma directa, pero no son capaces de generar nuevo repertorio verbal complejo y esto parece tener una relación directa con la emergencia de intraverbales. Como consecuencia, los aprendizajes de estos niños se vuelven mecánicos, en el sentido de que solo aprenden cuando se les enseña de una

forma implícita, y esto hace que el desarrollo de su lenguaje sea mucho más lento y menos funcional.

Identificar qué variables pueden facilitar la emergencia de intraverbales implica identificar las variables que hacen que un niño genere de forma espontánea nuevo lenguaje complejo. Esta habilidad permitirá al niño adquirir un repertorio verbal a un ritmo mucho más elevado, influirá en su capacidad para iniciar y mantener interacciones sociales y facilitará el aprendizaje de conocimientos académicos complejos tanto en niños con dificultades de aprendizaje como en niños de desarrollo típico. La adquisición de esta habilidad en los niños con dificultades de aprendizaje establece la base para producir un cambio radical en su vida dirigido a la completa integración social.

## **2. Objetivos**

### **2.1. Objetivos Generales**

**Primero**, se pretende comprobar si se produce la emergencia de intraverbales basadas en relaciones de equivalencia de estímulos a partir de la enseñanza de otras intraverbales simples.

**Segundo**, se pretende comprobar si se produce la emergencia de intraverbales basadas en la relación de simetría a partir de la enseñanza de tectos basados en discriminaciones condicionales, y la enseñanza de tectos y otras intraverbales.

**Tercero**, se pretende comprobar si se produce la emergencia de intraverbales basadas en relación de simetría a partir de la enseñanza de tectos y otras intraverbales y las diferencias entre ambas enseñanzas.

### **2.2. Objetivos Específicos de los Artículos Publicados**

Los objetivos específicos de los experimentos que se describen en los cuatro artículos que forman la tesis se exponen a continuación.

**Primer Artículo:** *Emergence of Complex Intraverbals Determined by Simpler Intraverbals* [Emergencia de Intraverbales Complejas Determinada por Intraverbales Simples]: El primer objetivo de esta investigación fue analizar cómo los adultos muestran la emergencia de intraverbales basadas en relaciones de equivalencia después de enseñar las intraverbales A-B y B-C. El segundo objetivo de esta investigación fue analizar el efecto de la enseñanza de los Ejemplares o las Categorías, por separado, en

los adultos que no muestran la emergencia de las intraverbales tras la enseñanza de las intraverbales A-B y B-C.

**Segundo Artículo:** *Exemplars and Categories Necessary for the Emergence of Intraverbals About Transitive Reasoning in Typically Developing Children* [La Necesidad de los Ejemplares y Categorías para la Emergencia de Intraverbales Relacionadas con el Razonamiento Transitivo en Niños de Desarrollo Típico]: El objetivo de esta investigación fue analizar la necesidad de la enseñanza de las Categorías, después de la enseñanza de las intraverbales A-B, B-C y los Ejemplares, en la emergencia de intraverbales basadas en relaciones de equivalencia en niños de desarrollo típico.

**Tercer Artículo:** *Effect of Learning Tacts or Tacts and Intraverbals on the Emergence of Intraverbals about Verbal Categorization* [El Efecto de la Enseñanza de Tactos y Tactos e Intraverbales en la Emergencia de Intraverbales relacionadas con la Categorización Verbal]: El objetivo principal de este experimento fue analizar el efecto de la enseñanza de tactos complejos, basados en discriminaciones condicionales, en la emergencia de intraverbales simétricas. Un segundo objetivo fue comparar los resultados de la enseñanza de tactos complejos con la enseñanza de tactos y una intraverbal en la emergencia de intraverbal simétrica a esa intraverbal.

**Cuarto Artículo:** *Emergence of Symmetrical Intraverbals Facilitated by Learning Skills with the Intraverbal Responses* [Emergencia de Intraverbales Facilitada por el Aprendizaje de Habilidades con las Respuestas de las Intraverbales]: El primer objetivo de esta investigación fue analizar el efecto de la enseñanza de tactos cuya respuesta era la misma que la respuesta de las intraverbales que esperaba que emergieran en la emergencia de intraverbales simétricas. El segundo objetivo fue analizar el efecto de enseñar nuevas intraverbales cuya respuesta era la misma que la respuesta de las intraverbales que esperaba que emergieran en la emergencia de intraverbales simétricas. Otro objetivo de este trabajo fue comparar la dificultad de la

emergencia de las intraverbales simétricas cuando se enseñaban en una dirección o en su dirección opuesta.

## 3. Artículos publicados

### 3.1. Primer Artículo

Psychol Rec (2014) 64:509–526  
DOI 10.1007/s40732-014-0047-6



ORIGINAL ARTICLE

## Emergence of Complex Intraverbals Determined by Simpler Intraverbals

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**Abstract** This research explored some factors involved in the emergence of intraverbals as demonstrated by Pérez-González, Herszlikowicz, and Williams (2008) in three experiments. Eleven adults learned to say the chemical elements corresponding to two chemical groups (the A-B relations) and to say the atomic numbers of two elements (the B-C relations). Thereafter, we probed the relations that result from combining these stimuli. For example, we asked the groups corresponding to the atomic numbers (the C-A relations). In Experiment 1, we taught A-B and B-C and probed the remaining relations without additional teaching. In Experiment 2, *with Categories*, participants learned to say the categories of the exemplars (i.e., “What is polonium?” –the correct answer was “an element”). In Experiment 3, *with Exemplars*, participants learned to say the exemplars of the categories (i.e., “Name a chemical element”); the correct answers were the two chemical elements). The *Categories* facilitated emergence in some but not all participants. The *Exemplars* was shown to be effective in promoting the emergence of the emergent relations. These results indicate that the simpler intraverbals (*Categories* and *Exemplars*) play a role in the emergence of the more complex intraverbals.

**Keywords** Intraverbals · Verbal behavior · Stimulus equivalence · Stimulus relations · Reasoning · Answering questions · Adults

Intraverbals are verbal operants characterized by the emission of a verbal response after the presentation of a verbal stimulus that shows no point-to-point correspondence with the response

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(Skinner 1957). Intraverbals are ubiquitous in everyday life, especially in the context of social interactions such as conversations, songs, stories, plays, etc., and in most academic skills (e.g., saying the alphabet, counting or answering utterances like, “What is your name,” “Name the opposite of dark”). In addition, more sophisticated verbal skills, like answering questions about what one did on the weekend, or telling what utensils are used for making soup, also involve intraverbals.

Intraverbals can be taught via transfer-of-stimulus-control procedures in which echoic, tact, or textual prompts are presented (e.g., Axe 2008; Braam and Poling 1983; Finkel and Williams 2001; Ingvarsson et al. 2007, 2012; Ingvarsson and Hollobaugh 2010; Luciano 1986; Miguel et al. 2005; Partington and Bailey 1993; Sundberg et al. 1990; Sundberg and Sundberg 1990; Vedora et al. 2009; Vignes 2007; Watkins et al. 1989 –see reviews by Axe 2008 and Cihon 2007) or brought about with other teaching strategies (e.g., Greer et al. 2005; Kisamore et al. 2011; Sautter et al. 2011). Moreover, the functional independence of intraverbals and other verbal operants such as tacts have been demonstrated (Goldsmith et al. 2007; Kelley et al. 2007; Lerman et al. 2005; Miguel et al. 2005); these studies were conducted after the seminal paper by Lamarre and Holland (1985) in which these authors demonstrated the functional independence of mands and tacts.

The emergence of novel intraverbals by transfer of stimulus control from stimuli of non-intraverbal operants (i.e., echoics, tacts, etc.) has been widely demonstrated in studies that have often been analyzed in terms of categorization skills (e.g., Braam and Poling 1983; Chase et al. 1985; Luciano 1986; Partington and Bailey 1993; Pérez-González and Belloso-Díaz 2005; Pérez-González et al. 2006; Petursdottir et al. 2008a; Sundberg and Sundberg 1990; and Watkins et al. 1989). The teaching of tact and listener repertoires has also led to the emergence of novel intraverbals (Pérez-González and Belloso-Díaz 2005; Pérez-González et al. 2006; Petursdottir et al. 2008a, b;

Petursdottir and Hafliadóttir 2009). Transfer among intraverbals has been also demonstrated (e.g., Pérez-González et al. 2007, 2013; Petursdottir et al. 2008a, b; Polson and Parsons 2000). Most of these studies demonstrated that the procedure of teaching and probing verbal operants with several exemplars results in the eventual emergence, without explicit teaching, of other untaught operants (e.g., Pérez-González et al. 2007).

Pérez-González et al. (2008) used a variation of the stimulus equivalence paradigm with intraverbals. The main purpose of their study was teaching and probing intraverbals with the ABC structure, typical of the stimulus equivalence paradigm, in which three stimulus sets are related and novel relations are probed; they used the linear series teaching structure (e.g., Saunders and Green 1999). Thus, they taught A-B and B-C and probed B-A (as in symmetry), C-B (as in symmetry), A-C (as in transitivity), and C-A (as in an equivalence probe). For teaching the A-B relations, they used intraverbals such as, “Name a city of Argentina” – “Buenos Aires” (where A1 is “Argentina” and B1 is “Buenos Aires”) and for teaching the B-C relations they used intraverbals such as, “Name a park of Buenos Aires” – “El Botánico” (where B1 is “Buenos Aires” and C1 is “El Botánico”). It is important to notice that an additional stimulus (besides one stimulus A and one stimulus B, for example) seems necessary in order to get the answer of the category required. If not, a stimulus would always evoke the same response; for example, the stimulus “Argentina” would always evoke “Buenos Aires” as response; thus, if “Argentina”- “Buenos Aires” is taught, then there is no way to probe other relations other than A-B, with A as the antecedent stimulus. By adding to the intraverbal the stimulus related to the category of the A stimulus, for example, teaching and probing additional relations is possible. Thus, for example, the researchers included “city” in A-B to prompt a response of the category of B (the stimulus was, “Name a city of Argentina”), and they included “park” in the A-C probe to prompt a response of the category of C (the stimulus was, “Name a park of Argentina”). The intrinsic complexity of these intraverbals could result in human performance quite different from that of the typical studies on stimulus equivalence with selection-based topographies. Such an outcome was found in the first experiment: most participants, five- and six-year-old children, did not show some of the probed intraverbals; i.e., symmetry B-A (“Name the country of Buenos Aires”) and equivalence C-A (“Name the country of El Botánico”) did not emerge in four of the five participants.

A second experiment by Pérez-González et al. (2008) studied the effect of learning simpler intraverbals on the emergence of the targeted intraverbals B-A, C-B, A-C, and C-A. Specifically, they taught simple intraverbals of the type, “Name a city” – “Buenos Aires,” which were denominated “Exemplar intraverbals,” and, “What is Buenos Aires” – “A city,” which were denominated “Category intraverbals,” before

probing B-A, C-B, A-C, and C-A. Notice that the simple intraverbals had a single stimulus (e.g., “city”) instead of two (“city of Argentina”), on one hand, and that the stimuli of the simple intraverbals are the same as in the ABC intraverbals. The experiment’s results demonstrated that teaching the simple intraverbals facilitated the emergence of the probed ABC intraverbals. In other terms, Pérez-González et al. (2008) data are congruent with the hypothesis that Exemplars and Categories facilitate the emergence of the probed ABC intraverbals. Carp and Petursdottir (2012) replicated Pérez-González et al.’s results with 6-year and 7-year-old children in that teaching *Exemplars* and *Categories* is necessary for most children for the probed ABC intraverbals to emerge. They also found that the order in which the *Exemplars* and *Categories* are taught does not affect the emergence.

In a related experiment, Pérez-González et al. (2013) analyzed whether *Exemplars* emerge after learning *Categories* and vice versa in six-year-old children. Some children that learned the *Exemplars* showed the emergence of the *Categories*. Other children did so after additional teaching. The children that learned the *Categories*, however, did not show the emergence of the *Exemplars*. Even after additional teaching, only one out of ten children showed the emergence of the *Exemplars*. Pérez-González et al.’s results suggest that the *Exemplars* are enough to form the stimulus classes corresponding to the *Exemplar-Category* partition, but *Categories* are not.

The ABC intraverbals used by Pérez-González et al. (2008) and Carp and Petursdottir (2012) are intraverbals in which responding is conditional to the presence of two discriminative stimuli simultaneously. They are conditional discriminations (i.e., in the intraverbal, “Name a city of Argentina” – “Buenos Aires,” when responding depends on the stimuli “city” and “Argentina”)—notice that across intraverbals, these stimuli “city” and “Argentina” change, e.g., to “park” and “Uruguay”). *Categories* and *Exemplars*, on the other side, are intraverbals in which responding is conditional to the presence of only one discriminative stimulus; they are simple discriminations (i.e., in the intraverbal, “Name a city” – “Buenos Aires,” responding depends on the stimulus “city”)—notice that “Name a...” is the same in all *Exemplars* and, therefore, does not affect responding within this context) (see a detailed analysis by Axe 2008). ABC intraverbals, *Categories*, and *Exemplars* are related to one another because they share stimuli. *Categories* and *Exemplars* are very likely easier to learn because they are simple discriminations. Moreover, *Categories* and/or *Exemplars* could facilitate the learning and emergence of ABC intraverbals. The present research deals with the relations among these two types of intraverbals and how the emergence of complex intraverbals (namely, the ABC intraverbals, which are conditional discriminations) are facilitated by previous learning of simpler

intraverbals with the same stimuli (namely, Categories and Exemplars, which are simple discriminations).

Pérez-González et al.'s (2008) study was conducted with children. It is unknown whether adults require *Exemplars* and *Categories* to demonstrate the emergence of the probed ABC intraverbals, as most children require. Moreover, this study did not answer the question of whether *Exemplars*, *Categories*, or both, facilitates the emergence of the target intraverbals, because both *Exemplars* and *Categories* were taught together instead of exploring the effect of just introducing one. Carp and Petursdottir (2012) introduced one (either Exemplars or Categories), and after just one probe of the ABC intraverbals they introduced the other one; hence, it is unknown what would have happened had the probes being repeated before introducing the other intraverbal. A primary interest for answering this question consists of knowing with more precision the type of intraverbals that an individual needs to acquire for the probed ABC intraverbals to emerge. Exemplars share with the ABC intraverbals the elements that function as stimuli and responses (e.g., “Name a park” and, “Name a park of Buenos Aires”) whereas Categories do not (e.g., the stimulus is, “What is El Botánico”); therefore, it may be that Exemplars may be enough for facilitating the emergence of the probed ABC intraverbals. For similar reasons, it may be that Categories do not facilitate the emergence of the probed ABC intraverbals. Moreover, because Categories easily emerge from Exemplars, but not the opposite, it is of theoretical and practical interest finding out the role that each intraverbal type plays in the emergence of the probed ABC intraverbals. It may be that, because Exemplars facilitate the emergence of their corresponding Categories, learning Exemplars can facilitate further emergence as if the learner had acquired both Exemplars and Categories. If Categories are learned instead, because Categories do not easily bring about the emergence of the Exemplars, learning Categories alone could not be enough, or could not have a strong influence, for the subsequent emergence of the probed ABC intraverbals. The present study was designed to answer these questions. The first goal of the present research was to find out whether adults show the emergence of the probed ABC intraverbals after learning the A-B and B-C intraverbals, without being taught *Categories* or *Exemplars*. The second goal of the present research was to find out whether adults who did not show the emergence of the probed ABC intraverbals would show it after learning either *Categories* or *Exemplars*, but not both. For that purpose, three studies were conducted. In Experiment 1 we explored the emergence of the probed ABC intraverbals without teaching Categories or Exemplars. In Experiment 2, we explored the effect of teaching the Categories on the emergence of the probed ABC intraverbals. In Experiment 3, we

explored the effect of teaching the Exemplars on that emergence.

## General Procedure

### Participants

Eleven Spanish-speaking adults (six females and five males) participated. Two participants were liberal arts students and the rest of them had different professions, from plumber to lawyer. Three other participants of similar characteristics were discarded because they responded correctly to more than one question in the pretest phase of the experiment (see below).

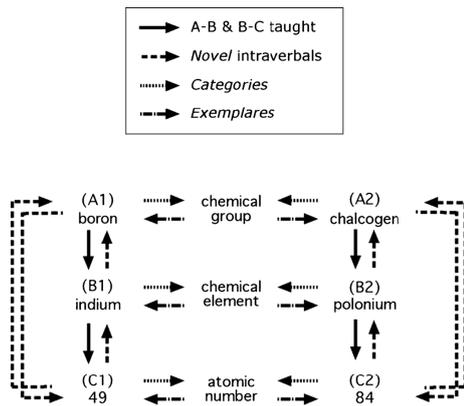
### Stimuli and Definition of Correct Responses

All of the study was conducted in Spanish. We designed four intraverbals in Spanish for teaching<sup>1</sup> (see an overview of the relations in Fig. 1; see, “Taught A-B Chemical group-Chemical element” and, “Taught B-C Chemical element-Atomic Number” in Table 1). For example, in the A-B intraverbal, the antecedent stimuli were, “Name the boron[-group] element” and the correct response was “indium”; in the B-C intraverbal, the antecedent stimuli were “Name the atomic number of the indium” and the correct response was “49.” The other two A-B and B-C intraverbals were analogous, referred to the chalcogen group, polonium, and the atomic number 84. For clarity purposes, we denominated the four A-B and B-C intraverbals as the *taught* intraverbals.

We also designed another eight intraverbals, which resulted from combining some of the stimuli of the four intraverbals taught (the resulting intraverbals are the *probed* intraverbals indicated in Table 1). This resulted in the B-A Chemical element-Chemical group, the C-B Atomic number-Chemical element, the A-C Chemical group-Atomic number, and the C-A Atomic number-Chemical group intraverbals. For example, in the B-A Chemical element-Chemical group probe, the antecedent stimuli were “Name the chemical group of the indium” and the correct response was “boron[-group].” We denominated these eight intraverbals as the *probed* intraverbals or the *novel* intraverbals.

Taking together the four taught and the eight *probed* intraverbals, we formed all the intraverbals that result from combining the six stimuli (boron[-group], chalcogen, indium, polonium, 49, and 84) as stimuli and responses. We denominated these intraverbals as the *ABC intraverbals*. In addition to the ABC intraverbals, we designed two other types

<sup>1</sup> Because the study was conducted in Spanish, all the intraverbals had a similar structure; also, we used only one word to refer to the chemical group, as shown in Tables 1 and 2.



**Fig. 1** Overview of the relations taught and probed. Each arrow indicates an intraverbal, which points from one stimulus of the intraverbal to the defined correct response

of intraverbals, which were denominated *Categories* and *Exemplars*.

**Categories** The *Categories* were six intraverbals in which the antecedent stimuli was the expression, “What is the...” followed by one of the following terms: “boron[-group]”, “indium”, “49”, “chalcogen”, “polonium”, or “84”. The responses to such utterances defined as correct were, “A chemical group,” “A chemical Element,” or “An atomic number” (see top of Table 2 for details). For example, when asked, “What is chalcogen?” the correct response was “A chemical group.” These intraverbals were labeled as *Categories* because their correct response consisted of saying the name of a category.

**Exemplars** The *Exemplars* were six intraverbals in which the antecedent stimuli were the terms of the expression, “Name a/an...” followed by one of the following terms: “chemical group”, “chemical element”, or “atomic number.” The responses to such utterances defined as correct were the two exemplars of these categories used in the A-B and B-C operants (see bottom of Table 2). More specifically, when asked, for example, “Name a chemical group” both “boron[-group]” and “chalcogen” were correct responses. On the subsequent trial, however, the question asked was slightly modified (i.e., “Name another chemical group”) and in this case only the response not given in the previous trial was considered correct (e.g., if a participant answered “boron[-group]” in the first trial, the correct response in the subsequent trial was “chalcogen”). These intraverbals were labeled as *Exemplars* because their correct answer consisted of saying the exemplar of a category.

#### Setting, Instructions, Stimulus Presentation, and Consequences

The research was conducted in a quiet room located in the School of Psychology of the University of Oviedo or in the house of one of the authors. In both cases, the rooms were equipped with (at least) one table and several chairs, were comfortable and silent, and it was guaranteed that nobody could interrupt the session.

During the experimental sessions, the experimenter—either of the authors—sat in front of the participant. At the start of the first session, the experimenter told the participant: “I am going to ask you some questions. Sometimes I will let you know whether your answers are correct, but other times I will not tell you anything. Try to do the best you can do, because I will record all your answers.” Later on, the experimenter read each question aloud to the participant, waited for 5 s for his/her response, presented the appropriate consequences, wrote down the response and moved on to the next trial.

For each trial, only the first word said by the participant after the question read to him/her by the experimenter was considered as his/her response for that trial. If the participant said the first syllable of an incorrect answer, then the response was considered incorrect. The absence of any answer to the question presented by the experimenter within 5 s was also considered as an incorrect response. During the teaching phases, correct responses were followed by expressions such as “Very good”, “Excellent”, or “Well done”; while incorrect responses, were followed by “No, [the correct response]” or just by the correct response (for example –“Name a chemical element of the Boron[-group]” –“84” was followed by “No, indium” or “Indium”). The expressions for correct responses proved to function as reinforcers in the context of this research; also, the consequences for incorrect responses decreased incorrect responding. During the probes, no consequences were provided. Sessions lasted the time that was necessary to complete a probe-teaching-probe cycle—about 20 minutes.

#### Initial Probes

**Probes of the ABC intraverbals** In the pretest, the probe of the ABC intraverbals consisted of presenting the antecedent stimuli of the 12 intraverbals of Table 1 in random order. Thereafter, when the probe was presented to evaluate the effect of teaching the A-B and B-C intraverbals on the emergence of the rest of the ABC intraverbals, it consisted of presenting the 12 intraverbals of Table 1 twice, also in random order.

**Probe of the Categories** This probe consisted of presenting the antecedent stimuli of the six intraverbals shown on top of

**Table 1** Stimuli and response components of the intraverbals taught and probed. The notation within brackets was not spoken. The English translation appears in italics below each intraverbal type

Antecedent stimuli		Correct response	
<i>Taught A-B Chemical group-Chemical element</i>			
Dime	el elemento	[A1] térreo	[B1] (Indio)
Dime	el elemento	[A2] anfigeno	[B2] (Polonio)
Name	<i>the chemical element of the</i>	[A1] boron[-group]	[B1] (Indium)
Name	<i>the chemical element of the</i>	[A2] chalcogen	[B2] (Polonium)
<i>Taught B-C Chemical element-Atomic number</i>			
Dime	el número atómico del	[B1] Indio	[C1] (El 49)
Dime	el número atómico del	[B2] Polonio	[C2] (El 84)
Name	<i>the atomic number of the</i>	[B1] indium	[C1] (49)
Name	<i>the atomic number of the</i>	[B2] polonium	[C2] (84)
<i>Probed B-A Chemical element- Chemical group</i>			
Dime	el grupo químico del	[B1] Indio	[A1] (Térreo)
Dime	el grupo químico del	[B2] Polonio	[A2] (Anfigeno)
Name	<i>the chemical group of</i>	[B1] indium	[A1] (Boron[-group])
Name	<i>the chemical group of</i>	[B2] Polonium	[A2] (Chalcogen)
<i>Probed C-B Atomic number-Chemical element</i>			
Dime	el elemento químico del	[C1] 49	[B1] (Indio)
Dime	el elemento químico del	[C2] 84	[B2] (Polonio)
Name	<i>the chemical element of</i>	[C1] the 49	[B1] (Indium)
Name	<i>the chemical element of</i>	[C2] the 84	[B2] (Polonium)
<i>Probed A-C Chemical group-Atomic number</i>			
Dime	el número atómico del	[A1] térreo	[C1] (El 49)
Dime	el número atómico del	[A2] anfigeno	[C2] (El 84)
Name	<i>the atomic number of</i>	[A1] Boron[-group]	[C1] (49)
Name	<i>the atomic number of</i>	[A2] chalcogen	[C2] (84)
<i>Probed C-A Atomic number- Chemical group</i>			
Dime	el grupo químico de	[C1] el 49	[A1] (Térreo)
Dime	el grupo químico de	[C2] el 84	[A2] (Anfigeno)
Name	<i>the chemical group of</i>	[C1] the 49	[A1] (Boron[-group])
Name	<i>the chemical group of</i>	[C2] the 84	[A2] (Chalcogen)

Table 2, in random order. Each intraverbal was presented twice, making up a 12-trial probe.

*Probe of the Exemplars* This probe consisted of presenting the antecedent stimuli of the six intraverbals shown on bottom of Table 2, in random order. Each intraverbal was presented twice, making up a 12-trial probe.

Teaching the A-B and B-C Intraverbals

*Teaching A-B Chemical group-Chemical element* We taught the A-B intraverbals in 3 phases. In Phase 1, the question was, “Name the chemical element of the boron[-group]” [A1]. The experimenter provided the correct response (indium [B1]) in the first two trials (a prompt). After three consecutive correct responses with no prompts, the experimenter moved to Phase 2. Phase 2 was identical to Phase 1, but the question was, “Name the chemical element of a chalcogen” [A2] and the

correct response was polonium [B2]. In Phase 3, the two questions of Phases 1 and 2 were intermixed randomly, with the restriction that two trials of each question appeared every four trials. The experimenter did not provide prompts in any trial. After 12 correct consecutive responses, the experimenter moved to the next phase.

*Teaching B-C Chemical element-Atomic number* We taught the B-C intraverbals in 3 phases, exactly as the A-B intraverbals. The questions were, “Name the atomic number of indium” [B1] (“49” [C1] was the correct response), and, “Name the atomic number of polonium” [B2] (“84” [C2] was the correct response).

*Teaching A-B Chemical group-Chemical element and B-C Chemical element-Atomic number mixed* Finally, the experimenter presented the four Chemical group-Chemical element and Chemical element-Atomic number questions randomly intermixed, with the restriction that the four questions

**Table 2** Stimuli and response components of the Categories and the Exemplars. The English translation appears in italics below each intraverbal type

Antecedent stimuli	Correct response
<i>Categories</i>	
¿Qué es térreo?	(Un grupo químico)
¿Qué es anfigeno?	(Un grupo químico)
¿Qué es Polonio?	(Un elemento)
¿Qué es Indio?	(Un elemento)
¿Qué es 49?	(Un número atómico)
¿Qué es 84?	(Un número atómico)
<i>What is the boron[-group]?</i>	<i>(A chemical group)</i>
<i>What is the chalcogen[?]</i>	<i>(A chemical group)</i>
<i>What is polonium?</i>	<i>(A chemical element)</i>
<i>What is indium?</i>	<i>(A chemical element)</i>
<i>What is 49?</i>	<i>(An atomic number)</i>
<i>What is 84?</i>	<i>(An atomic number)</i>
<i>Exemplars</i>	
Dime un grupo químico	(Térreo)
Dime un grupo químico	(Anfigeno)
Dime un elemento químico	(Polonio)
Dime un elemento químico	(Indio)
Dime un número atómico	(El 49)
Dime un número atómico	(El 84)
<i>Name a chemical group</i>	<i>(The boron[-group])</i>
<i>Name a chemical group</i>	<i>(Chalcogen)</i>
<i>Name a chemical element</i>	<i>(Indium)</i>
<i>Name a chemical element</i>	<i>(Polonium)</i>
<i>Name an atomic number</i>	<i>(49)</i>
<i>Name an atomic number</i>	<i>(84)</i>

appeared every four trials. This phase ended after 12 consecutive correct responses. From the second cycle of teaching and probing onwards, the teaching of the A-B and B-C intraverbals consisted only of this phase.

#### Teaching Categories and Exemplars

**Teaching Categories** We taught the Categories in 11 phases. In Phase 1, the antecedent stimuli were, “What is a boron[-group]?”, and the correct response was, “A chemical group.” The experimenter provided the correct response in the first two trials. After three consecutive correct responses with no prompts, the experimenter moved on to Phase 2. Phase 2 was identical to Phase 1, but the antecedent stimuli were, “What is polonium” and the correct response was, “A chemical element.” In Phase 3, the two questions of Phases 1 and 2 were intermixed randomly, with the restriction that two questions of each type appeared every four trials. The experimenter did not provide prompts in any trial. After 12 correct consecutive

responses, the experimenter moved on to the next phase. Phases 4, 5, and 6 were identical to Phases 1 to 3, except for that the stimuli presented were, “What is 49?” (The correct response was, “An atomic number”) and, “What is a chalcogen (the correct response was “A group”). Phases 7, 8, and 9 were identical to Phases 1 to 3, except for that the stimuli were, “What is indium?” (The correct response was “A chemical element”) and, “What is 84?” (The correct response was, “An atomic number”). In Phase 10, the four operants taught in Phases 1 to 6 were intermixed randomly, with the restriction that all the four questions appeared every four trials. After 12 correct consecutive responses, the next phase began. In Phase 11, the six intraverbals taught in Phases 1 to 9 were intermixed, with the restriction that all of them appeared every six trials. When the participant made 12 correct consecutive responses in this phase, the teaching of the Categories ended.

**Teaching Exemplars** Because in the Exemplars each question had two correct responses, we presented the same request for two consecutive trials. On the first trial, the correct response was either one of the previously defined correct answers (see Table 2). On the second trial, the correct response was the correct answer not produced in the first trial. For example, on the first trial, we asked, “Name a chemical group.” If the participant responded “boron[-group]” or “chalcogen”, the response was correct. Let us suppose that the participant responded “boron[-group]”, then that response was correct. Thereafter, we asked, “Name another chemical group.” Now, the correct response was “chalcogen”; then, on this trial, answering “Boron[-group]”, was not correct. We taught the Exemplars in 5 phases: In Phase 1, the question was, “Name a chemical group.” In the first four trials, the experimenter prompted the correct answer. Starting in the 5th trial, the experimenter did not provide prompts, but he/she continued providing differential consequences. When the participant made four consecutive correct responses, we moved on to Phase 2. Phase 2 was identical to Phase 1, except that the stimuli were, “Name a chemical element.” In Phase 3, pairs of trials with the stimuli of Phases 1 and 2 were intermixed. After 12 consecutive correct responses, we moved on to the next phase. Phase 4 was identical to Phases 1 and 2, but the stimuli were, “Name an atomic number.” Phase 5 was like the previous phases, but pairs of trials with the three stimuli of Phases 1, 2, and 4 were intermixed, with the restriction that the six pairs of questions appeared every twelve trials. When the participant made 12 consecutive correct responses in this phase, the teaching of the Exemplars ended.

#### Data Recording and Interobserver Agreement

One observer was present in some sessions to take data independently for computing the interobserver agreement. In the study, 886 trials, of a total of 2,813, were observed

(31.5 %). The experimenter and the observer agreed on 880 trials; thus inter-observer agreement ( $\text{agreements} / [\text{agreements} + \text{disagreements}] \times 100$ ) was 99.32 %.

### Experiment 1

The goal of this experiment was to explore whether adults learning of the A-B and B-C intraverbals would result in the emergence of the B-A, C-B, A-C, and C-A intraverbals.

#### Method

**Participants** Nine adults were presented with the initial probe. Three of them showed more than one correct response and, therefore, were discarded. The remaining six adults continued with the experiment: Manuel, Belén, Benigno, Ana, Edgar, and Alexis. For clarity, we will only describe the results of these six participants.

**Procedure** Participants received the probes of the ABC intraverbals, the Categories, and the Exemplars (see Table 3). The six participants who did not pass the initial probes (because they responded correctly in one trial or less) were then taught the A-B and B-C intraverbals. Later on, they received the probe of the ABC intraverbals twice. We repeated this cycle of teaching and probing to explore whether the mere repetition of the cycle would lead to the emergence of the eight probed ABC intraverbals. As explained above, from the second repetition of the cycle onwards, the participants received an abbreviated version of the A-B and B-C teaching. When a participant reached 12 correct responses in two consecutive ABC probes or after six teaching-probing cycles (12 probes) his/her participation in the experiment was discontinued.

### Results

Figure 2 shows the results of the participants in the probes of the ABC intraverbals. Detailed results appear in Tables 4, 5, 6, 7, 8 and 9. Four out of six participants showed the emergence of the ABC intraverbals. Manuel, Belén, Benigno, and Ana reached the emergence criterion in eight to eleven probes. Edgar and Alexis demonstrated the emergence of the B-A, C-B, and A-C intraverbals, but they did not demonstrate the emergence of the C-A intraverbals after 12 probes. The C-B and A-C intraverbals were the first to emerge in all participants. The B-A intraverbals emerged afterwards in four participants and in the fourth place in two others. The C-A intraverbals emerged in the latter place for two participants, in third place for two others, and did not emerge in the remaining two participants.

### Discussion

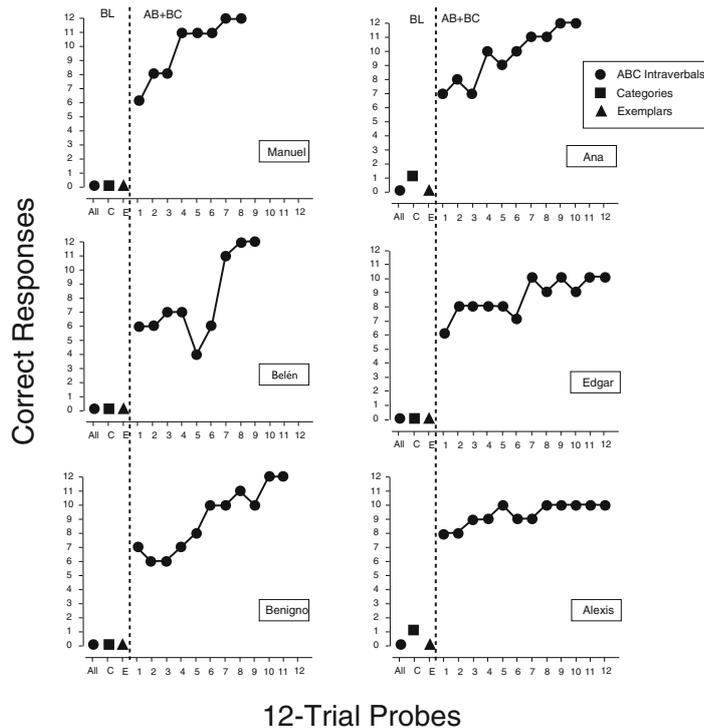
The results of Experiment 1 indicate that learning the A-B and B-C intraverbals is sufficient for some adults to show the emergence of the remaining ABC intraverbals. Simultaneously, they indicate that learning A-B and B-C is not sufficient for other adults to show that emergence. These results replicate those from Pérez-González et al. (2008) and Carp and Petursdottir (2012) with children in that one child in the first study and three children in the second study showed the emergence of the intraverbals after learning the A-B and B-C intraverbals, but the remaining children did not. They also replicated, with four participants, Pérez-González et al.'s results in that the C-A intraverbals emerged after the remaining probed intraverbals had emerged—the two other participants showed the emergence of C-A before showing the emergence of B-A. Thus, data indicates that the C-A intraverbals are the most difficult intraverbals to emerge in

**Table 3** Sequence followed by the participants of each condition in the first cycle and in the subsequent cycles. When two or three states appear in a cell, it indicates that some participants received the one indicated first, and other participants received the ones indicated second and third

Operants probed or taught	Experiment 1 A-B & B-C alone		Experiment 2 Categories		Experiment 3 Exemplars	
	First Cycle	Subsequent Cycles	First Cycle	Subsequent Cycles	First Cycle	Subsequent Cycles
A-B, B-C, B-A, C-B, A-C, & C-A	Probe	No	Probe	No	Probe	No
Categories	Probe	No	Probe	No	Probe	No
Exemplars	Probe	No	Probe	No	Probe	No
Categories	No	No	No, teach*	No, teach, or review*	No	No
Exemplars	No	No	No	No	No, teach*	No, teach, or review*
A-B and B-C	Teach	Review	Teach	Review	Teach	Review
A-B, B-C, B-A, C-B, A-C, & C-A	Probe	Probe	Probe	Probe	Probe	Probe

\* The procedure depended on whether the participant was experimentally naïve or had participated in the previous experiment and on the condition in the multiple-baseline design

**Fig. 2** Performance of participants of Experiment 1 (*A-B* and *B-C* alone) in the *Probe of the ABC intraverbals*. Each data point represents correct responses in a 12-trial probe. Typically, two probes were conducted in a row



adults as well as in children, but there are exceptions (see a [discussion](#) in Carp and Petursdottir). In all participants of the present study and in Pérez-González et al.'s (2008) study, however, C-B and A-C emerged before than B-A and C-A.

### Experiment 2

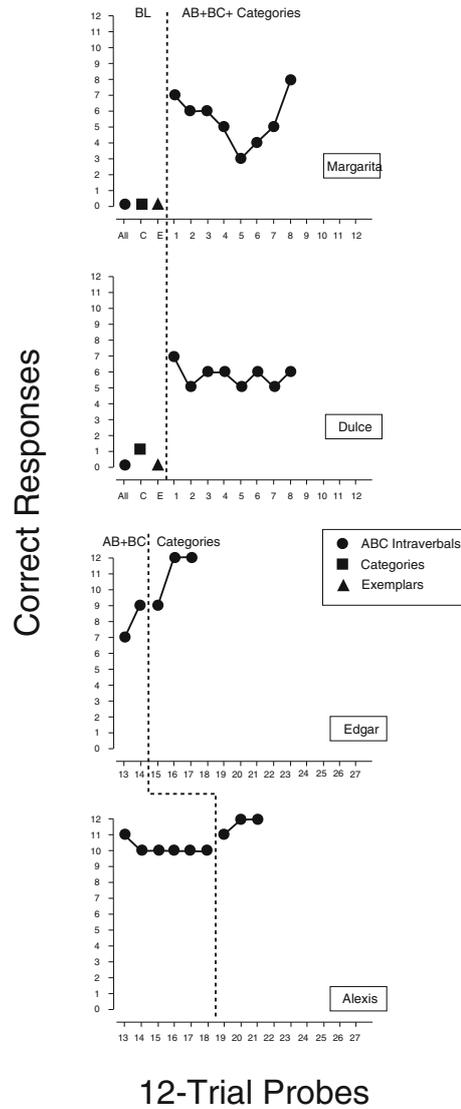
Experiment 1 demonstrated that some adults do not show the emergence of all probed ABC intraverbals. It is possible that learning simpler intraverbals with some elements of the ABC intraverbals could facilitate that emergence. Thus, the goal of *Experiment 2* was to analyze in adults the effect of learning the Categories together with learning the A-B and B-C intraverbals, on the emergence of the B-A, C-B, A-C, and C-A intraverbals. The specific goals were to find out (a) whether teaching the Categories, and the A-B, and B-C intraverbals suffices to produce the emergence of all the novel intraverbals, and (b) whether teaching the Categories would produce that emergence faster than when they are not taught, as in Experiment 1.

### Method

**Participants** Four adults participated. Two of them were experimentally naïve (Margarita and Dulce). The other two participants were the participants from *Experiment 1* who did not show the emergence of all probed intraverbals (Edgar and Alexis).

**Procedures and design** The procedures are outlined in Table 3. The experimentally naïve participants received the initial probes, the teaching of the Categories, and the A-B and B-C intraverbals. The two participants that had taken part in Experiment 1 received one and three additional cycles in

**Fig. 3** Performance of participants of *Condition with Categories* in the *Probe of the 12 operants*. Each data point represents correct responses in a 12-trial probe. Typically, two probes were conducted in a row. Notice that participants Edgar and Alexis had participated before in Experiment 1 and they received six cycles of teaching or reviewing A-B and B-C and probing the remaining ABC intraverbals; in the 12 12-trial probes conducted they had not demonstrated the emergence of all intraverbals, as shown in Fig. 2



which the A-B and B-C intraverbals were reviewed and the remaining ABC intraverbals were probed, in accordance with

a multiple-baseline design across participants. Then, the Categories were taught, the A-B and B-C intraverbals were reviewed, and the remaining ABC intraverbals were probed. The fastest participant from Experiment 1 showed the emergence of the probed ABC intraverbals after eight probes. One of the goals of the present experiment was to find out whether teaching the Categories, together with teaching the A-B and the B-C intraverbals, would result in a faster emergence of the probed ABC intraverbals (as compared with teaching the A-B and B-C intraverbals alone). The cycle of teaching and probing in Experiment 2 was repeated for a maximum of four sessions following the teaching of the Categories, which made up eight probes.

Results

Results of in the probes of the ABC intraverbals appear in Fig. 3. Detailed results appear in Tables 10, 11, 12 and 13. Edgar and Alexis who had learned the A-B and B-C intraverbals before learning the Categories, showed the emergence of the probed ABC intraverbals after just three probes following the learning of the Categories. They showed the emergence in the same order: C-B, A-C, B-A, and finally C-A. On the contrary, the two experimentally naïve participants, Margarita and Dulce, who learned the Categories before learning the A-B and B-C intraverbals, did not show the emergence of all probed ABC intraverbals; Dulce also made errors in the taught A-B intraverbals presented in the ABC probe. Margarita showed the emergence of most instances of the C-B intraverbals and some of the A-C intraverbals, but she did not show the emergence of the B-A and C-A intraverbals after four teaching-probing cycles. Dulce showed similar results: she only showed the emergence of the C-B intraverbals and some of the A-C intraverbals; she did not show the emergence of the B-A and C-A intraverbals after four teaching-probing cycles.

Discussion

The experiment results were mixed and unexpected: The two participants who learned the Categories after been presented with several cycles of A-B and B-C teaching and ABC probing, showed the emergence of the probed intraverbals. The two participants who learned the Categories before learning the A-B and B-C intraverbals, however, did not show the emergence of the probed intraverbals. These results suggest that learning the Categories after the A-B and B-C intraverbals facilitates the emergence of complex intraverbals in adults, whereas learning the Categories before learning the A-B and B-C intraverbals does not. Moreover, Margarita and Dulce showed errors in the maintenance of A-B intraverbals. This fact could preclude the emergence of B-A and C-A intraverbals. It is also possible that teaching the Categories

first could have produced the disruption of the learned A-B intraverbals. These suggestions must be considered with caution because the number of participants is too low for drawing a clear conclusion. Further research is needed to clarify the influence of the Categories on the emergence of the probed ABC intraverbals. If the results of the present experiment were confirmed, it would be interesting to know if the effect of teaching the Categories before teaching the A-B and B-C intraverbals makes it more difficult to show the emergence of novel intraverbals of the ABC type. Finally, it should be noted that the two participants who showed the emergence of all the probed ABC intraverbals –Edgar and Alexis– did so in the same order as the children who participated in Pérez-González et al.'s (2008) study.

### Experiment 3

Experiments 1 and 2 demonstrated that some adults do not show the emergence of all probed ABC intraverbals, even when the Categories are taught (as in Experiment 2). Thus, it would be of interest, for theoretical and practical reasons, to find out whether additional learning experiences can bring about the emergence of all the probed ABC intraverbals in adults. For that reason, the goal of Experiment 3 was to analyze in adults the effect of learning the Exemplars, prior to learning A-B and B-C intraverbals, on the emergence of the B-A, C-B, A-C, and C-A intraverbals.

### Method

**Participants** Four adults participated. Three participants (Mercedes, Sabela, and Juan) were experimentally naïve. The other participant was Dulce, who had participated in Experiment 2, and had not showed the emergence of all the probed ABC intraverbals.

**Procedure** The procedures varied across participants in order to evaluate as soon as possible the effect of learning the Exemplars (see Table 3). *Dulce* (who had learned the Categories and the A-B and B-C intraverbals in Experiment 2) learned the Exemplars, reviewed the A-B and B-C intraverbals, and received the probe of the ABC intraverbals. *Mercedes* and *Sabela* received the initial probes, learned the Exemplars and the A-B and B-C intraverbals, and received the probes of the ABC intraverbals. *Juan* received the initial probes first, two cycles in which he learned (or reviewed) the A-B and B-C intraverbals and the probes of the ABC intraverbals; after the two cycles, he learned the Exemplars, reviewed the A-B and B-C intraverbals and received the probes of the ABC intraverbals once again.

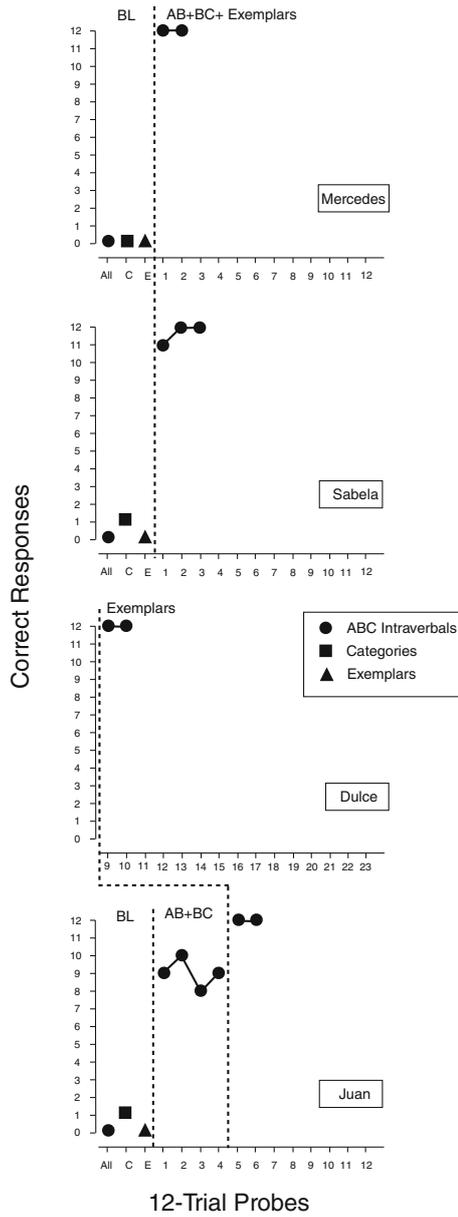
**Fig. 4** Performance of participants of *Condition with Exemplars* in the *Probe of the 12 operants*. Each data point represents correct responses in a 12-trial probe. Typically, two probes were conducted in a row. Notice that participant Dulce had participated before in Experiment 2 and she received six cycles of teaching A-B and B-C, and the Categories and probing the remaining ABC intraverbals; in the 12 12-trial probes conducted she had not demonstrated the emergence of all intraverbals, as shown in Fig. 3

### Results

Results of the probed intraverbals appear in Fig. 4. Detailed data appear in Tables 14, 15, 16 and 17. All participants showed the emergence of the intraverbals after learning the *Exemplars* and the A-B and B-C intraverbals. Mercedes, Sabela, and Dulce showed the emergence of the intraverbals after one, two, and one teaching and probing cycles, respectively. Thus, two participants showed the emergence without errors and the third participant made only one error. Juan received, after the initial probes, two cycles of teaching–reviewing the A-B and B-C intraverbals together with the probes of the ABC intraverbals. He showed the emergence of the C-A intraverbals and some instances of C-B and B-A intraverbals, but he did not show the emergence of the A-C intraverbals after the two cycles. By the next cycle, he learned the *Exemplars* before the A-B and B-C intraverbals were reviewed. Juan showed the emergence of all intraverbals immediately after learning the *Exemplars*. With these data, it is evident that the four probed ABC intraverbals emerged immediately in three participants. In the fourth participant, there came first the B-A and C-A intraverbals, but, in the same session, he showed the emergence in 2 out of 4 trials of C-B and 1 out of 4 trials of A-C. In the next session, he did not show the same pattern; in the third session, he showed the emergence of all probed ABC intraverbals immediately.

### Discussion

All participants showed the emergence of the probed ABC intraverbals immediately after learning the *Exemplars*. This happened with the three participants who learned the *Exemplars* before learning the A-B and B-C intraverbals as well as with the participant who learned the *Exemplars* after learning and reviewing the A-B and B-C intraverbals. Thus, the results suggest that learning the *Exemplars* facilitates the immediate emergence of the probed ABC intraverbals, and does so regardless of the sequence of teaching and probing. Because the four intraverbals emerged immediately in three of the four participants, all four probed ABC intraverbals emerged at the same time; the four participants did not show a clear pattern, but the fact that all intraverbals emerged so quickly indicates that the order of emergence was not due to the fact that some intraverbals emerge before than others, but to other factors that affect to all intraverbals equally.



**General Discussion**

Ten out of the eleven participants showed the emergence of the *probed ABC* intraverbals. Participants learned the A-B Chemical group-Chemical element and B-C Chemical element-Atomic number relations. Thereafter, they showed the B-A Chemical element-Chemical group, the C-B Atomic number-Chemical element, the A-C Chemical group-Atomic group, and the C-A Atomic number-Chemical group relations. Thus, the present research replicated and extended to adults the results of Pérez-González et al.'s (2008) and Carp and Petursdóttir (2012) regarding the emergence with selection-based operants of the type of the ABC intraverbals.

The first goal of the present study was to find out whether adults need Exemplars and/or Categories to show the emergence of the probed ABC intraverbals. That question was answered in Experiment 1: Four adults demonstrated the emergence of the probed ABC intraverbals without additional learning of either Categories or Exemplars. These results demonstrate that some adults do not need learning Categories or Exemplars to show the emergence of the probed ABC intraverbals. On the other hand, two other adults did not show the emergence after repeated teaching and probing. Thus, these results demonstrate that some adults need additional learning to show that emergence. These results are congruent with those obtained with children by Pérez-González et al. (2008) and Carp and Petursdóttir (2012).

The second goal of the present research was to explore whether learning *Categories* alone, *Exemplars* alone, or both, facilitates the emergence of the intraverbals. The possibility that learning *Categories* alone (i.e., without learning the *Exemplars*) is sufficient for bringing about the emergence of the probed ABC intraverbals was examined in Experiment 2. Two adults showed the emergence of the probed ABC intraverbals after learning the A-B and B-C intraverbals together with the *Categories*, but another two adults did not. The results with these two participants are very interesting. They did not show that emergence of the ABC intraverbals after seven and nine cycles (14 and 18 probes) involving the learning of the A-B and B-C intraverbals and the probe of all ABC intraverbals; they did show that emergence, however, almost immediately after learning the *Categories*. The results of these two participants indicate that teaching the *Categories* may have a great influence on the emergence of the probed ABC intraverbals, at least with some participants. It is also interesting that the two participants who demonstrated the emergence of the probed ABC intraverbals were the two participants that learned first the A-B and B-C intraverbals and then the *Categories*, whereas the two participants that did not show the emergence of ABC intraverbals learned first the *Categories*, and they learned thereafter the A-B and B-C intraverbals. These results suggest that teaching *Categories* after A-B and B-C intraverbals could make it more difficult

for the emergence of the probed ABC intraverbals. This hypothesis is suggested by the results of only four participants but it is congruent with the results of Carp and Petursdottir (2012). In their study, the two children who showed the emergence of the probed ABC intraverbals immediately after learning the Categories (in the condition with Exemplars first of his study) had learned the Categories after learning the A-B and B-C intraverbals.

The possibility that learning Exemplars alone is sufficient for the emergence of the ABC intraverbals was examined in Experiment 3. The four participants in this experiment showed the emergence of the probed ABC intraverbals almost without errors. These results indicate that learning the Exemplars, either before or after learning the A-B and B-C intraverbals, greatly facilitates the emergence of the probed ABC intraverbals. This conclusion appears even clearer if the performance of the six participants that did not learn the Exemplars, in Experiment 1, is compared with the performance of the four participants that learned them in Experiment 3. None of the six participants in Experiment 1 showed the emergence of the probed ABC intraverbals within the first three cycles that consisted of teaching or reviewing the A-B and B-C intraverbals and probing the probed ABC intraverbals. In contrast, all four participants of Experiment 3 showed that emergence immediately. Thus, the facilitating effect of learning the Exemplars appears to be very strong.

Developmental factors could mediate the facilitating effect of learning the *Exemplars* on the emergence of the probed ABC intraverbals. The proportion of adults who showed that emergence without learning the Categories and *Exemplars* was higher than the proportion of children who did so. That is, four out of six adults showed the emergence of the ABC intraverbals in the present study, whereas only one out of five 6-year-old children showed that emergence in Pérez-González et al. (2008) and three out of nine 6- and 7-year-old children showed emergence in Carp and Petursdottir (2012). Moreover, other unpublished studies conducted in our lab showed that many children demonstrate the probed ABC intraverbals only after learning Exemplars and Categories. Yet, further research is needed to confirm this apparent difference between adult and children. Although the results obtained in Experiments 1 and 2 needs to be confirmed, all the results obtained so far are congruent with the following hypothesis: First, children need learning either the Exemplars or the Exemplars and Categories for showing the emergence of the ABC intraverbals. Second, as an individual acquires more experiences along his/her life with intraverbals of this type or of similar types, that person requires fewer components to show the emergence after learning intraverbals of this type with stimuli. That person would require learning only the Exemplars, and later on that person could demonstrate the emergence of the ABC intraverbals without the need of

learning the Exemplars or the Categories. See an analysis in terms of developmental capabilities in Pérez-González (2014).

The results of the present experiments demonstrate the interrelation among intraverbals of different type with common stimuli. It is very likely that the processes involved in the emergence of the probed ABC intraverbals are representative of the emergence processes with intraverbals that are related to one another in a unidirectional way (Exemplars and Categories are related in a unidirectional way because the emergence of Categories after learning the Exemplars is more likely than in the opposite way). The emergence processes with intraverbals of other types, however, could very likely be different. For example, emergence of antonyms (e.g., Pérez-González et al. 2007) is bidirectional (because the probability of the emergence of the B-A intraverbal given A-B is the same as having the emergence of the A-B intraverbal given B-A. If the stimuli do not affect responding, then they could facilitate emergence; intraverbals involving native and foreign words (e.g., Petursdottir and Hafliadótir 2009; Petursdottir et al. 2008a, b), however, are unidirectional; hence, the processes involved in the emergence with complex intraverbals with native and foreign words could be similar to those shown with Exemplars and Categories. Further research is necessary to study this hypothesis.

*Adults Reasoning* The present research shows some basic learning processes involved in *reasoning*. According to some views that suppose that adults possess a great reasoning competence (for an extensive review, see Kahneman 2011), the present results could be considered surprising. Under the particular conditions of the present research, with a minimum of specific instructions, the adults did not show the emergence of all relations. Thus, after learning only the A-B and B-C relations, some adults' performance is like that of some children. Therefore, the present research and those of Pérez-González et al. (2008) and Carp and Petursdottir (2012) indicate that some learning sequence promotes emergence of relations, which is taken as evidence of reasoning. Other learning sequences, however, do not guarantee emergence (e.g. do not show reasoning). Even more, the results with two participants of the *Condition with Categories* may be due to the fact that the learning sequence consisting of learning first the ABC intraverbals and thereafter the Categories could interfere with reasoning. Those facts have important practical applications, for promoting reasoning in normal-developing persons and persons with learning disabilities.

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### Appendix A

**Table 4** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2-5) and order of emergence of each intraverbal shown by Manuel in Study 1

Intraverbal	PRE	After learning AB+BC				Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	
AB	0	3	4	4	4	-
BC	0	3	4	4	4	-
BA	0	0	1	3	4	4th
CB	0	4	4	3	4	1st
AC	0	3	4	4	4	2nd
CA	0	1	2	4	4	3rd

**Table 5** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2-6) and order of emergence of each intraverbal shown Belen in Study 1

Intraverbal	PRE	After learning AB+BC					Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	
AB	0	3	3	1	4	4	-
BC	0	4	4	4	4	4	-
BA	0	0	0	0	4	4	2nd
CB	0	1	4	3	4	4	1st
AC	0	2	3	2	3	4	3rd
CA	0	0	0	0	4	4	2nd

**Table 6** Correct responses out of two trials (in Sessions 1 and 7) or four trials (in Sessions 2-6) and order of emergence of each intraverbal shown by Benigno in Study 1

Intraverbal	PRE	After learning AB+BC						Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	
AB	0	3	2	2	4	4	2	-
BC	0	4	4	4	3	4	2	-
BA	0	0	1	3	4	2	2	2nd
CB	0	3	4	4	4	4	2	1st
AC	0	3	2	2	4	4	2	2nd
CA	0	0	0	0	0	4	2	3rd

**Table 7** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2-6) and order of emergence of each intraverbal shown by Ana in Study 1

Intraverbal	PRE	After learning AB+BC					Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	
AB	0	2	4	4	4	4	–
BC	0	4	4	4	4	4	–
BA	0	2	2	3	4	4	3rd
CB	0	2	4	2	4	4	2nd
AC	0	4	4	4	4	4	1st
CA	0	1	0	2	4	4	3rd

**Table 8** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2-7) and order of emergence of each intraverbal shown by Edgar in Study 1

Intraverbal	PRE	After learning AB+BC						Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	
AB	0	4	4	3	4	4	4	–
BC	0	4	4	4	3	3	3	–
BA	0	0	0	1	4	4	4	3rd
CB	0	4	4	3	4	4	4	1st
AC	0	2	4	4	4	4	4	2nd
CA	0	0	0	0	0	0	0	–

**Table 9** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2-7) and order of emergence of each intraverbal shown by Alexis in Study 1

Intraverbal	PRE	After learning AB+BC						Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	
AB	0	3	4	4	4	4	4	–
BC	0	4	4	4	4	4	4	–
BA	0	3	3	4	3	4	4	2nd
CB	0	4	4	4	4	4	4	1st
AC	0	2	3	2	4	4	4	3rd
CA	0	0	0	1	0	0	0	–

**Table 10** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2–5) and order of emergence of each intraverbal shown by Margarita in Study 2

Intraverbal	PRE	After learning AB+BC+Categories				Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	
AB	0	3	2	0	3	–
BC	0	4	4	4	4	–
BA	0	0	0	0	0	–
CB	0	4	4	2	4	1st
AC	0	2	1	1	2	–
CA	0	0	0	0	0	–

**Table 11** Correct responses out of two trials (in Session 1) or four trials (in Sessions 2–5) and order of emergence of each intraverbal shown by Dulce in Study 2

Intraverbal	PRE	After learning AB+BC+Categories				Order of Emergence
	Session 1	Session 2	Session 3	Session 4	Session 5	
AB	0	1	1	1	1	–
BC	0	4	4	4	4	–
BA	0	0	0	0	0	–
CB	0	4	4	4	4	1st
AC	0	3	3	2	2	–
CA	0	0	0	0	0	–

**Table 12** Correct responses out of four trials (in Sessions 8–10) or two trials (in Session 11) and order of emergence of each intraverbal shown by Edgar in Study 2

Intraverbal	After learning AB+BC		After learning Categories		Order of Emergence
	Session 8	Session 9	Session 10	Session 11	
AB	4	4	4	2	–
BC	4	3	3	2	–
BA	4	1	4	2	1st
CB	4	4	4	2	1st
AC	4	4	4	2	1st
CA	0	0	2	2	–

**Table 13** Correct responses out of four trials (in Session 8-11) or two trials (in Session 12) and order of emergence of each intraverbal shown by Alexis in Study 2

Intraverbal	After learning AB+BC			After learning Categories		Order of Emergence
	Session 8	Session 9	Session 10	Session 11	Session 12	
AB	4	4	4	4	2	–
BC	4	4	4	4	2	–
BA	4	4	4	4	2	1st
CB	4	4	4	4	2	1st
AC	4	4	4	4	2	1st
CA	1	0	0	3	2	2nd

**Table 14** Correct responses out of two trials (in Session 1) or four trials (in Session 2) and order of emergence of each intraverbal shown by Mercedes in Study 3

Intraverbal	PRE	After learning AB+BC+Exemplars	Order of Emergence
	Session 1		
AB	0	4	–
BC	0	4	–
BA	0	4	1st
CB	0	4	1st
AC	0	4	1st
CA	0	4	1st

**Table 15** Correct responses out of two trials (in Sessions 1 and 3) or four trials (in Session 2) and order of emergence of each intraverbal shown by Sabela in Study 2

Intraverbal	PRE	After learning AB+BC+Exemplars	Session 3	Order of Emergence
	Session 1			
AB	0	4	2	–
BC	0	4	2	–
BA	0	4	2	1st
CB	0	4	2	1st
AC	0	4	2	1st
CA	0	3	2	2nd

**Table 16** Correct responses out of four trials and order of emergence of each intraverbal shown by Dulce in Study 3

Intraverbal	After learning Exemplars Session 6	Order of Emergence
AB	4	–
BC	4	–
BA	4	1st
CB	4	1st
AC	4	1st
CA	4	1st

**Table 17** Correct responses out of four trials and order of emergence of each intraverbal shown by Juan in Study 3

Intraverbal	PRE	After learning AB+BC		After learning Exemplars	Order of Emergence
	Session 1	Session 2	Session 3	Session 4	
AB	0	4	4	4	–
BC	0	4	4	4	–
BA	0	4	1	4	1st
CB	0	2	4	4	2nd
AC	0	1	0	4	3rd
CA	0	4	4	4	1st

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## 3.2. Segundo Artículo

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ORIGINAL ARTICLE

# Exemplars and Categories Necessary for the Emergence of Intraverbals About Transitive Reasoning in Typically Developing Children

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**Abstract** This research aimed to explore the effect of teaching Categories on the emergence of the intraverbals studied by Pérez-González, Herszlikowicz, and Williams (*The Psychological Record* 58:95–129, 2008). Ten 6- and 7-year-old children were recruited and divided into 2 conditions. In Condition 1, 5 children learned intraverbals in which they had to say exemplars of 3 categories (e.g., “Name a continent”—“Europe”)—the Exemplars. They also learned intraverbals in which they had to say the categories of the exemplars named by the experimenter (e.g., “What is Europe”—“A continent”)—the Categories. Thereafter, they learned to say the countries corresponding to two cities (the A-B relations) and to say the continents of the two countries (the B-C relations). Finally, the intraverbals that result from combining A, B, and, C stimuli were probed, such as asking the cities corresponding to the continents. Five children in Condition 2 received the same experience, but they did not learn the Categories initially. Four of the 5 children of Condition 1 demonstrated the emergence of all probed ABC intraverbals, but no child of Condition 2 did so initially. These results indicate that learning Categories together with the Exemplars plays a strong role in the emergence of the probed ABC intraverbals. These findings reveals some basic learning processes involved in reasoning processes, such as transitive inference.

**Keywords** Intraverbals · Verbal behavior · Stimulus equivalence · Stimulus relations · Reasoning · Transitive inference · Answering questions · Children

Intraverbals are verbal operants characterized by the emission of a verbal response after the presentation of a verbal stimulus that shows no point-to-point correspondence with the response (Skinner, 1957). Intraverbals are ubiquitous in everyday life, especially in the context of social interactions, such as conversations, songs, stories, and plays, and in most academic skills (e.g., telling the alphabet, counting or answering utterances like, “What is your name,” “Name the opposite of dark”). In addition, more sophisticated verbal skills, like answering questions about what one did on the weekend or telling what utensils are used for making soup, also involve intraverbals. Intraverbals can be directly taught via transfer-of-stimulus-control procedures in which echoes, tacts, or textual prompts and reinforcers are presented (see reviews by Axe, 2008, and Cihon, 2007), they can be brought with other teaching strategies (e.g., Greer, Yuan, & Gautreaux, 2005; Kisamore, Carr, & LeBlanc, 2011; Sautter, LeBlanc, Jay, Goldsmith, & Carr, 2011), and they can emerge from the learning of other operants.

An important developmental milestone occurs when a person demonstrates novel skills that have not been taught directly to him or her, as an extra outcome of learning-related skills, typically by direct contingencies (Greer & Ross, 2008; Pérez-González, 2015). Demonstrations of novel skills of a sort constitute demonstrations of a type of emergence. Emergent processes are involved in generative behavior and in responding to novel verbal utterances, for example, in the generation and understanding of metaphors and analogies. The emergence of novel intraverbals has been widely demonstrated in studies that have often been analyzed in terms of categorization skills

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(e.g., Bellosó-Díaz & Pérez-González, 2015a, 2015b; Braam & Poling, 1983; Chase, Johnson, & Sulzer-Azaroff, 1985; Partington & Bailey, 1993; Petursdóttir, Carr, Lechago, & Almason, 2008; Sundberg & Sundberg, 1990; Vignes, 2007; Watkins, Pack-Teixeira, & Howard, 1989). Also, the emergence of intraverbals after learning tact and listener repertoires (Bellosó-Díaz & Pérez-González, 2015a, b; Petursdóttir, Carr et al., 2008; Petursdóttir & Haflidadóttir, 2009; Petursdóttir, Ólafsdóttir, & Aradóttir, 2008) or from other intraverbals (e.g., Carp & Petursdóttir, 2012; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Pérez-González, Herszlikowicz, & Williams, 2008; Pérez-González, Salameh, & García-Asenjo, 2014b; Polson & Parsons, 2000) has been broadly demonstrated.

The processes involved in learning and emergence of intraverbals are processes involved in complex human behavior known in everyday life as reasoning. More specifically, tasks described as demonstrative of transitive inference (e.g., Munnelly, Dymond, & Hinton, 2010; Solomon, Frank, Smith, Ly, & Carter, 2011; Werchan & Gómez, 2013) are closely related to intraverbals. Moreover, processes involved in the emergence of intraverbals may be involved in the processes of transitive inference and other deductive reasoning processes.

Pérez-González et al. (2008) taught and probed intraverbals with the ABC structure, typical of the stimulus equivalence paradigm and of deductive reasoning, with 5- and 6-year-old children. In Experiment 1, the experimenters taught A-B relations, such as “Name a city of Argentina”—“Buenos Aires” (where A1 is “Argentina” and B1 is “Buenos Aires”) and B-C relations, such as, “Name a park of Buenos Aires”—“El Botánico” (where B1 is “Buenos Aires” and C1 is “El Botánico”). It is important to note that within the experimental procedure the researchers included “city” in A-B to prompt a response of the B category (the stimulus was “Name a city of Argentina”), and they included “park” in the A-C probe to prompt a response of the C category (the stimulus was “Name a park of Argentina”). Most children did not demonstrate some of the probed intraverbals; that is, symmetry B-A (“Name the country of Buenos Aires”) and equivalence C-A (“Name the country of El Botánico”) did not emerge in four of the five participants. In Experiment 2, Pérez-González et al. (2008) studied the effect of learning simpler intraverbals on the emergence of the targeted intraverbals B-A, C-B, A-C, and C-A. Specifically, they taught simple intraverbals of the type “Name a city”—“Buenos Aires,” which were denominated “Exemplar intraverbals,” and intraverbals of the type, “What is Buenos Aires”—“A city,” which were denominated “Category intraverbals,” before probing B-A, C-B, A-C, and C-A (the probed ABC intraverbals). It is important to note that the simple intraverbals had a single stimulus (e.g., “city”) instead of two (“city of Argentina”), on one hand, and that the stimuli of the simple intraverbals are the same as in the

ABC intraverbals. Teaching the simple intraverbals facilitated the emergence of the probed ABC intraverbals. In other terms, the results of the Pérez-González et al. study are congruent with the hypothesis that Exemplars and Categories facilitate the emergence of the probed ABC intraverbals.

Carp and Petursdóttir (2012) replicated the study conducted by Pérez-González et al. (2008) with slightly older participants between the ages 6 and 7. They found that three out of nine children demonstrated the emergence of the probed ABC intraverbals without learning the Exemplars or the Categories. Four additional children demonstrated the emergence after learning Exemplars and Categories. Two children did not demonstrate the emergence of all the probed ABC intraverbals. Pérez-González, Bellosó-Díaz, Caramés-Méndez, and Alonso-Álvarez (2014) analyzed the emergence of probed ABC intraverbals in adults. They found that four of six adults demonstrated the emergence of the probed ABC intraverbals without learning the Exemplars and the Categories. Teaching the Categories resulted in the emergence of all target ABC intraverbals in two of four adult participants. Teaching the Exemplars produced the immediate emergence in the four adults probed. The major findings of these studies can be summarized this way: First, the probed ABC intraverbals can emerge without teaching Exemplars or Categories, as well in children as in adults; the results so far suggest that some factor related to age—such as behavioral experience—is involved in the emergence, as it emerged in one of five 6-year-old children (20%), three of nine 6- and 7-year-old children (33%), and four of six adults (66%). Second, teaching both Exemplars and Categories seems to produce the emergence of the probed ABC intraverbals in most children (the four 6-year-old children in Pérez-González et al., 2008, study and four of six children in the Carp and Petursdóttir study) and in all adults (the four adults in the Pérez-González et al. 2014a, b, study).

With the data obtained so far, it is impossible to know the effect of teaching Exemplars or Categories alone in children. Carp and Petursdóttir (2012) probed the effect of teaching either Exemplars or Categories first to 6- and 7-year-old children, but the results were not conclusive because some children demonstrated an increase in some of the probed ABC intraverbals while other participants demonstrated little increase. Moreover, the researchers presented only one to three cycles of teaching AB/BC and probing before teaching intraverbals of the other type (e.g., they reviewed AB and BC, taught Exemplars, and, if not all probed ABC intraverbals emerged, they taught the Categories in the next session). It may be that the effect of teaching intraverbals of a specific type (Exemplars or Categories) could have been observed after repeating cycles without teaching additional intraverbals.

The initial purpose of the present research was to analyze the effects of teaching Exemplars or Categories, together with the AB and BC intraverbals, in the emergence of the probed

ABC intraverbals. Because teaching Categories alone did not produce a clear effect in either children (Carp & Petrusdottir, 2012) or adults (Pérez-González et al. 2014a), it was considered that enough evidence exist so far that learning Categories alone does not suffice for the probed ABC intraverbals to emerge. For this reason, the goal of the present study was to analyze the effects of teaching the Categories in children who had already have learned the Exemplars and the AB and BC intraverbals.

**Method**

**Participants**

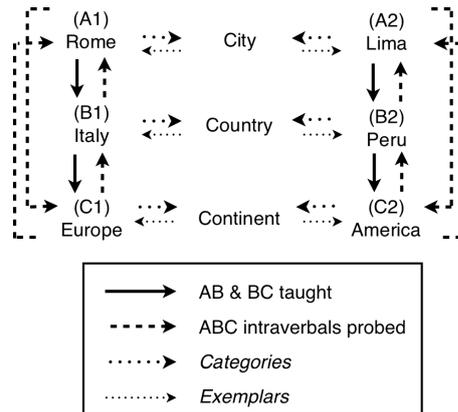
Ten Spanish-speaking children with ages between 6 years and 7 months and 7 years and 4 months (four females and six males) participated (see Table 1). They were typically developing and from a medium social class. They attended the First Grade of Primary Education in a public school, located in a middle-class neighborhood of a medium-size city where most of the population is native. All children demonstrated no learning difficulties in the First Grade of Primary Education Curriculum, as informed by the school professionals. The children were randomly selected among the children of the class whose parents gave their consent to participate in the study.

**Stimuli and Definition of Correct Responses**

All the experimental procedures were conducted in Spanish. Four intraverbals in Spanish were used for teaching (see an overview of the relations in Fig. 1; see “Taught A-B City-Country” and “Taught B-C Country-Continent” in Table 2).

**Table 1** Name, sex, and age (years and months) of the participants

Name	Sex	Age
<b>Condition 1</b>		
Alex	Male	7 years, 2 months
Mario	Male	6 years, 7 months
Naza	Male	6 years, 10 months
Paul	Male	7 years, 3 months
Ana	Female	6 years, 9 months
<b>Condition 2</b>		
Mary	Female	7 years, 1 month
Lucy	Female	7 years, 4 months
Lara	Female	7 years, 3 months
Luis	Male	7 years, 3 months
Jonny	Male	6 years, 8 months



**Fig. 1** Overview of intraverbals taught and probed. Each arrow indicates an intraverbal, which points from one stimulus of the intraverbal to the defined correct response. Note that each stimulus related to a category (“City,” “Country,” and “Continent”) is related to two exemplars. Therefore, it is equally related to class “1” as to class “2.”

For example, in an A-B City-Country intraverbal, the antecedent stimuli were “Name the country of Rome” and the correct response was “Italy”; in the B-C Country-Continent intraverbal, the antecedent stimuli were “Name the continent of Italy” and the correct response was “Europe.” The other two A-B and B-C intraverbals were analogous, referred to Lima, Peru, and America. For clarity purposes, we denominated the four A-B and B-C intraverbals as the taught intraverbals.

Another eight intraverbals resulted from combining some of the stimuli of the four intraverbals taught. These were the B-A Country-City, the C-B Continent-Country, the A-C City-Continent, and the C-A Continent-City intraverbals. For example, in the C-A intraverbal, the antecedent stimuli were “Name the city of Europe” and the correct response was “Rome.” We denominated these eight intraverbals as the probed ABC intraverbals, or the novel intraverbals.

We formed all the intraverbals that result from combining the six stimuli (Europe, America, Italy, Peru, Rome, and Lima) as stimuli and responses, with a result in the four taught and the eight probed intraverbals. We denominated these intraverbals as the ABC intraverbals. In addition to the ABC intraverbals, we designed two other types of intraverbals, which were denominated Exemplars and Categories.

**Exemplars** The Exemplars were six intraverbals in which the antecedent stimuli were the terms of the expression, “Name a/an ...” followed by one of the following terms: “city,” “county,” or “continent.” The responses to such utterances defined as correct were the two exemplars of these categories

**Table 2** Stimuli and response components of the taught and probed intraverbals. The notation within brackets was not spoken. The English translation appears in italics below each intraverbal type

Antecedent stimuli	Correct response	
<b>Taught A-B City- Country</b>		
Dime el país de	[A1] Roma	[B1] (Italia)
Dime el país de	[A2] Lima	[B2] (Perú)
Name <i>the country of</i>	[A1] <i>Rome</i>	[B1] <i>(Italy)</i>
Name <i>the country of</i>	[A2] <i>Lima</i>	[B2] <i>(Peru)</i>
<b>Taught B-C Country-Continent</b>		
Dime el continente de	[B1] Italia	[C1] (Europa)
Dime el continente de Perú	[B2] Polonio	[C2] (América)
Name <i>the continent of</i>	[B1] <i>Italy</i>	[C1] <i>(Europe)</i>
Name <i>the continent of</i>	[B2] <i>Peru</i>	[C2] <i>(America)</i>
<b>Probed B-A Country-City</b>		
Dime la ciudad de	[B1] Italia	[A1] (Roma)
Dime la ciudad de	[B2] Perú	[A2] (Lima)
Name <i>the city of</i>	[B1] <i>Italy</i>	[A1] <i>(Rome)</i>
Name <i>the city of</i>	[B2] <i>Peru</i>	[A2] <i>(Lime)</i>
<b>Probed C-B Continent-Country</b>		
Dime el país de	[C1] Europa	[B1] (Italia)
Dime el país de	[C2] América	[B2] (Perú)
Name <i>the country of</i>	[C1] <i>Europe</i>	[B1] <i>(Italy)</i>
Name <i>the country of</i>	[C2] <i>America</i>	[B2] <i>(Peru)</i>
<b>Probed A-C City-Continent</b>		
Dime el continente de	[A1] Roma	[C1] (Europa)
Dime el continente de	[A2] Lima	[C2] (América)
Name <i>the continent of</i>	[A1] <i>Rome</i>	[C1] <i>(Europe)</i>
Name <i>the continent of</i>	[A2] <i>Lima</i>	[C2] <i>(America)</i>
<b>Probed C-A Continent-City</b>		
Dime la ciudad de	[C1] Europa	[A1] (Roma)
Dime la ciudad de	[C2] América	[A2] (Lima)
Name <i>the city of</i>	[C1] <i>Europe</i>	[A1] <i>(Rome)</i>
Name <i>the city of</i>	[C2] <i>America</i>	[A2] <i>(Lima)</i>

used in the A-B and B-C operants (reference the top portion of Table 3). More specifically, when asked, for example, “Name a country,” both “Italy” and “Peru” were correct responses. On the subsequent trial, however, the question asked was slightly modified (i.e., “Name another country”), and in this case only the response not given in the previous trial was considered correct (e.g., if a participant answered “Peru” in the first trial, the correct response in the subsequent trial was “Italy”). These intraverbals were labeled as Exemplars because their correct answer consisted of saying the exemplar of a category.

**Categories** The Categories were six intraverbals in which the antecedent stimuli was the expression “What is ...” followed by one of the following terms: “Rome,” “Lima,” “Italy,”

**Table 3** Stimuli and response components of the Categories and the Exemplars. The English translation appears in italics below each intraverbal type

Antecedent stimuli	Correct response
<b>Exemplars</b>	
Dime una ciudad	(Roma)
Dime una ciudad	(Lima)
Dime un país	(Italia)
Dime un país	(Perú)
Dime un continente	(Europa)
Dime un continente	(América)
Name <i>a city</i>	<i>(Rome)</i>
Name <i>a city</i>	<i>(Lima)</i>
Name <i>a country</i>	<i>(Italy)</i>
Name <i>a country</i>	<i>(Peru)</i>
Name <i>a continent</i>	<i>(Europe)</i>
Name <i>a continent</i>	<i>(America)</i>
<b>Categories</b>	
¿Qué es Roma?	(Una ciudad)
¿Qué es Lima?	(Una ciudad)
¿Qué es Italia?	(Un país)
¿Qué es Perú?	(Un país)
¿Qué es Europa?	(Un continente)
¿Qué es América?	(Un continente)
What is Rome?	<i>(A city)</i>
What is Lima?	<i>(A city)</i>
What is Italy?	<i>(A country)</i>
What is Peru?	<i>(A country)</i>
What is Europe?	<i>(A continent)</i>
What is America?	<i>(A continent)</i>

“Peru,” “Europe,” and “America.” The responses to such utterances defined as correct were, “A city,” “A country,” or “A continent” (see lower part of Table 3). For example, when asked, “What is Rome” the correct response was “A city”. These intraverbals were labeled as Categories because their correct response consisted of saying the name of a category.

**Setting, Instructions, Stimulus Presentation, and Consequences**

The research was conducted in a quiet room located in the participants’ school. The room was equipped with one table and three chairs, and children’s motives decorated the walls. Only the participant, the researcher, and the observer were in the room to guarantee a quiet work environment during the time that the sessions were conducted. Silent was guaranteed by assuring that no other person could interrupt the session. During the experimental sessions, the experimenter—the first

author—sat in front of the participant. At the start of the first session, the experimenter told the participant the following: “I am going to ask you some questions. Sometimes I will let you know whether your answers are correct, but other times I will not tell you anything. Try to do the best you can do. I will record all your answers, and if you do well I will give you some [collection] stamps. OK?” Later on, the experimenter read each question aloud to the participant, waited for 5 s for his or her response, presented the appropriate consequences, wrote down the response, and moved on to the next trial.

For each trial, only the first word said by the participant after the question asked by the experimenter was considered as his or her response for that trial. If the participant said the first syllable of an incorrect answer, then the response was considered incorrect. The absence of any answer to the question presented by the experimenter within 5 s was also considered as an incorrect response. During the teaching phases, correct responses were followed by expressions such as “Very good!,” “Excellent!,” or “How clever you are!” Incorrect responses were followed by “No, [the correct response]” or just by the correct response (e.g., “Name a country”—“Europe” was followed by “No, Italy” or “Italy”). The expressions for correct responses proved to function as reinforcers in the context of this research; also, the consequences for incorrect responses decreased incorrect responding. During the probes, no consequences were provided. Sessions lasted the time that was necessary to complete a probe–teaching–probe cycle: about 30 min when intraverbals were taught and about 15 min when the intraverbals were reviewed. At the end of each session, the experimenter gave the child three collection stamps for participation. Typically, one session was conducted per day (about 3 days per week); sometimes, two sessions were conducted the same day, but the two sessions were always completed in less than 30 min. The children received from 3 to 20 sessions (see below), across a range of 2 to 15 days.

### Overview and Experimental Design

The children were randomly assigned to one of two conditions (see Fig. 2). The five children in Condition 1 learned the Categories, the Exemplars, and the AB and BC intraverbals before the first postintervention probe of the remaining ABC intraverbals; this revision-probe sequence (denominated cycle) was repeated. The five children in Condition 2 learned the Exemplars and the AB and BC intraverbals (but not the Categories) and received the first postintervention probe of the remaining ABC intraverbals; after a variable number of revision-probe cycles (depending on the participant), the Categories were incorporated to the cycle; thus, the Categories were learned, the Exemplars and the AB and BC intraverbals were reviewed, and the postintervention probe was conducted. Thereafter, the cycles were as in Condition 1. When a child

achieved a criterion of 12 correct responses in the probe for the ABC intraverbals, the child’s participation was terminated at that point.

The dependent variable was the emergence of the probed ABC intraverbals. The independent variable was the effect of learning the Categories. The teaching of the Exemplars and the AB and BC intraverbals were experimental preparations. The intervention as a whole (i.e., Conditions 1 and 2) was a multiple-baseline design with repeated probes for the emergence of the untaught ABC intraverbals in which the effect of learning of the Categories was analyzed. Thus, within participants, the data before and after learning the Categories could be compared; across participants, the data of the children who had already learned the Categories at a given point could be compared to the data of the children who had not learned the Categories at that point. The number of participants in Condition 1 allowed additional between-participant comparisons; thus, the data of five children who learned the Categories could be compared to the data of five children who did not at that point yet learn the Categories. In order to facilitate this comparison, the Categories were introduced to the children who received Condition 2 after most children in Condition 1 had demonstrated the emergence of all probed ABC intraverbals. This comparison was especially interesting because it was suspected, after carefully analyzing data of previous and pilot studies, that the moment of learning the Categories could have an effect on the emergence.

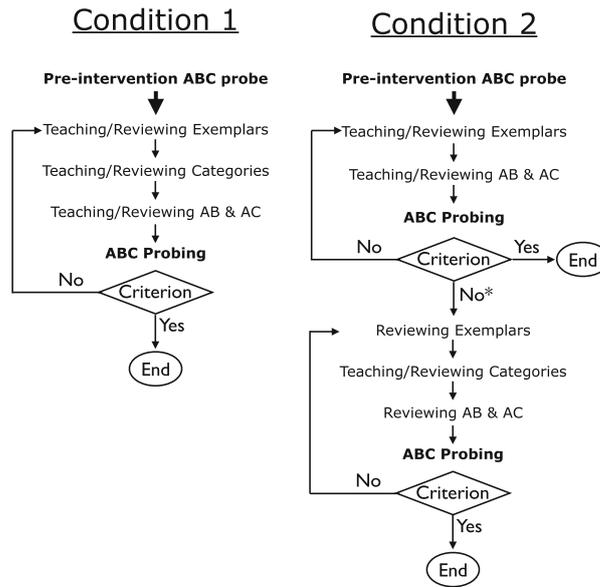
### Conditions 1 and 2

All children received preintervention probes to ensure that they did not have acquired the intraverbals prior to the experiment. Children in Condition 1 received the preintervention probes, learned the Categories, learned the Exemplars, learned A-B and B-C relations, and received the probed ABC intraverbals (as described in the next sections). If the child did not respond correctly to the 12 intraverbals in the probe, Phase 11 of the Categories, Phase 5 of the Exemplars, and Phase 7 of the ABC intraverbals were reviewed and the probes of the ABC intraverbals were repeated. The child’s participation was terminated when the child achieved criterion, or after a maximum of 15 probes. Children in Condition 2 received identical sequence, except that the Categories were introduced in the 7th, 8th, 9th, 10th, and 14th cycle, and the child’s participation finished if criterion was not achieved after a maximum of eight probes since the introduction of the Categories.

### Preintervention Probes

**Probes of the ABC intraverbals** In the pretest, the probe of the ABC intraverbals consisted of presenting the antecedent stimuli of the 12 ABC intraverbals (see Table 2) in random

**Fig. 2** Probing and teaching sequence in Conditions 1 and 2. The first time a type of intraverbals appears in the sequence, these intraverbals were taught; thereafter, they were reviewed. The asterisk indicates the continuation of the procedure after a variable number of cycles (see text), with the inclusion of teaching and reviewing the Categories



order with the restriction that the stimuli of each intraverbal were presented once in each 12 trials block. Thereafter, when the probe was presented to evaluate the effect of teaching the A-B and B-C intraverbals on the emergence of the rest of the ABC intraverbals. It consisted of presenting the 12 intraverbals of Table 1 twice, also in random order with the restriction that each intraverbal was presented once in each 12 trial block.

**Probe of the Categories** This probe consisted of presenting the antecedent stimuli of the six intraverbals shown in the bottom part of Table 3, in random order. Each intraverbal was presented twice, making up a 12-trial probe.

**Probe of the Exemplars** This probe consisted of presenting the antecedent stimuli of the six intraverbals shown in the upper part of Table 3, in random order. Each intraverbal was presented twice, resulting in a 12-trial probe.

**Teaching the A-B and B-C Intraverbals**

**Teaching A-B City-Country** We taught the A-B intraverbals in 3 phases. In Phase 1, the question was, “Name the country of the Rome” [A1]. The experimenter provided the correct response (“Italy” [B1]) in the first two trials. After three consecutive correct responses, the experimenter moved to Phase 2. Phase 2 was identical to Phase 1, but the target question changed to, “Name the country of Lima” [A2] and the correct response was

“Peru” [B2]. In Phase 3, the two questions from Phases 1 and 2 were intermixed randomly, with the restriction that two trials of each question appeared every four trials. The experimenter did not provide prompts within any trial. After 12 correct consecutive responses, the experimenter moved to the next phase.

**Teaching B-C Country-Continent** We taught the B-C intraverbals in three phases, exactly as the A-B intraverbals. The questions were, “Name the continent of Italy” [B1], (“Europe” [C1] was the correct response) and, “Name the continent of Peru” [B2] (“America” [C2] was the correct response).

**Teaching A-B City-Country and B-C Country-Continent mixed** During the last phase of teaching the ABC intraverbals, the experimenter presented the four City-Country and Country-Continent questions randomly intermixed, with the restriction that the four questions appeared every four trials. This phase ended after 12 consecutive correct responses. From the second cycle of teaching and probing onward, the teaching of the A-B and B-C intraverbals consisted only of this phase.

**Teaching Exemplars and Categories**

**Teaching Exemplars** Because each question of an Exemplar had two correct responses, the experimenter presented the same request for two consecutive trials. In the first trial, the

correct response was either one of the previously defined correct answers (see Table 3). In the second trial, the correct response was the correct answer not produced in the first trial. For example, in the first trial, the experimenter asked, "Name a city." If the participant responded "Lima," then the response was considered correct. Thereafter, the experimenter asked, "Name another city." In this case, the correct response was "Rome"; then, in this trial, answering "Lima" was not correct. We taught the Exemplars in five phases: In Phase 1, the question was "Name a city." In the first four trials, the experimenter prompted the correct answer. Beginning with the fifth trial, the experimenter did not provide prompts, but he or she continued providing differential consequences. When the participant emitted four consecutive correct responses, the experimenter moved on to Phase 2. Phase 2 was identical to Phase 1 except that the antecedent stimuli were "Name a country," and the correct responses were "Italy" and "Peru." In Phase 3, pairs of trials with the stimuli of Phases 1 and 2 were presented in a random order. After 12 consecutive correct responses, the experimenter moved on to the next phase. Phase 4 was identical to Phases 1 and 2, but the stimuli were "Name a continent" and the correct responses were "Europe" and "America." Phase 5 was similar to previous phases, but pairs of trials with the three stimuli of Phases 1, 2, and 4 were intermixed, with the restriction that the six pairs of questions appeared every 12 trials. When the participant made 12 consecutive correct responses in this phase, the teaching of the Exemplars ended.

**Teaching Categories** We taught the Categories in 11 phases. In Phase 1, the antecedent stimuli were, "What is Rome?" and the correct response was "A city." The experimenter provided the correct response in the first two trials. After three consecutive correct responses with no prompts, the experimenter moved on to Phase 2. Phase 2 was identical to Phase 1, but the antecedent stimuli were "What is Peru?" and the correct response was, "A country." In Phase 3, the two questions of Phases 1 and 2 were intermixed randomly, with the restriction that two questions of each type appeared every four trials. The experimenter did not provide prompts in any trial. After 12 correct consecutive responses, the experimenter moved on to the next phase. Phases 4, 5, and 6 were identical to Phases 1 to 3, except for that the stimuli presented were, "What is Europe?" (the correct response was "A continent") and, "What is Lima?" (the correct response was "A city"). Phases 7, 8, and 9 were identical to Phases 1 to 3, except for that the stimuli were, "What is Italy?" (the correct response was, "A country") and, "What is America?" (the correct response was, "A continent"). In Phase 10, the four operants taught in Phases 1 to 6 were intermixed randomly, with the restriction that all the four questions appeared every four trials. After 12 correct consecutive responses, the next phase began. In Phase 11, the six intraverbals taught in Phases 1 to 9 were intermixed, with the restriction that all of them appeared every six trials. When

the participant emitted 12 correct consecutive responses in this phase, the teaching of the Categories ended.

#### Data Recording and Interobserver Agreement

One observer was present in some sessions to collect data independently for computing interobserver agreement. In the study, 7,829 trials of a total of 13,951 were observed (56.11%). The experimenter and the observer agreed on 7,819 trials; thus interobserver agreement (agreements / [agreements + disagreements] × 100) was 99.8%. The observer verified the integrity of the procedure by recording whether the experimenter presented the antecedent and consequent stimuli according to the predetermined experimental plan. The experimenter presented the stimuli correctly in all trials.

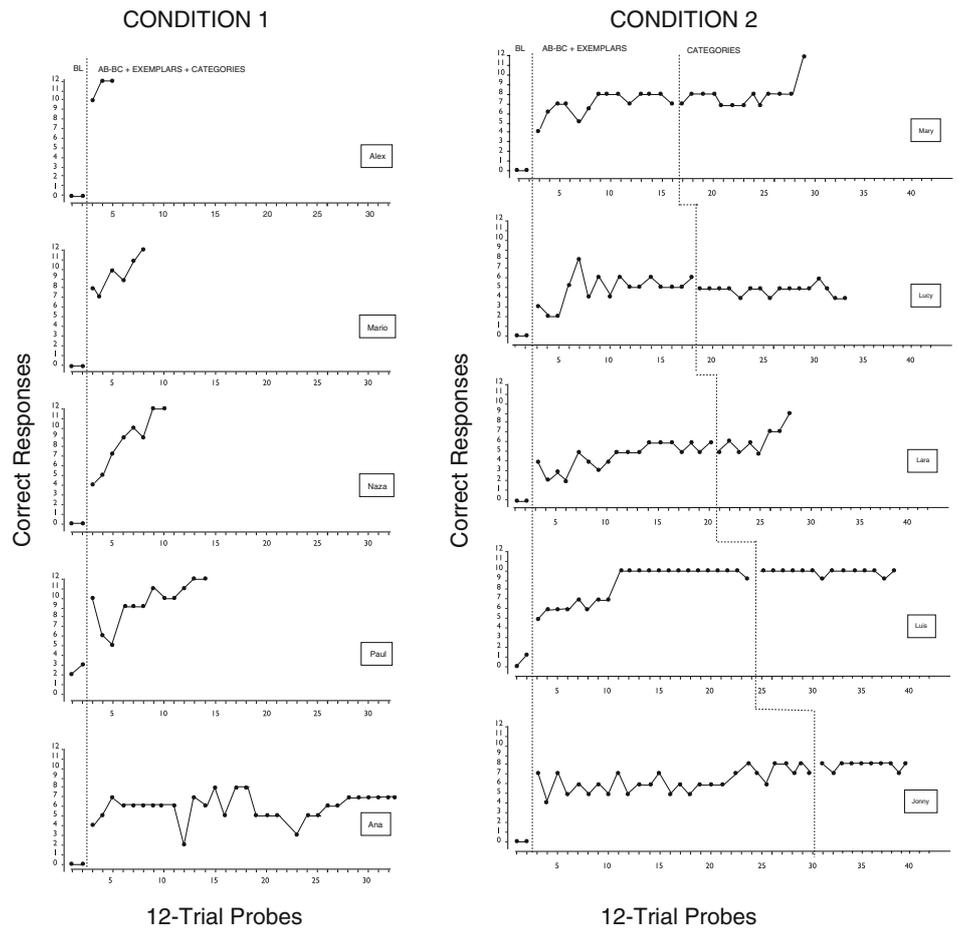
## Results

### Preintervention Probes

Eight of the 10 children responded incorrectly to all trials of the ABC, Category, and Exemplar probes. Paul responded correctly to 5 of the 24 trials of the probed ABC intraverbals, and he responded incorrectly to all trials of the Category and Exemplar probes. Luis responded correctly to 1 of 24 trials of the probed ABC intraverbals, and he responded incorrectly to all trials of the Category and Exemplar probes.

**Condition 1** Figure 3 shows the results of the participants to the ABC intraverbals probes. Detailed results appear in Table 4 in the appendix. Four out of five participants demonstrated the emergence of the ABC intraverbals. Participants Alex, Mario, Naza, and Paul reached the emergence criterion in two to six probes. Participant Ana demonstrated the emergence of the A-C intraverbals, but they did not demonstrate the emergence of the C-A, B-A, and CB intraverbals after 15 probes. The B-A and A-C intraverbals were the first to emerge in all participants. The C-B intraverbals emerged afterwards in one participant (Paul) and the C-B and C-A intraverbals emerged at the same time in three participants (Alex, Mario, and Naza).

**Condition 2** Figure 3 shows the results of the participants to the probes of the ABC intraverbals. Detailed results appear in Tables 5, 6, 7, 8, and 9. None of the children demonstrated the emergence of all the probed ABC intraverbals after learning the Exemplars and the A-B and B-C relations but not the Categories. Participant Luis demonstrated the emergence of BA, AC, and CB relations, but he did not demonstrate the CA relations. Participant Jonny demonstrated the emergence of only the BA and CB relations and participants Lucy and Lara did not demonstrate the emergence of any probed ABC relations. After learning the Categories, only participant Mary demonstrated the



**Fig. 3** Correct responses obtained in the ABC intraverbal probes. The vertical lines on the left separate results preintervention probes from probes after the first intraverbals were taught. The scattered vertical

lines on the right in Condition 2 separate probes conducted before and after the Categories were taught

emergence of all novel intraverbals. The remaining four participants did not demonstrate the emergence of any relation that had not demonstrated before learning the Categories.

**Discussion**

The main goal of the present study was to analyze the effect of teaching the Categories together with the Exemplars in the

emergence of the probed ABC intraverbals. The five children who demonstrated the emergence of all the ABC intraverbals did so after learning the Categories. Four children were from Condition 1 and, therefore, learned the Categories before the first probe of the ABC intraverbals. The fifth child, from Condition 2, demonstrated the emergence of the BA and AC intraverbals before the Categories were introduced, but she only demonstrated the emergence of the CB and CA intraverbals after she learned the Categories. In contrast, none of the five children of Condition 2 demonstrated the

emergence of all the ABC intraverbals before learning the Categories. Participant Luis demonstrated the BA, AC, and CB intraverbals before the Categories were introduced, and he did not demonstrate emergence of the remaining intraverbals after learning the Categories. Participant Jonny demonstrated the emergence of BA and CB intraverbals before learning the Categories, and he did not demonstrate the emergence of the remaining intraverbals after the Categories were introduced. Participants Lucy and Lara did not demonstrate the emergence of any intraverbal either before or after the Categories were introduced. These results indicate that teaching the Categories, together with the Exemplars and the AB and BC intraverbals, has a strong influence in the emergence of the probed ABC intraverbals in 6- and 7-year-old children.

An additional goal of the present study was to determine whether learning the Exemplars alone (i.e., before learning the Categories) could be enough for demonstrating the probed ABC intraverbals. None of the five children in the present study demonstrated the emergence of the probed ABC intraverbals after learning the Exemplars and the AB and BC intraverbals alone. These results strongly indicate that teaching the Exemplars without the Categories has little or no influence in the emergence of the probed ABC intraverbals. Given the observed results, the main conclusion of the present study is that for most 6- and 7-year-old children to demonstrate the emergence of the probed ABC intraverbals, they need to learn the simple Exemplar and Category intraverbals, and the AB and BC complex intraverbals from the beginning.

The most surprising finding of the present research was that four children out of the five who learned the Categories before the first postintervention ABC intraverbals probe (in Condition 1) demonstrated the emergence of the probed ABC intraverbals, whereas only one child out of the five who learned the Categories after a number of cycles with ABC intraverbals probes (in Condition 2) demonstrated the emergence. Moreover, four children of Condition 1 who demonstrated the emergence did so in the second, third, fourth, and sixth probe, at a faster rate of acquisition than the child of Condition 2 who demonstrated the emergence in the 14th probe; this was the same number of probes that were conducted for the participant who demonstrated the emergence with fewer probes.

The children participants were randomly assigned to one of the two conditions. They attended the same classroom, of the same grade and school, and none of the children were identified as having learning difficulties. Moreover, the participants of Condition 2 were identified as being approximately 2 months older than the participants of Condition 1. Thus, the outcomes of the present study suggest that learning the Categories to mastery, together with the Exemplars, before the first post-intervention ABC intraverbals probe, has a strong influence in the emergence of all the probed ABC intraverbals.

#### **Do Exemplars and Categories Guarantee the Emergence of the ABC Probed Intraverbals?**

The results of the present study replicated the Pérez-González et al. (2008) results, as all 4- to 7-year-old children who learned the Exemplars and Categories first in that study demonstrated the emergence of all the probed ABC intraverbals. Thus, most children (eight out of nine 6- to 7-year-old children) who learned the Exemplars and the Categories in these two studies demonstrated the emergence of the ABC intraverbals. Moreover, seven out of nine 6- to 7-year-old children who participated in Carp and Petursdottir (2012) study demonstrated the emergence of the probed ABC intraverbals; these children learned Exemplars and Categories in the case that they did not demonstrate the emergence of the probed ABC intraverbals before. Five children of that study demonstrated the emergence before learning both Exemplars and Categories. Four children received one probe after learning both Exemplars and Categories; two of these four children demonstrated the emergence of the probed ABC intraverbals, and the other two children did not. According to the data of the present study, it would be likely that these two children had demonstrated the emergence of the probed ABC intraverbals in the event that (a) they had learned the Exemplars and Categories before the first probe, and (b) additional probes had been conducted. In such a case, most or all of the 6- and 7-year-old children would have demonstrated the emergence of the probed ABC intraverbals. In conclusion, the results of the three studies conducted so far are congruent with the theory that most 6- and 7-year-old children demonstrate the emergence of the probed ABC intraverbals if they learn before the Exemplars and the Categories.

#### **Do Exemplars Suffice for the Emergence?**

None of the five children in the present study demonstrated the emergence of the probed ABC intraverbals after learning the AB and CB intraverbals and Exemplars alone (e.g., that have not learned the Categories). The only study, as far as we know, that has explored the emergence of the probed ABC intraverbals after learning the Exemplars and the AB and BC intraverbals alone with children was Carp and Petursdottir (2012) study, with two 6-year-old children. None of these children demonstrated the emergence of all the probed ABC intraverbals. The results of the present study and those of Carp and Petursdottir study suggest that teaching the Exemplars alone in 6- and 7-year-old children does not affect the emergence of the probed ABC intraverbals.

#### **Are Exemplars and Categories Necessary for the Emergence?**

According to the data of the three studies on the ABC intraverbals, neither Exemplars nor Categories are necessary

for the emergence of the probed ABC intraverbals, even in 6- and 7-year-old children. This assertion is demonstrated by the fact that one child in Pérez-González et al. (2008) study and three children in Carp and Petursdottir (2012) study who did not learn Exemplars and Categories demonstrated the emergence of the probed ABC intraverbals after learning just the A-B and the B-C intraverbals.

#### Why Have both Exemplars and Categories a so Strong Influence in Emergence?

Collectively, the data of the present study together with those of previous studies provide a clear answer to the questions about the influence of Exemplars and Categories in the emergence of all probed ABC intraverbals after learning the A-B and B-C intraverbals. The accumulation of the data obtained with the 10 children who participated in the present study clarifies the role of Exemplars and Categories: First, the probed ABC intraverbals emerged even when the participant had not learned Exemplars or Categories, in children as well as in adults. It emerged in 1 of 15 6-year-old children (as observed in Pérez-González et al. 2014a, b, and the present study), 6%; it emerged in 3 of 9 of 6- and 7-year-old children (Carp & Petursdottir, 2012), 33%; and it emerged in 4 of 6 adults (Pérez-González et al. 2014a, b), 66%. Second, learning Exemplars alone (together with the A-B and B-C intraverbals) did not facilitate the emergence of the probed ABC intraverbals in any of the eight 6- and 7-year-old children (five in the present study and three in Carp & Petursdottir study), 0%; but it facilitated the emergence in all the adults (in Pérez-González et al. 2014a, b), 100%. The influence of learning the Categories alone seems to be less effective than learning Exemplars alone: zero of three 6-year-old children (in Carp & Petursdottir), 0%; and two of four adults (in Pérez-González et al. 2014a, b), 50%. In summary, the percentage of participants that demonstrated the emergence with a given experience (i.e., learning Exemplars or Categories) increased with age; moreover, the requirements for the emergence of the probed ABC relations decrease with age. First, Exemplars and Categories have a strong influence; later, Exemplars do; and, finally, some children and most adults demonstrate the emergence without the need of learning neither Exemplars nor Categories.

We believe that age is not a variable of influence per se; actually, the data of the present and previous studies show a large variability across individuals of the same age. Instead, we believe that the achievements acquired along development are the result of the individual's interactions with the environment. Therefore, age is used in this theoretical analysis because of the likely correlations between time and interactions. It is very likely that the process responsible for the individuals needing fewer requirements for demonstrating the emergence of the probed ABC intraverbals across time deals with the

acquisition of specific skills or specific verbal developmental behavioral cusps or capabilities (e.g., Greer & Du, 2015; Pérez-González 2015).

The identified requirement for acquiring the Exemplars for the ABC emergence is not surprising according to a pure discriminative analysis. For example, for the C-A intraverbal, "Name a city of Europe"—"Rome" to emerge, it is reasonable that the child had to acquire the simpler Exemplar intraverbal, "Name a city"—"Rome." The response in the C-A intraverbal is controlled by two stimuli ("city" and "Europe"), and the response in the Exemplar intraverbal is controlled by only one stimulus ("city"). The later intraverbal plus another intraverbal with the other stimulus ("Europe") can be enough for the emergence of this C-A intraverbal (see also a discussion on this issue in Carp & Petursdottir, 2012). In fact, studies with selection-based responses conducted with adults show that if a stimulus (P1) controls the selection of A1 and stimulus Q1 also controls the selection of A1, then P1 and Q1 together control the selection of A1 when this stimulus is presented with two other stimuli, with which a selection has been controlled by only one stimulus (e.g., either A2 or B1). Under the proper learning conditions, all participants demonstrated the emergence of this responding (Alonso-Álvarez & Pérez-González, 2006; Pérez-González, & Alonso-Álvarez, 2008; Alonso-Álvarez & Pérez-González, 2011; Alonso-Álvarez & Pérez-González, 2013), but it is very important to note that teaching or probing symmetry was not necessary in any of these studies. This behavioral description describes what in lay terms could be explained as that in order to respond that Rome is a city of Europe, a person needs to know that Rome is a city. In pure and direct behavioral terms, the participant must be able to respond "Rome" when asked to name a city.

The results of the present study indicate that acquiring the direct "city"—"Rome" operant is not enough for the emergence of complex ABC intraverbals (i.e., Exemplars are not enough). Instead, the two symmetrical relations that involve "city" and "Rome" are needed; in other words, the Category operant, "What is Rome"—"A city" is needed as well as the Exemplar intraverbal. In behavioral terms, the person must be able to respond "Rome" when asked to name a city as well as to respond "city" when asked what is "Rome." This symmetrical requirement may be surprising to some scholars and it is the main finding of the present and former studies on this issue. This finding, however, has been found in other, related processes: The first process was observed with selection-based conditional discriminations in a study on complex stimulus relations in which selection was dependent upon the relation between other stimuli (Pérez-González, 1994). Initially, a conditional discrimination AB was taught; this established the A1-B1, A2-B2, and A3-B3 relations. Second, a Stimulus A and another Stimulus B were presented as a compound sample (e.g., A1-B1) and two novel Stimuli X1 and X2 were the comparisons. Selections of X1 were reinforced if the two

stimuli in the sample have been together in AB (e.g., A1-B1) and selections of X2 were reinforced if the two stimuli in the sample have not been together in AB (e.g., A1-B3); this teaching aimed to give X1 a function similar to say, “Yes, these two stimuli go together,” and to give X2 a function similar to say, “No, these two stimuli does not go together.” Third, a novel discrimination PQ was taught, with the purpose of teaching additional stimulus–stimulus relations similar to AB, as necessary for the final stage. Finally, a P and a Q stimulus were presented with stimuli X1 and X2 as comparisons, in an emergence probe; the purpose of this probe was to verify that the function of X1 and X2 were the intended functions, by demonstrating that the participants would select X1 and X2 according to the relation between the two stimuli in the sample in a generalized way, regardless of particular stimuli. Some adults demonstrated the emergence, and others did not. The surprising finding here was that virtually all adults and children that received symmetry probes of the AB and PQ relations (i.e., BA and QP) demonstrated the emergence. Interestingly, virtually all participants who demonstrated the emergence of the PQX relations in the replications of Pérez-González' (1994) study did so after being probed with the symmetrical relations (e.g., Carpentier, Smeets, & Barnes-Holmes, 2000, 2002a, b; Junior & Costa, 2003; Junior, Costa, Gonsales, & Golfeto, 2001).

The second process was observed in naming studies. A number of these have shown that children are able to perform a classification when they demonstrate naming and sometimes they are not able to before demonstrating naming (Horne, Hughes, & Lowe, 2006; Horne, Lowe, & Harris, 2007; Horne, Lowe, & Randle, 2004; Lowe, Horne, Harris, & Randle, 2002; Lowe, Horne, & Hughes, 2005; Mahoney, Miguel, Ahearn, & Bell, 2011; Miguel, Petursdottir, Carr, & Michael, 2008). Naming is defined as a bidirectional relation between an object and event and a name. Thus, it includes the Object-Name relation (the tact) and its symmetrical Name-Object relation. Of importance here is that it is not just the tact of the objects that has a strong influence in classification but also the tact and its symmetrical relation. Therefore, the effects of Exemplars and Categories in the emergence of the probed ABC intraverbals can be related to the role of symmetry in the emergence of complex conditional discriminations such as PQX and to the role of naming in categorization. These effects may be the result of a unique, general process. This hypothesis sounds very interesting. For this reason, it would be noteworthy if this hypothesis is analyzed in further research.

#### Replication of Previous Studies

The present study replicated the previous studies (Pérez-González et al. 2014a, b; Pérez-González, Herszlikowicz, & Williams, 2008) regarding the order of emergence of the probed ABC intraverbals. Specifically, the BC intraverbals emerged before than the BA intraverbals (both are the

symmetrical relations to the AB and BC intraverbals). Moreover, the AC intraverbals emerged before than the CA intraverbals (the AC intraverbals are transitive relations while the CA intraverbals combine transitivity and symmetry, by respect to the taught AB and BC intraverbals). The intraverbals with the A elements as responses emerged last. The reason can be related to the fact that the responses in the taught intraverbals are B and C elements and, hence, the A elements are never taught as responses. The effect of learning the Exemplars on the emergence of the probed ABC intraverbals can be related to this effect, as responses with the A elements are taught in the Exemplars.

#### Note on the Designs Suitable to Study Emergence

The present results compel the researchers to reconsider the types of designs that are ideal to probe the effects of independent variables on emergence probes. Traditional reversal designs have been of a great utility in behavior analysis, especially in applied behavior analysis. These designs cannot be used in emergence probes because once a relation has been learned or is shown in an emergence probe the participant typically continues to respond correctly; therefore, reverting the relation by coming back to the point in which the relation has not been learned or did not emerge is impossible. For that reason, reversals designs are not used in emergence experiments. Although simple AB designs have been used in stimulus equivalence studies and also in other studies on the emergence of novel relations, a number of studies have used multiple-baseline designs, which require repeating number of probes before introducing the independent variable. The results of the present study suggest that multiple-baseline designs are not ideal for studying the effect of the dependent variable because the repetition of probes may have an effect on the dependent variable. For this reason, other designs should be used. Multiple-probe designs (Horner & Baer, 1978) can serve because a reduced number of baseline probes are conducted before the intervention. Carp and Petursdottir (2012), however, failed to observe the emergence after presenting a very low number of probes before the intervention; even though a low number of probes were presented in that study, the data of the present study suggest that these probes could have prevented emergence. Pérez-González et al. (2014a, b) also found an effect between conducting the probes before or after Categories were taught; the effect was little and nonsignificant but noteworthy to analyze further. Therefore, these possible effects should be considered for selecting a specific design.

#### Limitations and Applications

The present study was conducted with a limited number of participants. Although they are coherent with the studies cited above, additional studies are needed to provide additional

evidence. Moreover, the factors involved in the acquisition of these capacities, that make possible that a child demonstrate a type of emergence at a given moment, are yet unknown and also call to carry out additional research.

All things considered, the present study has notable potential applications, as provide a way to facilitate or induce the emergence of intraverbals. For example, Solomon et al. (2011) have demonstrated that adults diagnosed with autism performed differently from neurotypical persons in transitive inference tasks, something that could be related the difficulties to generalize and properly adapt to social situations demonstrated by many persons with this diagnosis. The results of the present study, together with previous studies on the emergence

of intraverbals, can help to develop techniques that provide people with autism with the capabilities to comprehend with greater sophistication, especially in novel situations, and derive socially appropriate responding.

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**Appendix A**

**Table 4** Correct responses out of 4 trials (or 2 trials when indicated by the asterisk) in each intraverbal in each session of Condition 1, in the preintervention probes ("Pre"), and after learning the AB, BC intraverbals, the Exemplars, and the Categories

Intraverbal	Session															
	Pre	AB + BC + Exemplars + Categories														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<b>Alex</b>																
AB	0	4	2*													
BC	0	4	2*													
BA	0	4	2*													
CB	0	3	2*													
AC	0	4	2*													
CA	0	3	2*													
Total	0	22	12*													
<b>Mario</b>																
AB	0	3	4	4												
BC	0	3	4	4												
BA	0	4	3	4												
CB	0	2	2	4												
AC	0	1	4	3												
CA	0	2	2	4												
Total	0	15	19	23												
<b>Naza</b>																
AB	0	4	4	4	2*											
BC	0	4	4	4	2*											
BA	0	1	4	1	2*											
CB	0	0	1	3	2*											
AC	0	0	3	4	2*											
CA	0	0	0	3	2*											
Total	0	9	16	19	12*											
<b>Paul</b>																
AB	3	3	3	2	4	4	2*									
BC	0	4	3	4	4	4	2*									
BA	2	4	3	3	3	4	2*									
CB	0	2	2	3	4	4	2*									
AC	0	2	2	4	4	4	2*									

**Table 4** (continued)

	Session															
	Pre	AB + BC + Exemplars + Categories														
Intraverbal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CA	0	1	1	2	2	1	2*									
Total	5	16	14	18	21	21	12*									
Ana																
AB	0	4	3	4	3	3	4	4	4	4	3	4	4	4	4	4
BC	0	4	4	3	4	3	4	4	4	4	4	3	4	4	4	4
BA	0	0	2	0	1	1	2	1	1	1	0	0	0	1	1	1
CB	0	1	3	2	2	0	0	0	1	0	0	0	0	2	2	2
AC	0	0	0	1	0	0	1	2	4	1	1	3	4	3	3	3
CA	0	0	1	2	2	1	2	2	2	0	0	0	0	0	0	0
Total	0	9	13	12	12	8	13	13	16	10	8	10	12	14	14	14

\*The probe was presented once because the criterion was achieved

**Table 5** Correct responses out of 4 trials (or 2 trials when indicated by the asterisk) in each intraverbal in each session of Condition 2 conducted with Mary in the preintervention probes ("Pre"), after learning the AB, BC intraverbals and the Exemplars, and after learning the Categories

	Session															
	Pre	AB + BC + Exemplars								Categories						
Intraverbal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
AB	0	4	4	3	4	4	4	4	3	4	4	4	4	4	2*	
BC	0	3	4	4	4	4	4	3	4	4	4	4	4	4	2*	
BA	0	0	2	0	4	3	4	4	4	4	4	4	4	4	2*	
CB	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2*	
AC	0	3	3	4	4	4	4	4	4	4	2	3	3	4	2*	
CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2*	
Total	0	10	14	11	16	15	16	15	15	16	14	15	15	16	12*	

\*The probe was presented once because the criterion was achieved

**Table 6** Correct responses out of 4 trials in each intraverbal in each session of Condition 2 conducted with Lucy in the preintervention probes ("Pre"), after learning the AB, BC intraverbals and the Exemplars, and after learning the Categories

	Session																
	Pre	AB + BC + Exemplars								Categories							
Intraverbal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
AB	0	4	3	3	4	4	4	4	4	4	4	4	3	4	4	2	2
BC	0	0	0	3	4	4	4	4	4	4	4	4	3	4	4	2	4
BA	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0
CB	0	0	1	2	1	1	1	0	0	0	0	0	1	0	0	2	0
AC	0	1	1	2	0	0	2	2	2	0	0	0	0	0	0	2	0
CA	0	0	1	2	0	1	0	0	1	2	2	1	1	2	2	3	2
Total	0	5	7	12	10	11	11	10	11	10	10	9	9	10	10	11	8

**Table 7** Correct responses out of 4 trials in each intraverbal in each session of Condition 2 conducted with Lara in the preintervention probes (“Pre”), after learning the AB, BC intraverbals and the Exemplars, and after learning the Categories

Intraverbal	Session													
	Pre										Categories			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
AB	0	4	4	4	4	4	4	4	4	4	4	4	4	4
BC	0	1	1	2	2	2	4	4	4	4	4	4	4	4
BA	0	1	0	3	1	3	1	2	1	2	1	1	0	1
CB	0	0	0	0	0	1	2	2	2	1	1	2	2	1
AC	0	0	0	0	0	0	0	0	0	0	1	0	1	2
CA	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Total	0	6	5	9	7	10	11	12	11	11	11	11	12	14

**Table 8** Correct responses out of 4 trials in each intraverbal in each session of Condition 2 conducted with Luis in the preintervention probes (“Pre”), after learning the AB, BC intraverbals and the Exemplars, and after learning the Categories

Intraverbal	Session																			
	Pre												Categories							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AB	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
BC	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
BA	0	3	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	3	4
CB	0	0	0	0	0	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4
AC	0	0	0	1	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	11	12	13	14	20	20	20	20	20	20	19	20	20	20	19	20	20	19	20

**Table 9** Correct responses out of 4 trials in each intraverbal in each session of Condition 2 conducted with Jonny in the preintervention probes (“Pre”), after learning the AB, BC intraverbals and the Exemplars, and after learning the Categories

Intraverbal	Session																			
	Pre															Categories				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AB	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
BC	0	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
BA	0	3	3	1	1	3	1	3	1	2	1	3	3	4	4	3	4	4	4	4
CB	0	1	1	2	1	1	2	1	2	2	4	4	3	3	3	4	4	4	4	3
AC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	11	12	11	11	12	12	12	11	12	13	15	14	15	15	15	16	16	16	15

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### 3.3. Tercer Artículo

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ORIGINAL ARTICLE

## Effect of Learning Tacts or Tacts and Intraverbals on the Emergence of Intraverbals About Verbal Categorization

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**Abstract** This research explored the effects of teaching tacts with two procedures on the emergence of intraverbals in 5- and 6-year-old children. Three children in Experiment 1 learned 2 verbally controlled tacts in the presence of a picture of a woman. For example, when they were asked “Name the country,” they learned to say her country (e.g., Pakistan); when they were asked “Name the tribe,” they learned to say the name of her tribe (e.g., Kalash). Then, the 2 country-tribe intraverbals were probed without reinforcement (e.g., “Name the tribe from Pakistan”—“The Kalash”). The three children demonstrated the emergence of the intraverbals. Seven children in Experiment 2 learned a tact (either to name the country or the tribe), as in Experiment 1, and an intraverbal (either “Name the tribe from Pakistan”—“The Kalash” or “Name the country of the Kalash”—“Pakistan,” respectively). Five children demonstrated the emergence of the probed intraverbals. These procedures were demonstrated to be effective to produce the emergence of the intraverbals. We discuss why the procedure in Experiment 1 was slightly more effective than that of Experiment 2 in terms of the discriminative control exerted by the nonverbal and verbal stimuli in each condition. The procedure can be useful for promoting the emergence of intraverbals in children with and without learning disabilities.

**Keywords** Intraverbals · Tacts · Verbal behavior · Stimulus equivalence · Stimulus relations · Reasoning · Transitive inference · Children

Intraverbals are verbal operants characterized by the emission of a verbal response after the presentation of a verbal stimulus that shows no point-to-point correspondence with the response (Skinner, 1957). Intraverbals are a relevant part of our complex language repertoire and they may have a big influence in social relations and reasoning. Intraverbals can be directly taught (e.g., Braam & Poling, 1983; Chase, Johnson, & Sulzer-Azaroff, 1985; Partington & Bailey, 1993; Sundberg & Sundberg, 1990; Vignes, 2007; Watkins, Pack-Teixeira, & Howard, 1989; see reviews by Axe, 2008; Cihon, 2007) or they can be brought about with other teaching strategies (e.g., Greer, Yuan, & Gautreaux, 2005; Kisamore, Carr, & LeBlanc, 2011; Sautter, LeBlanc, Jay, Goldsmith, & Carr, 2011).

An important developmental milestone occurs when a person demonstrates novel skills that have not been taught directly to him or her, as an extra outcome of learning related skills, typically by direct contingencies (Greer & Ross, 2008; Pérez-González, 2015). When a person responds correctly to new relations that have not been directly taught after learning other related relations, it is said that an *emergent* process has occurred. Being able to respond to questions after observing the environment and tacting its elements, for example, demonstrates the emergence of novel verbal skills. Emergent processes are involved in generative behavior and in responding to novel verbal utterances; for example, in the generation and understanding of metaphors, analogies, and transitive inference (see Pérez-González, 2015, for an extensive analysis of the importance of emergence). The emergence of intraverbals has been broadly demonstrated (e.g., Belloso-Díaz &

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Pérez-González, 2015a, b; Carp & Petursdóttir, 2012; Kisamore et al., 2011; May, Hawkins, & Dymond, 2013; Partington & Bailey, 1993; Pérez-González, Beloso-Díaz, Caramés-Méndez, & Alonso-Álvarez, 2014a; Pérez-González & García-Asenjo, 2015; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Pérez-González, Herszlikowicz, & Williams, 2008; Pérez-González, Salameh, & García-Asenjo, 2014b; Petursdóttir, Carr, Lechago, & Almason, 2008; Petursdóttir & Hafliadóttir, 2009; Petursdóttir, Ólafsdóttir, & Aradóttir, 2008; Polson & Parsons, 2000).

The theoretical analysis of stimulus equivalence can be useful for analyzing the existing possibilities to teach skills that result in the emergence of intraverbals. Of importance is to note that for the most studied types of emergence, stimuli in simple or conditional discriminations are linked to one another because a stimulus A1 is related to a stimulus B1, and B1 is related to a stimulus C1. Given certain learning and probing experiences, the three stimuli are related, such that, for example, a person demonstrates that relates stimulus C1 to A1; also, that person relates B1 to A1 (e.g., see Sidman, 1994). Demonstrations of the novel relations are verified in probed, not taught, discriminations. When a person demonstrates these discriminations, the emergence of each specific relation is documented. The emergence of intraverbals is possible from learning discriminations with common elements. The fact that these elements are of different modality or function (e.g., stimuli and responses) does not preclude the emergence, as demonstrated in the studies with intraverbals (e.g., Beloso-Díaz & Pérez-González, 2015a, 2015b; Carp & Petursdóttir, 2012; May et al., 2013; Pérez-González et al., 2014a; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Pérez-González, Herszlikowicz, & Williams, 2008; Pérez-González 2014b; Petursdóttir & Hafliadóttir, 2009; Petursdóttir, Ólafsdóttir, & Aradóttir, 2008; Polson & Parsons, 2000).

The simplest preparation to probe the emergence of intraverbals after learning related skills with nonverbal stimuli involves two verbal stimuli of the intraverbals and one nonverbal stimulus. For example, intraverbals can emerge after learning other intraverbals, tacts, and selections. In that vein, Petursdóttir, Carr et al. (2008) studied the emergence of intraverbals with words in Icelandic and Spanish in four Icelandic children who knew these words (i.e., had learned relations between the verbal stimuli in Icelandic and their corresponding nonverbal stimuli). They taught the children either (a) to tact the pictures in Spanish or (b) to select a picture after hearing its Spanish word, and probed the remaining relations. The two children who learned the tacts responded above 83 % in the emergence probes of the Icelandic-Spanish and the Spanish-Icelandic intraverbals. The other two children did not respond above that level in most probes. Petursdóttir and Hafliadóttir (2009) studied

the emergence of intraverbals with words in Icelandic and Italian in two Icelandic children who knew these words (i.e., had learned relations between the verbal stimuli in Icelandic and their corresponding nonverbal stimuli). They taught the children either (a) to tact a drawing in Italian, (b) to select a drawing after hearing the Italian word, (c) the Italian-Icelandic intraverbals, or (d) the Icelandic-Italian intraverbals, and probed the remaining relations. The intraverbals emerged in only one child in only two of the four conditions. The results of these studies (and other similar studies like the one by Petursdóttir, Carr et al., 2008) indicate how difficult is to design procedures that result in the intraverbal emergence.

Another study demonstrated the emergence of intraverbals after learning two related tacts: Lipkens, Hayes, and Hayes (1993) taught a 2-year-old boy to say the names of uncommon animals in response to "What is this?" and to say the supposed sound in response to "What does this say?" in the presence of the pictures in both cases. The child demonstrated the emergence of two intraverbals: "What does [name of the animal] say?," for the name-sound intraverbal, and expression like "Listen [animal sound], what do you hear?" for the sound-name intraverbal. These results were replicated by May et al. (2013) with three adolescents with autism. They taught them to respond to "What is the name of this monster?" while presenting a picture of the monster (e.g., "Simon"). Then, they taught them to respond to "What food does this monster eat?" while presenting the same picture of the monster (e.g., "chips"). Finally, they probed intraverbals such as "What food does Simon eat?" and "Which monster eats chips?" All three children demonstrated the emergence of the intraverbals.

The present study is a first attempt to systematically investigate the emergence of intraverbals after learning operants with one nonverbal stimulus (e.g., a picture) and two verbal stimuli (e.g., two names related to the picture). Three types of relations are involved: contextually controlled tacts, in which the stimulus is the nonverbal stimuli and the response is verbal; selections, in which the selection response to one of several nonverbal stimuli is controlled by a verbal stimulus; and intraverbals, in which a verbal stimulus controls a verbal response. After learning two relations, the remaining relations can emerge. In the present study, we analyzed the emergence of intraverbals after learning either two tacts or after learning one tact and one intraverbal. Thus, in Experiment 1, we explored emergence of intraverbals in which two related tacts were taught in the presence of a picture. The skills taught and probed were similar to those used by Lipkens et al. (1993) and May et al. (2013). In Experiment 2, we explored the emergence of one intraverbal after learning the picture-verbal stimulus relation (a tact) and the symmetrical intraverbal. In addition, we used words related to categorization in a different way; in fact, we used pictures of women as

nonverbal stimuli and the names of the country and the tribe they belong to as verbal stimuli. (Although most tribes belong only to a country, it is not always the case and the words *country* and *tribe* have not such a bidirectional relation to a particular woman as the woman's name could have; i.e., a country may have many tribes, and a tribe has many women, whereas a particular woman has a bidirectional relation with the name of that woman.) The main goal of the present study was to explore the emergence of intraverbals after learning other relations. In addition, we asked whether the procedures of Experiment 2 could result in more instances of intraverbal emergence than the procedures used in the studies that taught tacts, used in Experiment 1. Yet, a comparison among the results in the three conditions could be useful for understanding the processes involved in the emergence of these types of intraverbals.

### General Method

#### Participants

Ten Spanish-speaking children, four females and six males, with ages between 5 years 2 months and 6 years 2 months, participated (see Table 1). They were typically developing and attended the third grade of preschool in a public school. The children were randomly assigned to one of the two experiments and to one or the two conditions of Experiment 2.

#### Stimuli and Definition of Correct Responses

All the study was conducted in Spanish. There were intraverbals, tacts, and selections (see definitions below). See an overview of the relations in Figs. 1 and 3.

**Intraverbals** Two types of intraverbals were used: the A-B Country-Tribe and B-A Tribe-Country intraverbals (see Table 2). For example, in an A1-B1 Country-Tribe intraverbal, the antecedent stimuli were "Name the tribe from Pakistan" and the correct response was "The Kalash"; in the B-A Tribe-Country intraverbal, the antecedent stimuli were "Name the country of the Kalash" and the correct response was "Pakistan." The other two A-B and B-A intraverbals were analogous, referring to Ethiopia and the Surma.

**Tacts** Two types of tacts were used: the P-A Picture-Country and P-B Picture-Tribe tacts (see Table 2). In the P1-A1 Picture-Country tact, the antecedent stimuli was the picture of a woman from Pakistan and the verbal instruction "Name the Country," and the correct response was "Pakistan"; in the P1-B1 Picture-Tribe tact, the antecedent stimuli was the same picture of the woman from Pakistan

**Table 1** Name, sex, and age (years and months) of the participants

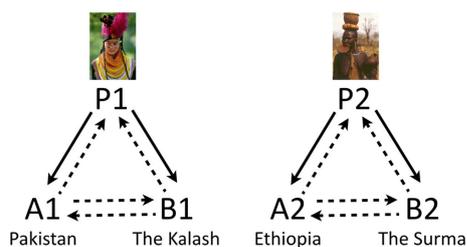
Name	Sex	Age
Experiment 1		
Alberto	Male	5y 6 m
Álvaro	Male	5y 5 m
Andrés	Male	5y 2 m
Experiment 2. Condition 1		
Bruno	Male	5y 10 m
Bea	Female	5y 7 m
Bárbara	Female	5y 7 m
Blanca	Female	5y 8 m
Experiment 2. Condition 2		
Celia	Female	5y 5 m
Carlos	Male	5y 11 m
Celso	Male	6y 2 m

with the verbal instruction "Name the tribe," and the correct response was "The Kalash." The other two P-A and P-B tacts were analogous, referring to Ethiopia and the Surma.

**Selections** There were also two types of selection skills: the A-P Country-Picture and the B-P Tribe-Picture (see Table 2). These were conditional discriminations in which the sample was the name of the country or the name of the tribe, and the comparisons were the pictures with the woman of each country/tribe. In A1-P1 Country-Picture skill, the antecedent stimuli were "Point to that from Pakistan," and the correct response was to select the picture of the woman from Pakistan. In the B-P Tribe-Picture skill, the antecedent stimuli were "Point to that from the Kalash," and the correct response was to select the picture of the woman from Pakistan.

#### Procedures

**Setting, Instructions, Stimulus Presentation, and Consequences** The research was conducted in a quiet room



**Fig. 1** Taught (solid lines) and probed (dashed lines) relations in Experiment 1

**Table 2** Stimuli and response components of the taught and probed relations

Antecedent stimuli		Correct response	
<b>P-A Picture-Country tact</b>			
Dime	el país	[P1]	[A1] Pakistán
Dime	el país	[P2]	[A2] Etiopía
Name	<i>the country</i>	[P1]	[A1] <i>Pakistan</i>
Name	<i>the country</i>	[P2]	[A2] <i>Ethiopia</i>
<b>P-B Picture-Tribe tact</b>			
Dime	la tribu	[P1]	[B1] Los Kalash
Dime	la tribu	[P2]	[B2] Los Surma
Name	<i>the tribe</i>	[P1]	[B1] <i>The Kalash</i>
Name	<i>the tribe</i>	[P2]	[B2] <i>The Surma</i>
<b>A-P Country-Picture selection</b>			
Señala	la de Pakistán	[P1] [P2]	Selecting [P1]
Señala	la de Etiopía	[P1] [P2]	Selecting [P2]
Point to	<i>that from Pakistan</i>	[P1] [P2]	Selecting [P1]
Point to	<i>that from Ethiopia</i>	[P1] [P2]	Selecting [P2]
<b>B-P Tribe-Picture selection</b>			
Señala	la de los Kalash	[P1] [P2]	Selecting [P1]
Señala	la de los Surma	[P1] [P2]	Selecting [P2]
Point to	<i>that from the Kalash</i>	[P1] [P2]	Selecting [P1]
Point to	<i>that from the Surma</i>	[P1] [P2]	Selecting [P2]
<b>A-B Country-Tribe intraverbal</b>			
Dime	la tribu de	[A1] Pakistán	[B1] Los Kalash
Dime	la tribu de	[A2] Etiopía	[B2] Los Surma
Name	<i>the tribe of</i>	[A1] <i>Pakistan</i>	[B1] <i>The Kalash</i>
Name	<i>the tribe of</i>	[A2] <i>Ethiopia</i>	[B2] <i>The Surma</i>
<b>B-A Tribe-Country intraverbal</b>			
Dime	el país de	[B1] los Kalash	[A1] Pakistán
Dime	el país de	[B2] los Surma	[A2] Etiopía
Name	<i>the country of</i>	[B1] <i>the Kalash</i>	[A1] <i>Pakistan</i>
Name	<i>the country of</i>	[B2] <i>the Surma</i>	[A2] <i>Ethiopia</i>

Note. The notation within brackets was not spoken. The English translation appears in italics below each relation type.

located in the participant's school. The room was equipped with one table and four chairs; moreover, children's drawings and pictures decorated the walls. Silence was guaranteed by assuring that no other person could interrupt the session. During the experimental sessions, the experimenter (the first author) sat in front of the participant. At the start of the first session, the experimenter told the participant the following: "I am going to ask you some questions. Sometimes I will let you know whether your answers are correct, but other times I will not tell you anything. Try to do the best you can do. I will record all your answers, and if you do well, I will give you some [collection] stamps. OK?" Later on, the experimenter read each question aloud to the

participant, waited for 5 s for his or her response, presented the appropriate consequences, wrote down the response, and moved on to the next trial.

For each trial, only the first response of the participant after the question read to him or her by the experimenter was considered as his or her response for that trial. If the participant said the first syllable of an incorrect answer, then the response was considered incorrect. The absence of any answer to the question presented by the experimenter within 5 s was also considered as an incorrect response. During the teaching phases, correct responses were followed by expressions such as "Very good!", "Excellent!", or "How clever you are!"; incorrect responses were followed by "No, [the correct response]" or just by the correct response (e.g., "Name the country—"The Kalash" was followed by "No, Pakistan" or "Pakistan"—a correction). The expressions for correct responses proved to function as reinforcers in the context of this research; also, the consequences for incorrect responses decreased incorrect responding. During the probes, no consequences were provided. Sessions lasted the time that was necessary to complete a probe-teaching-probe cycle—approximately, 15 to 20 minutes. At the end of each session, the experimenter gave the child three collection stamps, regardless of performance.

**Overview of the Sequence Followed in Each Study and Condition**

All children received preintervention probes to ensure that they had not acquired the relations prior to the experiment. Then, they learned the two relations assigned to each experiment or condition in Phases 1–3 and 4–6, and received Phase 7 in which the two learned relations were intermixed, with the restriction that the four questions appeared every four trials. This phase ended after 12 consecutive correct responses. Finally, they received the Postintervention Probe. If the child did not respond correctly to the 12 relations in the probe, Phase 7 of each teaching condition was reviewed and the Postintervention Probe was repeated. If the child achieved the criterion, stopped to respond during two probes, or after a maximum of 7 probes, the child's participation finished.

**Pre- and Postintervention Probes**

In the Preintervention Probe, the antecedent stimuli of the 12 relations described on Table 2 were presented in random order (12 trials). In the Postintervention Probe, when the probe was presented to evaluate the effect of the teaching procedures on the emergence of the remaining relations, it consisted of presenting the 12 relations twice (a total of 24 trials), also in random order.

**Teaching P-A Picture-Country Tacts**

We taught the P-A tacts in 3 phases. In Phase 1, the experimenter presented the picture of the woman from Pakistan (P1) and asked, "Name the Country." She provided the correct response ("Pakistan" [A1])

in the first two trials. After three consecutive correct responses without prompts, the experimenter moved to Phase 2. Phase 2 was identical to Phase 1, but she presented the picture of the woman from Ethiopia (P2) and the correct response was "Ethiopia" (A2). In Phase 3, the two pictures of Phases 1 and 2 were intermixed randomly, with the restriction that two trials of each picture appeared every four trials. The experimenter did not provide prompts in any trial, but incorrect responses were followed by the correct response emitted by the experimenter (a correction). After 12 correct consecutive responses, the experimenter moved to the next phase.

**Teaching P-B Picture-Tribe Tacts** We taught the P-B tacts in three phases, exactly as the P-A tacts. The experimenter presented the picture of the woman from Pakistan (P1) and asked, "Name the tribe" ("The Kalash" [B1] was the correct response), or presented the picture of the woman from Ethiopia (P2) ("The Surma" [B2] was the correct response).

**Teaching A-B Country-Tribe Intraverbals** We taught the A-B intraverbals in three phases. In Phase 1, the question was, "Name the tribe from Pakistan" (A1), and the correct response was "The Kalash" (B1). The experimenter provided the correct response in the first two trials. After three consecutive correct responses without prompts, the experimenter moved to Phase 2. Phase 2 was identical to Phase 1, but the question was, "Name the tribe from Ethiopia" (A2), and the correct response was "The Surma" (B2). In Phase 3, the two questions of Phases 1 and 2 were intermixed randomly, with the restriction that two trials of each question appeared every four trials. The experimenter did not provide prompts in any trial, but incorrect responses were followed by a correction. After 12 correct consecutive responses, the experimenter moved to the next phase.

**Teaching B-A Tribe-Country Intraverbals** We taught the B-A intraverbals using the same procedure as that used for teaching A-B Country-Tribe intraverbals but the question in Phase 1 was, "Name the country of the Kalash" (B1), and the correct response was "Pakistan" (A1), and the question in Phase 2 was "Name the country of the Surma" (B2), and the correct response was "Ethiopia" (A2). Moreover, these two questions were presented in Phase 3.

#### Experimental Designs

The dependent variable was the emergence of the two intraverbals, in Experiment 1, or the emergence of the probed intraverbals, in Experiment 2. Ancillary, the emergence of tacts and selections was also recorded. The independent variable was the procedure used in each condition, which consisted of teaching two relations. Experiment 1 consisted of one condition and Experiment 2 consisted of two conditions. Within conditions, a

pre-post experimental design with repeated probes was used. Typically, each child started and finished the experimental sessions at different days (thus, this manipulation controlled the effects of external variables, like in a nonconcurrent design). This manipulation controlled that the children had not learned the probed relations outside the experimental sessions.

#### Data Recording and Interobserver Agreement

A second observer was present in some sessions to take data independently for computing the interobserver agreement. In the study, 841 trials of a total of 2,576 were observed (32.6%). The interobserver agreement (agreements / [agreements + disagreements]  $\times$  100) was 99.8% (range across children from 99.6% to 100%). The observer verified that the experimenter presented the antecedent and consequent stimuli according to the predetermined experimental plan. The procedure was always performed according to it.

#### Experiment 1

The goal of Experiment 1 was to replicate, with simpler procedures, Lipkens et al.'s (1993) and May et al.'s (2013) studies. The procedures were aimed also to solve some of the limitations of May et al.'s procedures.

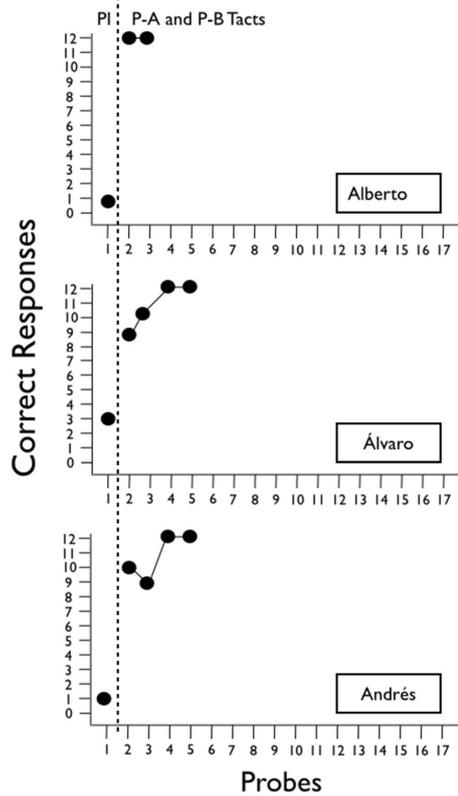
#### Specific Methods

The overview of the procedure consisted of teaching the P-A Picture-Country and the P-B Picture-Tribe tacts and probing the selections and the intraverbals (see Fig. 1). The detailed procedures were the following: We conducted the Preintervention Probes, taught the P-A Picture-Country tacts and the P-B Picture-Tribe tacts in Phases 1–3 and 4–6, respectively, mixed them in Phase 7 and conducted the Postintervention Probe. If the criterion was not reached, then Phase 7 and the Postintervention Probe were repeated.

#### Results

**Preintervention Probes** All children responded correctly only in some trials of the selection skill, and none responded correctly to all of them. The reason they responded correctly to only some of these trials was that their response was based on selection, and the probability to respond correctly was 50%. None of the three children responded correctly to any of the rest of the relations probed.

**Postintervention Probes** Figure 2 shows the results. Detailed results appear in Appendix, Table 5. All children demonstrated the emergence of all new relations. Participants Alberto, Álvaro, and Andrés demonstrated the emergence (i.e., made



**Fig. 2** Results in the 12-trial probes of Experiment 1, corresponding to four tacts, four intraverbals, and four selections (results of each operant appear in Appendix Table 5). Note. PI indicates “Preintervention probe.” Dotted lines indicate that the P-A and P-B tacts were taught. The probes were conducted twice in each session. After every two probes represented by two circles, the teaching phases with the P-A and P-B tacts were reviewed

four out of four correct responses) of all probed relations in one, two, and two probes, respectively. Alberto demonstrated the emergence of A-P and B-P selections and the A-B and B-A intraverbals in the first probe after learning P-A and P-B tacts. Álvaro demonstrated the A-P and B-P selections and the B-A intraverbals in the first probe after learning P-A and P-B tacts. Álvaro demonstrated the all relations in the second probe. Andrés demonstrated the emergence of A-P and B-P selections, B-A intraverbals, and some trials of A-B intraverbals (those related to the stimuli “Ethiopia” and “the Surma”), but he responded incorrectly to the taught P-B tact

relation related to the stimuli “Ethiopia” and “the Surma” in the first probe after learning P-A and P-B tacts. Andrés demonstrated the emergence of all relations in the second probe.

**Discussion**

All three children demonstrated the emergence of the intraverbals. The results replicated those obtained by Lipkens et al. (1993) and May et al. (2013). The procedure in the present study, however, was simpler than in the cited studies: First, Lipkens et al. used animal sounds. Because the relational frame with the sounds could have been taught to the child by his caregivers, this likely fact could have facilitated the emergence with the animal sounds used in the experiment (even though the sounds used in the study were novel to the child). Second, May et al. explicitly taught the relational frame before the children showed the emergence. That teaching could have facilitated the emergence. The result of the present study, instead, cannot be accounted for by using stimuli and relations similar to other learned by the children or by explicitly teaching a relational frame. Instead, the data of the present study shows a clear relation between learning the tacts and the emergence of intraverbals because children did not receive any pretraining and the stimuli used were not common stimuli in their daily life. The present results could have been affected by learning related relational frames, but the effect of such learning would be more remote than in the cited studies.

**Experiment 2**

Experiment 1 demonstrated the emergence of two intraverbals (and two selections) after learning two types of tacts. The goal of the present experiment was to explore the emergence of one complex intraverbal after learning the other (symmetrical) intraverbal and one of the two types of tacts.

**Specific Methods**

There were two conditions (see an overview in Fig. 3). In Condition 1, we taught the P-A Picture-Country tacts and the A-B Country-Tribe intraverbals. In Condition 2, we taught the P-B Picture-Tribe tacts and the B-A Tribe-Country intraverbals. In each condition we conducted the Preintervention Probe, taught the P-A Picture-Country or the P-B Picture-Tribe tacts in Phases 1–3 and the A-B Country-Tribe or B-A Tribe-Country intraverbals in Phases 4–6, mixed them in Phase 7, and conducted the Postintervention Probe. If the criterion was not reached, then Phase 7 and the Postintervention Probe were repeated. Thus, as explained in the General Method section, within conditions the experiment was a pre–post intervention design with repeated probes. Across conditions, the results in the emergence of the

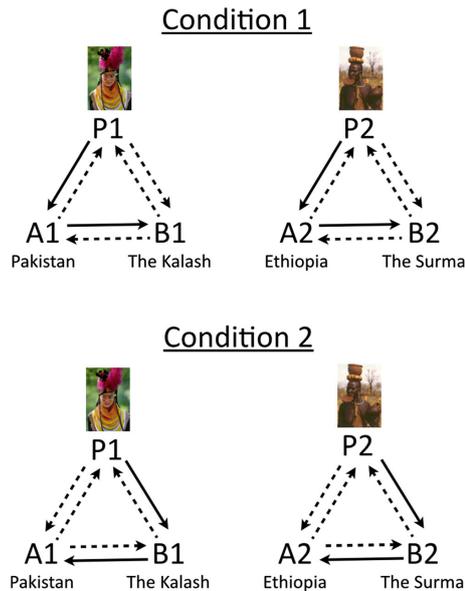


Fig. 3 Taught (solid lines) and probed (dashed lines) relations in Experiment 2

intraverbals were compared to find out what type of intraverbal could be more likely to emerge.

### Results

**Condition 1** Figure 4 shows the results of the participants in the probes. Detailed results appear in Appendix, Table 6. Three of four children demonstrated the emergence of all probed relations (i.e., reached the criterion of four correct responses in the four trials of each probed relations). Bruno, Bea, and Bárbara demonstrated the emergence of all probed relations after learning P-A tacts and A-B intraverbals by the second, second, and third probe, respectively. Bruno demonstrated the emergence of the A-P and B-P selections and the B-A intraverbals, but he respond incorrectly to one trial of P-A tact related to the stimuli “the Surma” and one trial of the taught P-A tact related to the stimulus “Pakistan.” Bruno demonstrated the emergence of all relations in the second probe. Bea responded correctly to two trials of P-B tacts, five trials of A-P, and B-P selections in the first probe after learning the P-A tacts and the A-B intraverbals. Bea demonstrated the emergence of all probed relations in the second probe. Bárbara demonstrated the emergence of A-P selections and B-A intraverbals, but she did not respond correctly to all trials of

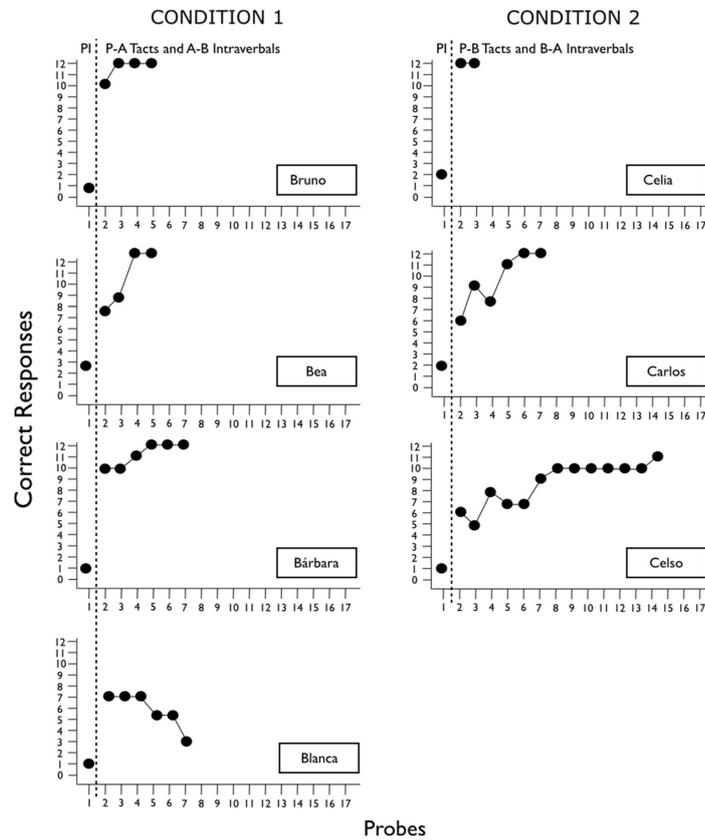
B-P selections, and the P-B tacts in the first probe after learning P-A tacts and A-B intraverbals. In the second probe, Bárbara responded correctly to all relations except one trial of P-B selections. She demonstrated the emergence of all probe relations in the third probe. Blanca demonstrated the emergence of only the A-P selections in the first probe after learning the P-A tacts and the A-B intraverbals. After the first probe, Blanca started to respond incorrectly to more trials in the probe; then, her participation finished.

**Condition 2** Figure 4 shows the results of the participants in the probes. Detailed results appear in Appendix, Table 7. Two of three children in Condition 2 demonstrated the emergence of all probed relations. Celia demonstrated the emergence of all probed relations in the first probe after learning the P-B tacts and B-A intraverbals. Carlos, in the first and second probes, demonstrated the emergence of A-P and B-P selections and responded correctly to some trials of A-B intraverbals and P-A tacts, but he failed to respond correctly in two trials of the taught P-B tact in the first probe. Carlos demonstrated the emergence of all probed relations in the third probe. Celso demonstrated the emergence of all relations except the A-B intraverbal related to the stimulus “Pakistan” and “the Kalash” after seven probes.

### Discussion

Five of seven children in this experiment demonstrated the emergence of the symmetrical intraverbals after learning the taught intraverbals and the tacts. These results indicated that the tacts can facilitate the emergence of bidirectional intraverbals in children. This studied replicated the results of Petursdottir, Ólafsdóttir et al. (2008) in that the children that learned the tacts demonstrated the emergence of the intraverbals. They contrast with the results obtained by Petursdottir and Hafliadóttir (2009) because in this study only one of the two children in one of the two stimulus sets demonstrated the emergence of one of the two probed intraverbals. The reasons for these differences can reside in specific procedures. The children in these two studies had already learned tacts and selections with the names in their native language. This fact could have affected the results. Moreover, the difference between the two studies (i.e., Petursdottir, Ólafsdóttir et al.’s and Petursdottir & Hafliadóttir’s) was that in the latter they taught tacts, selections, and intraverbals with four stimuli. That number of stimuli could have affected the emergence of the intraverbals in that the emergence could be more difficult than if the number of stimuli were lower (in that line, see

**Fig. 4** Results in the 12-trial probes of Experiment 2, corresponding to four tacts, four intraverbals, and four selections (results of each operant appear in Appendices Tables 6 and 7). *Note.* PI indicates “Preintervention probe.” Dotted lines indicate that the P-A and A-B intraverbals (in Condition 1) or the P-B tacts and B-A intraverbals (in Condition 2) were taught. The probes were conducted twice in each session. After every two probes represented by two circles, the teaching phases were reviewed



probable effects of teaching order on the emergence of the intraverbals in Bellosó-Díaz & Pérez-González, 2015a).

**General Discussion**

The three children of Experiment 1, who learned the P-A and P-B tacts, demonstrated the emergence of the two intraverbals. Five out of seven children of Experiment 2, who learned either the P-A and the A-B intraverbals or the P-B tacts and the B-A intraverbal, demonstrated the emergence of the other intraverbal. Thus, most children demonstrated the emergence of the intraverbals.

Experiments 1 and 2 produced similar results. The procedure of Experiment 1, however, was more effective than that of Experiment 2 for the emergence of the intraverbals, as all

children of Experiment 1 demonstrated the emergence of the intraverbals whereas two children of Experiment 2 failed to show the emergence. The intraverbals used in Experiment 1 were *complex* intraverbals, in the sense that the intraverbal response was under the control of two *relevant* stimuli; for example, the spoken words *country* and *Kalash*. The tacts were also complex tacts (also denominated *intraverbal tacts*) because the response was under the control of two *relevant* stimuli; for example, the picture of the woman from Pakistan and the verbal instruction, “Name the country.” The intraverbals, on one hand, and the tacts, on the other, taught in groups as in the present study, consisted of conditional discriminations because the response in each trial was controlled by two antecedent stimuli (see Alonso-Álvarez & Pérez-González, 2006, 2011, 2013; Axe, 2008; Eikeseth & Smith, 2013; Pérez-González & Alonso-Álvarez, 2008;

**Table 3** The discrimination presented in Phase 7 of Experiment 1, in Spanish and the English translation (italics)

Relation	Irrelevant stimulus	Relevant Stimuli		Response
		Verbal stimulus	Non-verbal stimulus	
<i>Spanish</i>				
P1-A1	Dime	el país	[Picture 1]	[A1] Pakistán
P2-A2	Dime	el país	[Picture 2]	[A2] Etiopía
P1-B1	Dime	la tribu	[Picture 1]	[B1] Los Kalash
P2-B2	Dime	la tribu	[Picture 2]	[B2] Los Surma
<i>English</i>				
P1-A1	Name	<i>the country</i>	[Picture 1]	<i>[A1] Pakistan</i>
P2-A2	Name	<i>the country</i>	[Picture 2]	<i>[A2] Ethiopia</i>
P1-B1	Name	<i>the tribe</i>	[Picture 1]	<i>[B1] The Kalash</i>
P2-B2	Name	<i>the tribe</i>	[Picture 2]	<i>[B2] The Surma</i>

*Note.* The relations are identical in both languages. Both the verbal stimulus and the picture control the response. Therefore, it is a conditional discrimination.

Pérez-González, Herszlikowicz, & Williams, 2008). In fact, when the children of Experiment 1 learned to respond to the P-A and P-B tacts, they learned to respond in the presence of two relevant stimuli (see Table 3). Moreover, the response was verbal and it was the same as in the probed intraverbals. Even more, as in May et al.'s (2013) study, the four taught tacts were intermixed across trials in Phase 7. For the participants to reach criterion in this phase, they had to attend both to a verbal stimulus (either "country" or "tribe") and also to the picture (either Picture 1 or Picture 2)—they did not need to attend to the remaining stimuli. The response in each trial was under the control of the two stimuli. The participants in this experiment demonstrated the emergence of the intraverbals very quickly. This fact indicates that the procedure used in Experiment 1 can be very effective to produce the emergence of complex intraverbals in children. Conversely, in the teaching phases of Experiment 2 the children did not have the opportunity to respond according to two relevant stimuli. Instead, they learned to respond to only one stimulus in an intraverbal and to one stimulus in the tact, even in Phase 7 when the P-A tacts and the A-B intraverbals were intermixed across trials (see Table 4). In the P-A tacts, children could respond correctly attending only to the picture shown because the remaining stimuli of the verbal instruction were the same across trials (i.e., "Name the country" in the P-A tacts); moreover, in the A-B intraverbal, children could have responded correctly attending only to one stimulus ("Pakistan" or "Ethiopia") because the remaining portion of the verbal instruction was the same across trials (i.e., "Name the tribe of"). Thus, the response in each trial was under the control of a single stimulus—the skill was a simple discrimination. Although several children demonstrated the emergence of the intraverbals, not all of them were successful. These facts indicate that if the conditional discrimination is not guaranteed, some children may not learn to respond under the appropriate

stimulus control and the emergence is less likely. In summary, the main contribution of the present study, as suggested by the results of Experiments 1 and 2, is that teaching tacts based on conditional discriminations may be more effective in facilitating emergence of complex intraverbals than if the children learn relations that do not involve conditional discriminations.

The results of Experiment 1 replicated those of Lipkens et al. (1993) and May et al. (2013). Like in those studies, the participants demonstrated the emergence of the two intraverbals after learning two contextually-controlled tacts. The results of Experiment 2 were congruent with those of Petursdottir, Ólafsdóttir et al. (2008) and Petursdottir and Hafliðadóttir (2009) because they demonstrated also the emergence of the probed intraverbals. More proportion of children demonstrated, however, the emergence of the probed

**Table 4** The discrimination presented in Phase 7 of Condition 1 of Experiment 2, in Spanish, and the English translation (italics)

Relation	Irrelevant stimuli	Relevant Stimuli	Response
<i>Spanish</i>			
P1-A1	Dime	el país	[Picture 1] [A1] Pakistán
P2-A2	Dime	el país	[Picture 2] [A2] Etiopía
A1-B1	Dime	la tribu de	[A1] Pakistán [B1] Los Kalash
A2-B2	Dime	la tribu de	[A2] Etiopía [B2] Los Surma
<i>English</i>			
P1-A1	Name	<i>the country</i>	[Picture 1] <i>[A1] Pakistan</i>
P2-A2	Name	<i>the country</i>	[Picture 2] <i>[A2] Ethiopia</i>
A1-B1	Name	<i>the tribe of</i>	[A1] <i>Pakistan</i> [B1] <i>The Kalash</i>
A2-B2	Name	<i>the tribe of</i>	[A2] <i>Ethiopia</i> [B2] <i>The Surma</i>

*Note.* The relations are identical in both languages. The picture and the verbal stimulus A1 or A2 control the response. The remaining verbal stimuli are not necessary for responding. Therefore, it is a simple discrimination.

intraverbals in the present study than in those of the two studies cited last. The differences could be related to specific parts of the procedures, as mentioned above. Moreover, we intermixed all taught and probed relations in the probes, whereas in some of the previous studies the learned relations were not intermixed.

The study had limitations. First, the experimental design was a pre-post intervention design with partial control of external variables by conducting the sessions with each child mostly nonconcurrently. Further studies with more elaborated designs are necessary for replicating the results of the present study. Second, two out of seven 5-year-old children did not show the emergence of the probed intraverbals. This fact indicates that some variables involved in the emergence, like the variable or variables that determined the emergence in most children but not in two children, are still to be controlled. A possible variable could be the previous experience with the emergence of related types of intraverbals: It could be that children in Experiment 2 who demonstrated the emergence had learned to attend two stimuli in operants like those used in the present study or other similar ones, and they did so during the present study, in spite that attending to only one stimulus would suffice to reach the learning criterion; participant Blanca, however, could attend only the stimuli required to reach criterion, and that was not sufficient to succeed in the emergence probes. Further studies should respond to the challenge of finding these variables. Those studies can analyze the function of some parts of the procedure. For example, they can analyze the effect of adding phases in which the taught relations are randomly intermixed or the effect of randomly intermixing all taught and probed relations in the probes, cited above.

If the results of the present study are replicated, the study has applications because it suggests ways to teach children with and without learning difficulties in order that they produce the emergence of intraverbals involved in reasoning tasks. The present study shows that the procedures used to produce the emergence of intraverbals were successful, and the procedure in Experiment 1 was more effective than those of Experiment 2. Other studies did not show improvement of emergence after teaching other tacts and intraverbals. The main difference between the procedure of the present study and other procedures used in previous studies is that during the teaching phases of the present study children learned to respond vocally to conditional discriminations related to the intraverbals that were probed for emergence. This variable seems to have a strong influence in the production of emergence of intraverbals. Thus, if emergence of intraverbals is the goal of a specific curriculum, then the procedure of Experiment 1 should be used, because it seems more suited to obtain the emergence. Therefore, teaching conditional discriminations involving the discrimination between the two tact types should suffice for the children to demonstrate the intraverbals.

## Appendix

**Table 5** Correct responses out of two trials in the Preintervention Probe or out of four trials in the postintervention probes, in each relation in each session of Experiment 1

Relation	Session															
	PI	P-A and P-B tacts														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>Alberto</b>																
P-A	0	4														
P-B	0	4														
<b>A-P</b>	<b>1</b>	<b>4</b>														
<b>B-P</b>	<b>1</b>	<b>4</b>														
<b>A-B</b>	<b>0</b>	<b>4</b>														
<b>B-A</b>	<b>0</b>	<b>4</b>														
Total	2	24														
<b>Álvaro</b>																
P-A	0	4	4													
P-B	0	2	4													
<b>A-P</b>	<b>2</b>	<b>4</b>	<b>4</b>													
<b>B-P</b>	<b>1</b>	<b>4</b>	<b>4</b>													
<b>A-B</b>	<b>0</b>	<b>1</b>	<b>4</b>													
<b>B-A</b>	<b>0</b>	<b>4</b>	<b>4</b>													
Total	3	19	24													
<b>Andrés</b>																
P-A	0	4	4													
P-B	0	2	4													
<b>A-P</b>	<b>0</b>	<b>4</b>	<b>4</b>													
<b>B-P</b>	<b>1</b>	<b>4</b>	<b>4</b>													
<b>A-B</b>	<b>0</b>	<b>2</b>	<b>4</b>													
<b>B-A</b>	<b>0</b>	<b>3</b>	<b>4</b>													
Total	1	19	24													

Note. "PI" indicates "Preintervention Probes." Data of untaught relations are written in bold.

**Table 6** Correct responses out of two trials in the Preintervention Probes or out of four trials in the postintervention probes, in each relation in each session of Condition 1 of Experiment 2

Relation	Session															
	PI	P-A tacts and A-B intraverbals														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>Bruno</b>																
P-A	0	3	4													
<b>P-B</b>	<b>0</b>	<b>3</b>	<b>4</b>													
<b>A-P</b>	<b>0</b>	<b>4</b>	<b>4</b>													
<b>B-P</b>	<b>0</b>	<b>4</b>	<b>4</b>													

**Table 6** (continued)

		Session															
		PI P-A tacts and A-B intraverbals															
Relation		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A-B		0	4	4													
<b>B-A</b>		<b>0</b>	<b>4</b>	<b>4</b>													
Total		0	22	24													
Bea																	
P-A		0	4	4													
<b>P-B</b>		<b>0</b>	<b>2</b>	<b>4</b>													
<b>A-P</b>		<b>0</b>	<b>3</b>	<b>4</b>													
<b>B-P</b>		<b>2</b>	<b>2</b>	<b>4</b>													
A-B		0	4	4													
<b>B-A</b>		<b>0</b>	<b>0</b>	<b>4</b>													
Total		2	15	24													
Bárbara																	
P-A		0	4	4	4												
<b>P-B</b>		<b>0</b>	<b>1</b>	<b>4</b>	<b>4</b>												
<b>A-P</b>		<b>1</b>	<b>4</b>	<b>4</b>	<b>4</b>												
<b>B-P</b>		<b>2</b>	<b>3</b>	<b>3</b>	<b>4</b>												
A-B		0	4	4	4												
<b>B-A</b>		<b>0</b>	<b>4</b>	<b>4</b>	<b>4</b>												
Total		3	20	23	24												
Blanca																	
P-A		0	4	4	4												
<b>P-B</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>												
<b>A-P</b>		<b>0</b>	<b>4</b>	<b>4</b>	<b>2</b>												
<b>B-P</b>		<b>1</b>	<b>2</b>	<b>1</b>	<b>0</b>												
A-B		0	4	2	2												
<b>B-A</b>		<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>												
Total		1	14	12	8												

Note. "PI" indicates "Preintervention Probes." Data of untaught relations are written in bold.

**Table 7** Correct responses out of two trials in the Preintervention Probes or out of four trials in the postintervention probes, in each relation in each session of Condition 2 of Experiment 2

		Session															
		PI P-B tacts and B-A intraverbals															
Relation		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Celia																	
<b>P-A</b>		<b>0</b>	<b>4</b>														
P-B		0	4														
<b>A-P</b>		<b>1</b>	<b>4</b>														
<b>B-P</b>		<b>1</b>	<b>4</b>														
<b>A-B</b>		<b>0</b>	<b>4</b>														
B-A		0	4														
Total		2	24														

**Table 7** (continued)

		Session															
		PI P-B tacts and B-A intraverbals															
Relation		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Carlos																	
<b>P-A</b>		<b>0</b>	<b>1</b>	<b>2</b>	<b>4</b>												
P-B		0	2	4	4												
<b>A-P</b>		<b>0</b>	<b>4</b>	<b>4</b>	<b>4</b>												
<b>B-P</b>		<b>2</b>	<b>4</b>	<b>4</b>	<b>4</b>												
<b>A-B</b>		<b>0</b>	<b>0</b>	<b>1</b>	<b>4</b>												
B-A		0	4	4	4												
Total		2	15	19	24												
Celso																	
<b>P-A</b>		<b>0</b>	<b>0</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>							
P-B		0	2	4	4	4	4	4	4	4							
<b>A-P</b>		<b>0</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>							
<b>B-P</b>		<b>1</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>							
<b>A-B</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>							
B-A		0	3	4	4	4	4	4	4	4							
Total		1	11	15	16	20	20	20	20	21							

Note. "PI" indicates "Preintervention Probes." Data of untaught relations are written in bold.

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### **3.4. Cuarto Artículo**

## **Emergence of Symmetrical Intraverbals Facilitated by Learning Skills with the Intraverbal Responses**

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## Abstract

The effects of learning tacts and intraverbals with the same response of probed intraverbals on the emergence of symmetrical intraverbals was analyzed in two experiments (e.g., “Name the country of the Kalash”-“Pakistan” was probed after learning the intraverbal with the stimulus-response functions interchanged –like, “Name the tribe of Pakistan”-“The Kalash”). In Experiment 1, the effects of learning tacts with the probed intraverbal as the response was explored by teaching participants to say the word in the presence of the picture (e.g., the experimenter presented a picture of a Kalash woman and asked, “Name the country” –“Pakistan” is the correct response). Five of the six participants demonstrated the emergence of the probed intraverbals after learning the tacts, but not before. In Experiment 2 the effects of learning an intraverbal with identical response, rather than a tact as in Experiment 1, was explored (e.g., learning to say, “Pakistan” in response to, “Name a country of Asia”). Five of the six participants demonstrated emergence of the probed intraverbals after learning intraverbals with the probed response, but not before. In summary, the results of the two experiments demonstrated that learning skills with the response of the targeted intraverbals facilitates the emergence of them. This study may have implications to facilitate verbal emergence in teaching children with and without learning difficulties.

*Key words:* intraverbals, verbal behavior, stimulus relations, symmetry, equivalence, emergence, reasoning, answering questions, children.

## **Emergence of Symmetrical Intraverbals Facilitated by Learning Skills with the Intraverbal Responses**

Intraverbals are verbal operants characterized by the emission of a verbal response after the presentation of a verbal stimulus that shows no point-to-point correspondence with the response (Skinner, 1957). Intraverbals are a relevant part of language, especially in the context of social interactions and in most academic skills (e.g., multiplication tables, naming the parts of the cell, or answering utterances like, “Name three animals,” “Name the color of the sky”). In addition, more sophisticated verbal skills, from answering questions about what happens in daily life to complex reasoning skills also involve intraverbals.

Intraverbals may be directly taught or they may emerge, like most verbal skills. For example, intraverbals can be directly taught with prompts and reinforcement (see Pérez-González, Salameh, & García-Asenjo, 2015; Petursdottir & Carr, 2012, for reviews). A unique feature of verbal behavior consists of generating novel verbal operants or skills that have not been directly taught, after a person has learned other related verbal operants and observed the environment. This discriminative behavior is learned derived from previous learning, as opposed to being taught directly. These novel verbal operants are denominated *emergent operants* or *emergent skills* and the process is denominated emergence (see Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000, and Pérez-González, 2015, for descriptions and discussions of the unique features of emergence). The typical procedure for demonstrating emergence of verbal relations consists of (a) probing without reinforcement the verbal operants for which emergence is sought, to verify that the participant did not learn these prior to the onset of the study, (b) teaching other related operants, and (c) repeating the initial probe without

reinforcement. The documentation of the target operants in the last probe as a result of learning related operants demonstrates emergence. The emergence of intraverbals has been demonstrated extensively (e.g., Braam & Poling, 1983; Carnerero & Pérez-González, 2015; Carp & Petursdottir, 2012; Chase, Johnson, & Sulzer-Azaroff, 1985; Grannan & Rehfeldt, 2012; Kisamore, Carr, & LeBlanc, 2011; Partington & Bailey, 1993; Pérez-González, Beloso-Díaz, Caramés-Méndez, & Alonso-Álvarez, 2014; Pérez-González & García-Asenjo, 2015; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Pérez-González, Herszlikowicz, & Williams, 2008; Petursdottir, Carr, Lechago, & Almason, 2008; Petursdottir & Hafliðadóttir, 2009; Petursdottir, Ólafsdóttir, & Aradóttir, 2008; Polson & Parsons, 2000; Sundberg & Sundberg, 1990; Vignes, 2007; Watkins et al., 1989).

A particular type of emergence of intraverbals results from teaching and probing intraverbals that share elements in reverse stimulus-response functions, which are denominated *symmetrical intraverbals* (see the original denomination of symmetry with selection-based conditional discriminations in Sidman, 1994; and Sidman & Tailby, 1982). For example, Pérez-González et al. (2007) taught children with Pervasive Developmental Disorder (PDD) intraverbals of the type, “Name the opposite of thin” - “thick,” and then probed the emergence of the intraverbal, “Name the opposite of thick”-“thin.” The elements “thin” and “thick” are present in the taught and the probed intraverbals with the opposite stimulus-response functions. For descriptive purposes, we will denominate the taught intraverbals A-B intraverbals and the probed intraverbals B-A intraverbals, where A are stimuli such as "thin" and B are related stimuli such as "thick.” Although symmetrical intraverbals may emerge, emergence does not always occur easily at earlier stages of development or when the intraverbals are complex. For example, in the cited study by Pérez-González et al. (2007), the two participants with

PDD demonstrated emergence, but only after learning both the A-B and B-A relations with several exemplars (i.e., Multiple Exemplar Instruction was required, see Greer & Ross, 2008).

Symmetrical intraverbals may also have different structure in that the two related intraverbals may have different contextual stimuli. For example, Polsons and Parsons (2000) taught intraverbals with either French-English or English-French words and probed the emergence of the inverse relation. In the French-English intraverbals the contextual stimuli were, “What is the English word for ...,” whereas in the English intraverbals the contextual stimuli were, “What is the French word for...”; thus, the words “English” and “French” functioned as contextual stimuli. The participants were native English speaking adults, and were required to respond by typing the words in either the foreign language or their native language. The rate of emergence was much higher when the response of the probed intraverbals was in the native language (i.e., English words for native English speakers) than when the response was in the foreign language (i.e., French words for native English speakers). These results were replicated and extended by Petursdottir and Ólafsdóttir (2009). The results of these two studies indicate that symmetry in intraverbals does not easily emerge. Later on, Pérez-González et al. (2015) studied the emergence of symmetry with intraverbals of the type, “Name a city”-“Buenos Aires”, after learning intraverbals of the type, “What is Buenos Aires”-“A city”. In the first intraverbal, the stimulus was a category (city) and the response was an exemplar of that category (Buenos Aires); thus, these intraverbals were denominated as *Exemplars*. In the second intraverbal, the stimulus was an exemplar and the response was the category corresponding to that exemplar; thus, these intraverbals were denominated as *Categories*. The authors studied the emergence of Exemplars after learning Categories and the emergence of Categories after learning Exemplars in 6- and

7-year-old children. Most children did not demonstrate the emergence of the symmetrical relations and even after a number of sophisticated procedures some children continued to fail the probes for emergence (e.g., emergence of the Exemplars was especially difficult). Also, Grannan and Rehfeldt (2012) probed the emergence of intraverbals of the type of the Categories (e.g., “What are four body parts”) before and after teaching tacts and other skills. They obtained emergence of the probed intraverbals in one child and intermediate levels of emergence in the other child.

When the stimuli in the intraverbals are related to non-verbal stimuli with operants different from the intraverbal, however, the results suggest that emergence is more likely. For example, Lipkens, Hayes, and Hayes (1993) taught a two-year-old boy to say the names of un-common animals in response to “What is this?”, and to say the sound the animal makes in response to, “What does this say?”, in the presence of the pictures in both cases. After teaching, the child demonstrated the emergence of two intraverbals: “What does [name of the animal] say?,” for the name-sound intraverbal, and “Listen [animal sound], what do you hear?” for the sound-name intraverbal. These results were replicated by Bellosó-Díaz and Pérez-González (2015b), with typically-developing children, and by May, Hawkins, and Dymond (2013) with three adolescents with an autism diagnosis. Therefore, it seems that learning two tacts with the same non-verbal stimuli greatly facilitates the emergence of intraverbals with the verbal components of the tacts. It is important to note that the tacts used in these studies are multiple-controlled tacts (Skinner, 1957), conditional tacts (e.g., Barnes-Holmes et al., 2000), or intraverbal tacts (Greer & Ross, 2008) because the tact response emitted in the presence of the picture depends upon an additional verbal stimulus (e.g., either, “What [the animal] says?” or “What is this [animal]?”)

The aforementioned studies suggest that the emergence of intraverbals can be facilitated by learning other operants that are related to the stimuli of the operant probed for emergence. This hypothesis is also coherent with a casual observation of the role that intraverbals play: Intraverbals are useful because the stimuli in the intraverbals are related to non-verbal stimuli. Early in development, children acquire mands and tacts that relate verbal stimuli (words) to reinforcers and to objects, people, actions, or in sum, to many non-verbal stimuli. Even though children are taught intraverbals such as, “How old are you?”-[The child’s age], these first intraverbals do not have a function as clear as that of mands or tacts. It seems that it is when children later learn more sophisticated intraverbals with direct relations with the non-verbal world that emitting these intraverbals become fully functional.

Several studies have analyzed the emergence of intraverbals after learning verbal operants that involve verbal (i.e., words) and non-verbal stimuli (i.e., pictures). For example, Petursdottir and Ólafsdóttir (2009) studied the emergence of intraverbals with words in Icelandic or Italian with Icelandic children who had learned relations between the verbal stimuli in Icelandic and their corresponding non-verbal stimuli (i.e., they *knew the meaning* of these words). Petursdottir, Carr et al. (2008), and Petursdottir and Hafliðadóttir (2009) conducted similar studies in which they observed the emergence of the new intraverbals in some participants but not in all participants. Moreover, Bellosó-Díaz and Pérez-González (2015b) analyzed the emergence of symmetrical intraverbals after learning the original intraverbal and a tact with the same response as the intraverbal probed for emergence; for example, children first learned to say the country of a woman that appeared in a picture—a Picture-Country tact—and the intraverbal that related the country with the tribe—a Country-Tribe intraverbal—, finally, the symmetrical Tribe-Country intraverbal was probed. Six of the seven six-year-old

children demonstrated the emergence of the symmetrical intraverbals. These results suggest that learning such tacts could affect the emergence of the symmetrical intraverbals. However, as the symmetrical intraverbals were not probed before teaching the tacts, the specific effect of the tacts on the emergence of symmetrical intraverbals was not clear. Moreover, because the above mentioned studies analyzed the effects of teaching tacts, it is unknown whether the tacts affected emergence because a non-verbal stimulus was involved, or because the tacts taught the participants to emit the verbal response of the probed intraverbal, or for some other reason.

The present experiments aimed to provide answers to some of these questions. In Experiment 1, we examined the effects of learning the tact in which the response is the same as the response in the probed, symmetrical, intraverbal on the emergence of those intraverbals. In Experiment 2, we examined whether these effects could be produced by learning an intraverbal, instead of a tact; in other words, by learning an operant with the same response as the tact but with a different stimulus (an auditory stimulus instead of a visual stimulus). A secondary goal involved examining whether two types of intraverbals (one symmetrical to the other) would emerge with the same difficulty (e.g., would require the same number of probes); that was examined in Experiments 1 and 2.

### **Experiment 1**

The main goal of Experiment 1 was to study the effects of learning tacts with the same response as the probed intraverbals on the emergence of intraverbals after learning the symmetrical intraverbal.

#### **Method**

**Participants.** Six typically-developing Spanish-speaking children, four males and two females, with ages between 6 years and 3 months and 7 years and 2 months

participated (see Table 1). They attended a public school in Oviedo, Spain. They were randomly assigned to one of two conditions.

**Materials and Stimulus Relations.** Pictures of two women were used as visual stimuli. One woman belonged to the tribe of the Kalash, in Pakistan; the other woman belonged to the tribe of the Surma, in Ethiopia. The remaining stimuli were auditory: The countries of the women in the pictures, “Pakistan” and “Ethiopia,” and the tribes of the woman, “Kalash” and “Surma”, respectively.

The combinations of auditory stimuli and vocal responses determined four intraverbals (see Figure 1). In the Country-Tribe Intraverbals, the antecedent stimuli were “Name the tribe of [Pakistan (C1) or Ethiopia (C2)]” and the correct responses were “Kalash” (T1) and “Surma” (T2), respectively. In the Tribe-Country Intraverbals, the antecedent stimuli were “Name the country of the [Kalash (T1) or Surma (T2)]”, and the correct responses were “Pakistan” (C1) or “Ethiopia” (C2), respectively. We used the Spanish forms of these sentences, as the study was conducted in Spanish.

We combined the visual stimuli and the four vocal responses to produce two types of tacts. For Country Tacts, the antecedent stimuli were pictures (either the picture of the Pakistani woman –P1– or the picture of the Ethiopian woman –P2) and the contextual stimuli “Name the country;” the correct response was the name of the country of the women in the picture (“Pakistan” –C1– or “Ethiopia” –C2–, respectively). For Tribe Tacts, the antecedent stimuli on each trial were a picture (either the picture of the Pakistani women –P1– or the picture of the Ethiopian women –P2) and the contextual stimuli “Name the tribe;” the correct response was the name of the tribe of the women in the picture (“Kalash” –T1– or “Surma” –T2).

**Dependent Variable.** The primary dependent variable was the emergence of intraverbals symmetrical to the taught intraverbals.

**Independent Variables.** The main independent variable was the learning of the tacts. A secondary independent variable was the type of intraverbals taught and probed. This variable was manipulated with two conditions: In Condition 1 we taught the Country-Tribe Intraverbals and probed the Tribe-Country Intraverbals. In Condition 2 we taught the Tribe-Country Intraverbals and probed the Country-Tribe Intraverbals.

**Experimental Design.** The effects of learning the tacts were evaluated using a non-concurrent multiple-baseline across participants design. Based on previous studies, we did not expect that learning the intraverbals alone would result in emergence in most six- and seven-year-old children before learning the tacts, but the experimental design controlled for the effect of learning just the intraverbals on emergence by teaching the intraverbals before teaching the tacts. The effect of teaching the tacts was evaluated by teaching them thereafter.

The number of probes in the first treatment condition (see below) was assigned prior to the experiment. There were two probes for the first participant, four probes for the second participant, and six probes for the third participant. The reason for not using long baselines before introducing the independent variable was that long baselines could prevent emergence (e. g., Belloso-Díaz & Pérez-González, 2015b). In addition, one goal of the study was to compare the results across conditions and across experiments. This comparison would be quite feasible if the number of probes before introducing the tacts were the same in both conditions. Across conditions, we also examined whether differences related to the intraverbals and tacts taught and the intraverbals probed occurred.

**Data Recording, Interobserver Agreement and Procedural Integrity.** One observer was present in some sessions to take data independently for purposes of computing the interobserver agreement and the integrity of the procedure. In

Experiments 1 and 2, 2,415 trials of a total of 5,891 were observed (40.9%). The observer recorded the participants' responses and the correct presentations of the trials – stimuli and consequences. The interobserver agreement ( $\text{agreements} / [\text{agreements} + \text{disagreements}] \times 100$ ) was 99.9% (range across children 99.5% to 100%). The observer verified the integrity of the procedure by recording whether the experimenter presented the antecedent and consequent stimuli according to the pre-determined experimental plan. The experimenter presented the stimuli according to the experimental plan in all trials.

**Setting.** The sessions were conducted in a quiet classroom in a public school in Oviedo, Spain, provided with tables, chairs, boards, and other materials. Only the experimenter, the child, and an observer were present during the sessions.

**General Procedures.** At the onset of the sessions, the experimenter told the child, “Now, I will ask you some questions. You have to respond the best you can. Sometimes, I will give you some prompts; other times, I will not give you any prompt. Sometimes, I will tell you if you are correct or not. If you do well, I will give you some collection stamps at the end of the session”.

Responses were correct if the child gave the correct response within 5 s after the instruction. Only the first response was considered (e.g., if the child emitted a response and immediately emitted another one, only the first response was considered and evaluated). Responses were considered incorrect if the child said the wrong word or after 5 s. In teaching phases, correct responses were followed by expressions such as, “Very good!” or, “That’s right!” after an incorrect response, the experimenter said “No”, followed by the correct response (a correction; e.g., “No, Surma”). In probe trials, the experimenter did not present any differential consequence. After each child’s response, the experimenter wrote the response in a recording sheet and continued to the

next trial. Sessions finished after the child met criterion in the teaching phase, after a probed phase or, after a maximum of 20 min.

**Procedure overview.** The experimenter initially probed all relations to be sure that the children had not acquired any relation prior to the study (see Pre-Intervention Probe below). Then, three children were randomly assigned to Condition 1 and the remaining children were assigned to Condition 2.

**Condition 1.** The three children in Condition 1 received the following sequence: First, the Country-Tribe Intraverbals were taught, and of the Tribe-Country Intraverbals were probed. Second, the children received cycles (e.g., similar to sessions) in which the Country-Tribe Intraverbals were reviewed and the Tribe-Country Intraverbals were probed. Third, after two, four, or six cycles, the child learned the Country Tacts, the Country-Tribe Intraverbals were reviewed, and the probes of the Tribe-Country Intraverbals were repeated. All subsequent cycles included the review of the Country Tacts and the Country-Tribe Intraverbals, and the probes of the Tribe-Country intraverbals. A child finished participating in the study after demonstrating the emergence of the Tribe-Country Intraverbals or after a maximum of 16 cycles.

**Pre-intervention Probe.** The pre-intervention probe consisted of presenting two trials of the Country Tacts, two trials of the Country-Tribe Intraverbals, and two trials of the Tribe-Country Intraverbals, in random order. This probe was conducted twice, which resulted in four trials of each relation type, with two trials per relation (e.g., four trials of the Country-Tribe intraverbals with two trials of the “Pakistan”-“Kalash” relation and two trials of the “Ethiopia”-“Surma” relation).

**Teaching the Country-Tribe Intraverbals.** The experimenter taught the Country-Tribe Intraverbals in three phases. In Phase 1, she asked, “Name the tribe of Pakistan” (C1), and provided the correct response, “Kalash” (T1; a prompt) in the first two trials.

From the third trial, the experimenter no longer provided the prompt. After 3 consecutive unprompted correct responses, the experiment advanced to Phase 2. Phase 2 was identical to Phase 1, but the experimenter asked, “Name the tribe of Ethiopia” (C2) and the correct response was, “Surma” (T2). Phase 3 was similar to Phases 1 and 2, but the two questions (C1 and C2) were randomly presented across trials, with the restriction that each question was presented twice every four trials, and prompts were never provided. After the child demonstrated 12 correct consecutive responses, the experiment continued with the intraverbal probes.

***Intraverbal probe.*** Two trials of the Country-Tribe Intraverbals and two trials of Tribe-Country Intraverbals were presented. After teaching Country Tacts, this probe was presented twice. Because the Country-Tribe Intraverbals were taught, correct responses in the Tribe-Country Intraverbals indicated that these intraverbals had emerged.

***Teaching the Country Tacts.*** The procedure was similar to the procedure to teach the Country-Tribe Intraverbals, but the experimenter placed a photo on the table in front of the participant (either P1 or P2), asked, “Name the Country”, and the correct response was to say the name of the country corresponding to the picture (C1 or C2, respectively).

**Condition 2.** The three children in Condition 2 received the same procedure as children in Condition 1, but the Tribe-Country Intraverbals were taught (instead of the Country-Tribe Intraverbals), the Country-Tribe Intraverbals were probed (instead of the Tribe-Country Intraverbals), and the Tribe Tacts were taught (instead of the Country Tacts).

***Pre-Intervention Probe.*** The Pre-intervention probe was identical to that of Condition 1 with the exception that two trials of Tribe Tacts, instead of Country Tacts, were presented.

***Teaching the Tribe-Country Intraverbal.*** The procedure was like that to teach the Country-Tribe Intraverbals of Condition 1, but in Phase 1 we asked, “Name the country of the Kalash” (T1) and the correct response was, “Pakistan”(C1). In Phase 2, we asked, “Name the country of the Surma” (T2) and the correct response was, “Ethiopia” (C2). In Phase 3, we presented the two Tribe-Country Intraverbals in a random order.

***Intraverbal probe.*** The intraverbal probe was identical to the intraverbal probe of Condition 1. Note, however, that in Condition 2 the Tribe-Country Intraverbals were taught and the Country-Tribe Intraverbals were probed for emergence.

***Teaching the Tribe Tacts.*** The procedure was similar to the procedure to teach the Country Tacts of Condition 1, but the experimenter placed a photo on the table in front of the participant (either P1 or P2), asked, “Name the tribe”, and the correct response was to tell the name of the country corresponding to the picture (T1 or T2, respectively).

## **Results**

**Teaching.** Children in Condition 1 learned the Country-Tribe Intraverbals in a range of 47-100 trials. In subsequent sessions, they reviewed these intraverbals with zero to three errors per session. The children learned the Country Tacts in a range of 32-61 trials. When these intraverbals and these tacts were intermixed in Phase 3 of teaching, all children made zero to three errors per session. Children in Condition 2 learned the Tribe-Country Intraverbals in a range of 62-124 trials. In subsequent sessions, they reviewed these intraverbals with zero to three errors per session. The children learned the Tribe Tacts in a range of 23-94 trials. When these intraverbals and

these tacts were intermixed and reviewed in subsequent sessions, two children made between zero and three errors per session; the third participant (Marta) made 10 errors in these intraverbals and these tacts in the first session in which these operants were intermixed and then responded with no errors in subsequent sessions.

**Emergence.** The results in the probes for emergence can be seen in Figures 2 and 3. In pre-intervention probes, all participants demonstrated that they had not acquired the intraverbals prior to the experiment. Then, in Condition 1, the Country-Tribe Intraverbals were taught and the Tribe-Country Intraverbals were probed. The three children responded incorrectly in all trials in the probe of the Tribe-Country Intraverbals; thus, they did not demonstrate the emergence of the Country-Tribe Intraverbals before learning the tacts. After learning the tacts, the three children reached the emergence criterion of making all four correct responses of the Tribe-Country Intraverbals by the 1st, 4th, or 9th probe.

In Condition 2, after the pre-intervention probe, the Tribe-Country Intraverbals were taught and the Country-Tribe Intraverbals were probed. In the first probes, before teaching the tacts, the three children responded incorrectly in all trials in the probe of the Country-Tribe Intraverbal; thus, they did not demonstrate emergence of the Country-Tribe Intraverbals before learning the tacts. After learning the tacts, two of the three children reached the emergence criterion of making all four correct responses of the Tribe-Country Intraverbals. One child needed 14 review-probes cycles, and the other child needed 6 review-probes cycles. During these sessions, they demonstrated the maintenance of the tacts. The third child made only one correct response in the 17 four-trial probes.

## **Discussion**

Five of the six children of the study demonstrated the emergence of the symmetrical intraverbals. The results of the emergence of the symmetrical intraverbals replicated those of previous research conducted with tacts (Belloso-Díaz & Pérez-González, 2015b; Grannan & Rehfeldt, 2012; Petursdottir, Carr et al., 2008; Petursdottir & Hafliðadóttir, 2009; Petursdottir & Ólafsdóttir, 2009). Thus, the procedures as a whole were effective to promote the emergence of the intraverbals. The main goal of the present experiment was to analyze the function of the tacts in the emergence. None of the six children demonstrated the emergence of the intraverbals prior to learning the tacts –the score was zero in all children. Moreover, five children demonstrated the emergence after learning the tacts. Therefore, the results suggest that learning tacts with the same response as the probed intraverbals facilitates the emergence of these intraverbals.

Ancillary, we examined whether two types of intraverbals (one symmetrical to the other) would emerge with the same difficulty. The three children in Condition 1 demonstrated the emergence of the Tribe-Country intraverbals whereas only two children in Condition 2 demonstrated this emergence. Moreover, two children in Condition 1 demonstrated the emergence by the 4th probe or earlier, whereas the two children in Condition 2 required a greater number of probes (12 and 8). Therefore, the emergence of the Tribe-Country Intraverbals was easier than the emergence of the Country-Tribe Intraverbals.

## **Experiment 2**

The main goal of Experiment 2 was to study the effects of learning intraverbals with the same response as the probed intraverbals on the emergence of intraverbals. The second goal was to explore if learning additional intraverbals instead of tacts facilitates

intraverbal emergence. Thus, the present experiment replicated the procedures of Experiment 1 except that novel intraverbals were used instead of tacts.

## **Method**

**Participants.** Six typically-developing Spanish-spoken children participated, four males and two females, with ages between 6 years and 6 months and 7 years and 5 months. They were of the same characteristics as those of Experiment 1.

**Materials and Stimulus Relations.** All materials and stimulus relations were identical to those used in Experiment 1, except for that intraverbals were used instead of the tacts (see Figure 4). Hence, pictures were not used. Two additional verbal stimuli were used, “Asia” (CN1) and “Africa” (CN2), which correspond to the continents of Pakistan (C1) and Ethiopia (C2). The intraverbals used for the first time in this experiment were the Continent-Country Intraverbals and the Continent-Tribe Intraverbals. In the Continent-Country Intraverbals, the antecedent stimulus was, “Name the Country of [Asia (CT1) or Africa (CT2)]” and the correct responses were, respectively, “Pakistan” (C1) and “Ethiopia” (C2). In the Continent-Tribe Intraverbals, the antecedent stimulus was, “Name the Tribe of [Asia (CT1) or Africa (CT2)]” and the correct responses were, respectively, “Kalash” (T1) and “Surma” (T2).

**Design and Procedures.** The design and procedures were identical to those of Experiment 1 with the exception of the following: In Condition 1, the three children, (a) learned the Country-Tribe Intraverbals, and received the probe of the Tribe-Country Intraverbals. Thereafter, (b) they received cycles with reviews of the Country-Tribe Intraverbals and probes of the Tribe-Country Intraverbals. After two, four, or six cycles, (c) the child learned the Continent-Country intraverbals, the Country-Tribe Intraverbals were reviewed and the probes of the Tribe-Country Intraverbals were repeated. In Condition 2, the Tribe-Country Intraverbals were taught (instead of the Country-Tribe

Intraverbals), the Country-Tribe Intraverbals were probed (instead of the Tribe-Country Intraverbals), and the Continent-Tribe Intraverbals were taught (instead of the Continent-Country Intraverbals).

***Teaching of the Continent-Country Intraverbals.*** The procedure was like the procedure to teach the Country-Tribe Intraverbals in Experiment 1, but the experimenter asked, “Name the country of Asia” (CN1) or, “Name the country of Africa” (CN2) and the correct response was to say the name of the country corresponding to the continent – “Pakistan” (C1) or “Ethiopia” (C2), respectively.

***Teaching of the Continent-Tribe Intraverbals.*** The procedure was like the procedure to teach the Continent-Country Intraverbals, but the experimenter asked, “Name the tribe of Asia” (CN1) or, “Name the tribe of Africa” (CN2) and the correct response was to tell the name of the tribe corresponding to the continent – “The Kalash” (T1) or “The Surma” (T2), respectively.

## **Results**

**Teaching.** Children in Condition 1 learned the Country-Tribe Intraverbals in a range of 88-115 trials. Thereafter, they reviewed these intraverbals with zero to five errors per session. The children learned the Continent-Country Intraverbals in a range of 38-70 trials. When all the intraverbals were intermixed and reviewed in subsequent sessions, all children made zero to four errors per session. Children in Condition 2 learned the Tribe-Country Intraverbals in a range of 91-137 trials. Thereafter, they reviewed these intraverbals with zero to three errors per session. They learned the Continent-Tribe Intraverbals in a range of 56-80 trials. When the intraverbals were intermixed and reviewed in subsequent sessions, all children made zero to six errors per session.

**Emergence.** The results in the emergence probes can be seen in Figures 5 and 6. In pre-intervention probes, all participants demonstrated that they had not acquired the intraverbals prior to the experiment. Then, in Condition 1, the Country-Tribe Intraverbals were taught and the Tribe-Country Intraverbals were probed. The three children responded incorrectly in all trials in the probe of the Tribe-Country Intraverbals; thus, they did not show the emergence of the Tribe-Country Intraverbals before learning the Continent-Country Intraverbal. After learning the Continent-Country Intraverbals, the three children reached the emergence criterion of making all four correct responses of the Tribe-Country Intraverbals, in the 3rd, 4th, and 1st probe.

In Condition 2, after the pre-intervention probe, the Tribe-Country Intraverbals were taught and the Country-Tribe Intraverbals were probed. The three children in Condition 2 responded incorrectly in all trials; thus, they did not show the emergence of the Country-Tribe Intraverbals before learning Continent-Tribe Intraverbals. After learning the Continent-Tribe Intraverbals, two of the three children reached the emergence criterion of making all four correct responses of the Country-Tribe Intraverbals. One child needed 14 probes, and the other child needed 8 probes. In these sessions, these two children did not show the maintenance of the Continent-Tribe Intraverbals (i.e., they scored below four correct responses in some sessions). In the probes, only two of the six children maintained the performance in the Country-Tribe Intraverbals.

## **Discussion**

Five of the six children of the study demonstrated the emergence of the probed intraverbals. The results on the emergence of the symmetrical intraverbals replicated those of Experiment 1 and also previous research conducted with tacts and intraverbals

(e.g., Belloso-Díaz & Pérez-González, 2015b; Petursdottir, Carr et al., 2008; Petursdottir & Hafliðadóttir, 2009; Petursdottir & Ólafsdóttir, 2009).

The main goal of the present experiment was to analyze the function of the Continent-Country Intraverbals on emergence. None of the six children demonstrated the emergence of the intraverbals prior to teaching the intraverbals; the score was zero for all children. Moreover, five children demonstrated emergence after teaching the Continent-Country Intraverbals. Therefore, the results suggest that teaching intraverbals with the same response as the probed intraverbals facilitates emergence.

Ancillary, we examined whether two types of intraverbals (one symmetrical to the other) would emerge with the same difficulty. The three children in Condition 1 demonstrated the emergence of the Tribe-Country intraverbals whereas only two children in Condition 2 demonstrated this emergence. Moreover, the children in Condition 1 demonstrated emergence after fewer probes than the two children in Condition 2 that demonstrated emergence (3, 4, and 9 probes for the children in Condition 1, and 16 and 8 for the children in Condition 2). Therefore the emergence of the Tribe-Country Intraverbals was easier than the emergence of the Country-Tribe Intraverbals.

The results of the present study replicated those obtained by Pérez-González, Herszlikowicz, and Williams (2008) as well as follow-up studies (Belloso-Díaz & Pérez-González, 2015b; Pérez-González et al., 2014). In fact, with virtually all participants in these studies, the B-C symmetrical intraverbals emerged before the A-B intraverbals after the participants learned the A-B and B-C intraverbals. This may have happened because the B-C intraverbals share the response with learned intraverbals whereas the A-B intraverbals. In fact, the C-B intraverbals had the B elements as responses, and intraverbals with these responses have been taught in A-B. That fact did

not happen with the B-A intraverbals, because intraverbals with stimuli A were not taught initially (e.g., in Experiment 1 of the study by Pérez-González, Herszlikowicz, & Williams, 2008). Thus, sharing responses with taught intraverbals facilitated emergence in the cited studies as well as in the present one.

### **General Discussion**

The emergence of intraverbals was analyzed in two experiments. In all, a total of 10 children out of 12 demonstrated the emergence of intraverbals. These results suggest that the procedures used in the present study were effective to promote emergence.

The first goal of the study was to examine the effects of learning tacts in which the response is the same as the response in the probed intraverbal on emergence (examined in Experiment 1). The results indicate that teaching these tacts facilitates the emergence of intraverbals. After Experiment 1, the specific source of control was not clear, because tacts involve two elements: the non-verbal stimuli (the photo) and the verbal response, which is the same as in the probed intraverbal. The issue has important practical implications because some people may believe that trying to learn intraverbals without the non-verbal referent could make learning quite more difficult or impossible. In other words, it is believed that the absence of the picture could prevent emergence. In that context, the goal of Experiment 2 was to examine whether the effect produced by the tacts could also be produced by teaching an intraverbal. The results were virtually identical to those of Experiment 1, as the additional taught intraverbals (i.e., either the Continent-Country or the Continent-Tribe intraverbals) produced the same results as the tacts in Experiment 1. Therefore, the results suggest that the facilitating effect is produced by teaching the response of the probed intraverbal, rather than presenting photos (non-verbal stimuli). Thus, contrary to some popular assumptions, it is the verbal responding what facilitates the emergence of intraverbals rather than the visual stimuli.

Learning a skill with a specific response had a stronger effect on the emergence of the intraverbals, as demonstrated by the fact that none of the 12 children demonstrated emergence before learning the operants with the response (either the tacts or the other intraverbals) and 10 of these children demonstrated emergence after learning these operants. This effect is coherent with the effect demonstrated in other studies that demonstrate that teaching a response facilitates further teaching. For example, studies on paired associates demonstrate that learning a list of paired words (i.e., saying a word in response to another word) facilitates learning a second list with novel words as stimuli and the same words as in the first list as responses (cfr., Catania, 2007). Also, in a recent study, Greer, Du, and Pérez-González (2015) found that teaching echoics facilitates learning tacts to the point that the reduction in number of trials for learning the tacts compensated for the number of trials required for learning the echoics. Therefore, learning operants with the responses of the intraverbals that are probed for emergence could facilitate the emergence of these intraverbals. That process is similar to what occurs when the responses of the operants targeted for being directly learned are taught before the targeted operants are taught. For instance, teaching or probing the echoics with the responses of the intraverbals that are going to be probed for emergence can also facilitate emergence. Further studies can analyze in more depth the effect of learning the response of the targeted operant.

A secondary goal was to examine whether two types of intraverbals (one symmetrical to the other) would emerge with the same difficulty. In both Experiments, the Tribe-Country Intraverbals emerged with one more participant and in fewer trials than the Country-Tribe Intraverbals. These results are coherent with results of other studies, in that Categories (i.e., intraverbals in which the response is the category of an exemplar presented as stimulus) after learning Exemplars (i.e., intraverbals in which the

response is to provide an exemplar of the category presented as stimulus) emerge more easily than Exemplars after learning the Categories (Pérez-González et al., 2015).

Because a tribe typically belongs to a country and many tribes live in a country, the Tribe-Country intraverbals can be considered for the present purposes as Categories and the Country-Tribe intraverbals can be considered as Exemplars. Therefore, the results of the present study that show that the Tribe-Country intraverbals emerge easier than the Country-Tribe intraverbals show the same process as those of Pérez-González et al. (2015) on the emergence of Categories and Exemplars. The reasons for this phenomenon are not clear yet. A hypothesis is that the responses in the Categories are more frequent than those of the Exemplars –for example, the word “animal” is used more often than “cow.” This can be due in part to the fact that typically several exemplars belong to the same category. In the present study, the words related to the countries (Pakistan and Ethiopia) are more frequent than the words related to the tribes. For this fact to have an impact on the emergence of the intraverbals, the children should have had some familiarity with these words. It is possible that the children had listened news on these countries and this familiarity could have affected the results. Another possibility can be that the element corresponding to the category appears in all the intraverbals related to that category, but the element corresponding to the exemplar appears only in just the intraverbals related to that exemplar (see also analysis on divergent multiple control by Axe, 2008; Michael, Palmer, & Sundberg, 2011; and Sundberg & Sundberg, 2011). Moreover, in the present study, the participants responded with fewer errors in teaching and probes with the Tribe-Country intraverbals than in the Tribe-Country intraverbals. Therefore, it may be possible that the intraverbals that are learned with fewer errors are the more likely to emerge.

Regarding the influence of learning the tacts on emergence, the results of the present study are consistent with the results of other studies. First, they replicated the results of Lipkens, Hayes, and Hayes (1993; replicated by Bellosó-Díaz & Pérez-González, 2015b, and by May et al. 2013), which obtained the emergence of the intraverbals after the participants learned the two tacts related to a picture. Second, the results replicated those obtained by Bellosó-Díaz and Pérez-González (2015b – Experiment 2), who taught the tacts initially. Related to the later study, the present study adds the knowledge that teaching the tacts, or other skill with the same response as the tact, produces a significant difference, because in the former study the tacts were taught initially whereas in the present study the introduction of the tacts was analyzed by introducing a initial phase with no tacts (or the second intraverbals with the same response as the intraverbal targeted for emergence); this fact allowed to know that tacts, or a skill with the same response as the tact, play an important role in the emergence. Third, Experiment 2 replicated Pérez-González et al. (2008) and related follow-up studies (Bellosó-Díaz & Pérez-González, 2015a; Pérez-González et al., 2014). As explained above, in these studies, the symmetrical intraverbals which response is initially taught (like the C-B intraverbals) typically emerge before than the symmetrical intraverbals which response is not initially taught (like the B-A intraverbals). Moreover, the results of these studies have also demonstrated that teaching Exemplars produce a strong effect in the facilitation of the emergence of the ABC intraverbals (i.e., the B-A, C-B, A-C, and C-A intraverbals after learning the A-B and B-C intraverbals). It is important to note that Exemplars are intraverbals with the responses of the elements of the ABC intraverbals; for example, “Name a country”-“Argentina” is an Exemplar intraverbal, whereas “Name the country of Buenos Aires”-“Argentina” is one of the B-A intraverbals which emergence is probed).

Knowing why intraverbals emerge is of theoretical and practical interest. We believe that a parsimonious explanation is that given certain experiences, specific stimuli and responses learned in one or several skills become functionally interchangeable and separated from the remaining stimuli and responses. These experiences may involve the acquisition of a generalized echoic repertoire and the acquisition of specific discriminations (see an analysis of this type by Belloso-Díaz & Pérez-González, 2015b). The acquisition of a generalized echoic repertoire can be necessary for producing as responses the elements that have been presented as stimuli (described as transformation of stimulus functions –see for example Greer & Ross, 2008). The present study identified that learning skills with the same response as the skills to be probed for emergence affects emergence. Additional known factors are related to learning with multiple exemplars interrelated skills of the type that are going to be taught and probed (e.g., Pérez-González et al, 2007). These hypotheses can be analyzed in more depth in further studies. Yet, many factors involved are still unknown and more research is necessary to identify them.

A methodological issue is worth considering: If the data on the emergence of the intraverbals obtained in the present study are compared with those obtained in our previous study (Belloso-Díaz & Pérez-González, 2015b), it results that the children of the previous study demonstrated the emergence of the intraverbals after fewer probes than in the present study (2.3 versus 3.7 probes on average in Condition 1 and 3.5 versus 10.5 probes on average in Condition 2). This occurred even though the children who demonstrated emergence in Experiment 2 of that study (6 out of 7) were more than one year younger than the children in the present study –the children in that study were 5 years and 9 months old on average and the children in the present study were 6 years and 10 months old on average. The difference between the procedures was that the tacts

and the intraverbals were taught from the very beginning in that study, whereas in the present study the children learned the intraverbals first and, after a variable number of probes, they learned the tacts (in Experiment 1). Therefore, all of these data strongly suggest that teaching all of the components needed for emergence of the intraverbals first may facilitate emergence. The same phenomenon was obtained by Pérez-González et al. (2014): They found that 4 of 5 children who learned Exemplars and Categories before the first post-intervention probe demonstrated the emergence of all the probed ABC intraverbals, whereas only 1 of the 5 children who received probes before learning the Categories demonstrated the emergence of these intraverbals. In summary, the results of the present study together with those of the previous cited studies strongly suggest that teaching the requisite intraverbals initially facilitates the emergence of the targeted intraverbals. These data bring the methodological implication that using designs with long baseline probes before introducing independent variable may be inadequate because presenting probes before teaching critical requisite skills could *prevent* or *difficult* emergence; hence, the manipulation of the independent variable in such a way can produce an effect on the dependent variable in the direction contrary to the change expected by the manipulation of the independent variable. This fact justifies the conservative design used in the present study. Moreover, this fact is worthy to take into consideration for designing further research studies on the emergence of intraverbals. Using a multiple probe design may reduce the undesirable effects but the introduction of any probe may have an effect; hence, alternative designs should be considered.

The data on the emergence of the intraverbals obtained in the present study can also be compared with those obtained in Experiment 1 of the study by Beloso-Díaz and Pérez-González (2015b). In that study, children demonstrated the emergence of

intraverbals faster than in the present study (1.7 versus 7.1 probes on average, respectively). This difference can be explained by the fact that in that study, we taught children to respond to the country and the tribe of the same pictures. Thus, children's responses were controlled by two stimuli. For example, the experimenter presented the picture of the woman of Pakistan or the picture of the woman of Ethiopia and asked, "Name the tribe/country"; this procedure gave the children the opportunity to learn to respond to the picture and to the verbal stimuli (the picture of Pakistan/Ethiopia combined with the verbal instruction "Name the country/tribe") during the teaching phases. In the present study, however, children did not have the opportunity to learn to respond attending to two stimuli. Instead, after learning, for example, the Country-Tribe Intraverbals and the Country Tacts (in Condition 1 of Experiment 1), all responses could have been controlled by just one stimulus (either an stimulus of the intraverbal or the picture of the tact). These differences in the procedures of the two studies may explain the difference in the speed to get emergence. (See processes similar to these in selection-based conditional discriminations in Alonso-Álvarez & Pérez-González, 2006; Alonso-Álvarez & Pérez-González, 2011; Alonso-Álvarez & Pérez-González, 2013; Pérez-González & Alonso-Álvarez, 2008; and theoretical analysis on intraverbals by Axe, 2008; and Eikeseth & Smith, 2013.)

The present study suffered limitations that should be considered for future research: First, in the multiple baseline design across-participants the implementation of intervention was determined a priori. We used this design to prevent the effects of long baselines in the emergence of intraverbals demonstrated in previous studies (e.g., Belloso-Díaz & Pérez-Gonzalez, 2015b), but it had the risk of introducing a change in the independent variable before the comparison participant demonstrated emergence. Alternative designs that can circumvent this problem as well the undesired effects of

using pre-intervention probes should be considered. As explained above, possible solution can be to use multiple probe designs. Another possibility is to compare performances of individual students separated in dyads. Second, the criterion for emergence in the present study was to achieve four correct responses in the probed intraverbals; this number may be low, because there some probability that a child responds by saying randomly two words of the same group (e.g. saying the two countries in an intraverbal in which the correct response is to say a country) and thus it results in  $1/2^4 = 1/16$  likelihood of pass the probe. Thus, four correct responses are not enough to rule out this type of random response with a great probability. Therefore, the criterion for the emergence for future research should be increased to 6 or 8. Third, the number of participants was low. Fourth, finally, the stimuli selected presented difficulties, which is has been often a problem for intraverbal studies, because variability in the results across stimuli is sometimes known and this variability affects to the appreciation of the results according to the independent variable.

The results were very likely affected also by other procedural elections. Although most participants demonstrated emergence, they did so after repeated probes and with a great deal of variability across participants. All these factors present challenges for further research in this line. In spite of these facts, the present research has potential applications: The results suggest that in order to facilitate the emergence of intraverbals, teaching operants with the responses first facilitates intraverbal emergence, even though pictures are not used.

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Table 1. *Name, sex, and age (years and months) of the participants*

Name	Sex	Age
Experiment 1. Condition 1		
Bibiana	Female	7y 1m
Bruno	Male	6y 3m
Berto	Male	6y 5m
Experiment 1. Condition 2		
Mateo	Male	7y 1m
Marco	Male	7y 2m
Marta	Female	7y 0m
Experiment 2. Condition 1		
Pedro	Male	7y 1m
Paula	Female	7y 4m
Paco	Male	6y 9m
Experiment 2. Condition 2		
Dacio	Male	6y 6m
Domingo	Male	7y 3m
Diana	Female	7y 5m

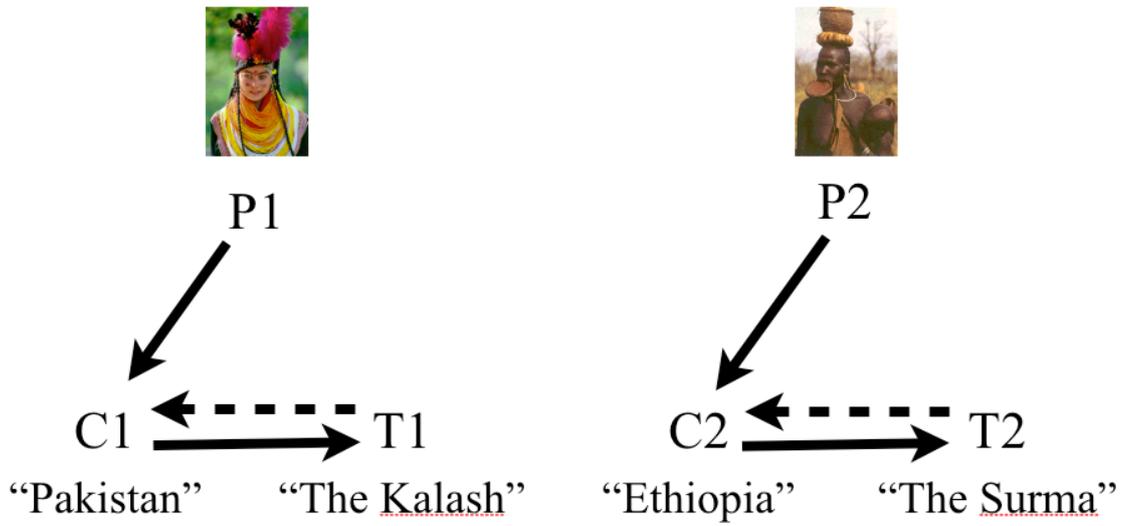
Table 2. *Stimuli and response components of the taught and probed relations in Experiment 1. The notation within brackets was not spoken. The English translation appears in italics below each relation type*

	Antecedent stimuli	Correct response
<b>Country-Tribe Intraverbal</b>		
Dime	la tribu de	[C1] Pakistán
Dime	la tribu de	[C2] Etiopía
<i>Name</i>	<i>the tribe of</i>	<i>[C1] Pakistan</i>
<i>Name</i>	<i>the tribe of</i>	<i>[C2] Ethiopia</i>
<b>Tribe-Country Intraverbal</b>		
Dime	el país de	[T1] los Kalash
Dime	el país de	[T2] los Surma
<i>Name</i>	<i>the country of</i>	<i>[T1] the Kalash</i>
<i>Name</i>	<i>the country of</i>	<i>[T2] the Surma</i>
<b>Picture-Country Tacts</b>		
Dime	el país	[Picture P1]
Dime	el país	[Picture P2]
<i>Name</i>	<i>the country</i>	<i>[Picture P1]</i>
<i>Name</i>	<i>the country</i>	<i>[Picture P2]</i>
<b>Picture-Tribe Tacts</b>		
Dime	la tribu	[Picture P1]
Dime	la tribu	[Picture P2]
<i>Name</i>	<i>the tribe</i>	<i>[Picture P1]</i>
<i>Name</i>	<i>the tribe</i>	<i>[Picture P2]</i>

Table 3. *Stimuli and response components of the taught and probed relations in Experiment 2. The notation within brackets was not spoken. The English translation appears in italics below each relation type*

	Antecedent stimuli	Correct response	
<b>Country-Tribe Intraverbal</b>			
Dime	la tribu de	[C1] Pakistán	[T1] Los Kalash
Dime	la tribu de	[C2] Etiopía	[T2] Los Surma
<i>Name</i>	<i>the tribe of</i>	<i>[C1] Pakistan</i>	<i>[T1] The Kalash</i>
<i>Name</i>	<i>the tribe of</i>	<i>[C2] Ethiopia</i>	<i>[T2] The Surma</i>
<b>Tribe-Country Intraverbal</b>			
Dime	el país de	[T1] los Kalash	[C1] Pakistán
Dime	el país de	[T2] los Surma	[C2] Etiopía
<i>Name</i>	<i>the country of</i>	<i>[T1] the Kalash</i>	<i>[C1] Pakistan</i>
<i>Name</i>	<i>the country of</i>	<i>[T2] the Surma</i>	<i>[C2] Ethiopia</i>
<b>Continent-Country Intraverbal</b>			
Dime	el país de	Asia [CN1]	[C1] Pakistán
Dime	el país de	África [CN2]	[C2] Etiopía
<i>Name</i>	<i>the country of</i>	<i>Asia [CN1]</i>	<i>[C1] Pakistan</i>
<i>Name</i>	<i>the country of</i>	<i>Africa [CN2]</i>	<i>[C2] Ethiopia</i>
<b>Continent-Tribe Intraverbal</b>			
Dime	la tribu de	Asia [CN1]	[T1] Los Kalash
Dime	la tribu de	África [CN2]	[T2] Los Surma
<i>Name</i>	<i>the tribe of</i>	<i>Asia [CN1]</i>	<i>[T1] The Kalash</i>
<i>Name</i>	<i>the tribe of</i>	<i>Africa [CN2]</i>	<i>[T2] The Surma</i>

### Condition 1



### Condition 2

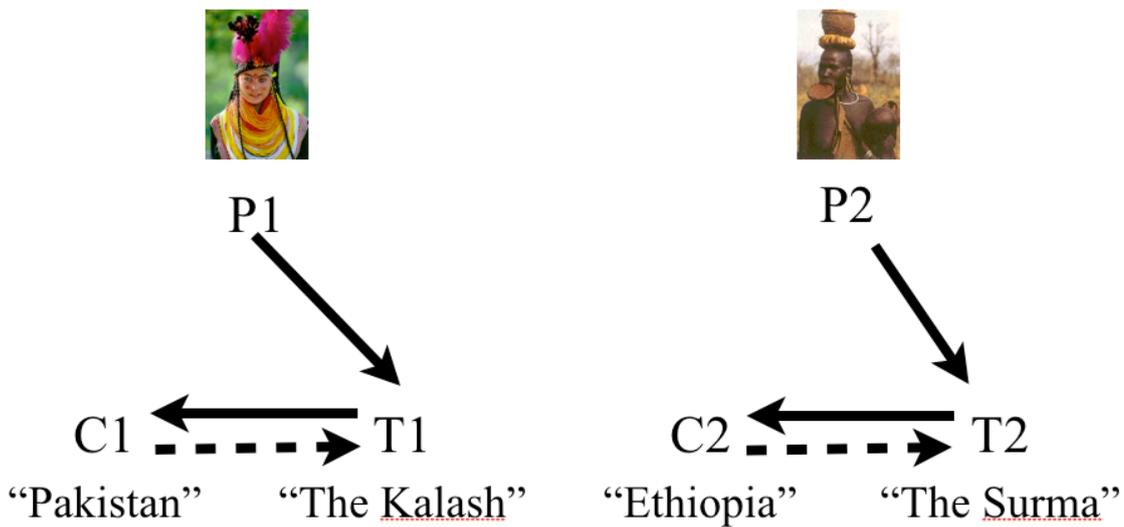


Figure 1. Taught (solid lines) and probed (dashed lines) relations in Experiment 1.

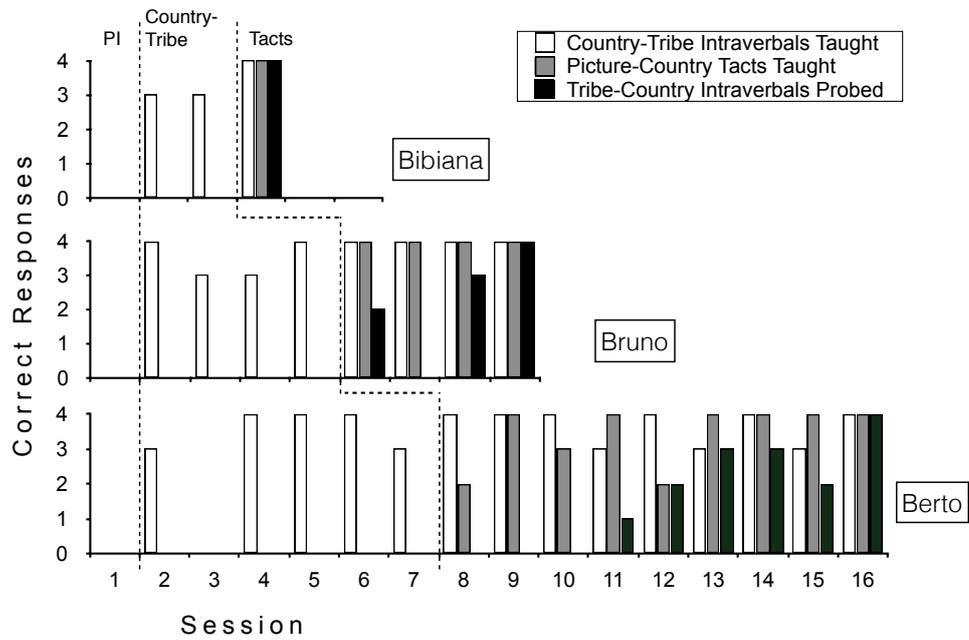


Figure 2. Correct responses out of 4 trials in the probes of each intraverbal in Condition 1 of Experiment 1. “PI” indicates the pre-intervention probe.

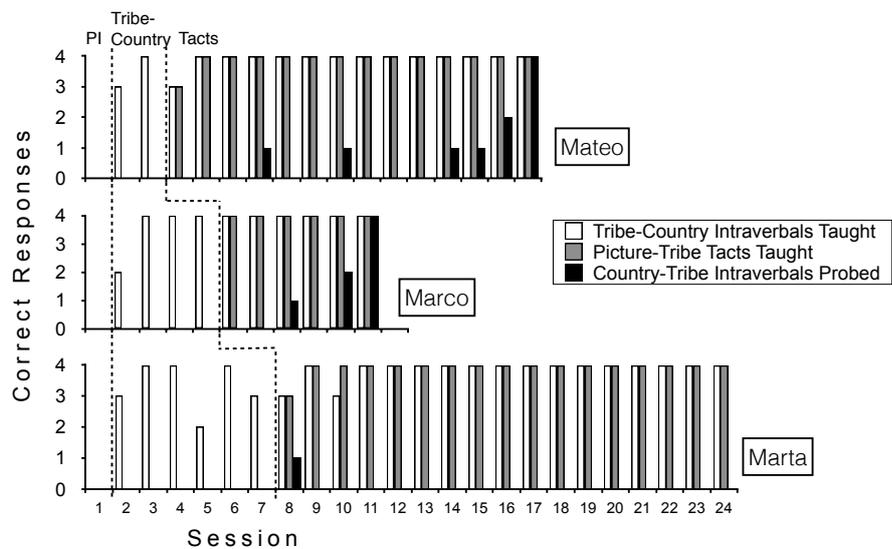
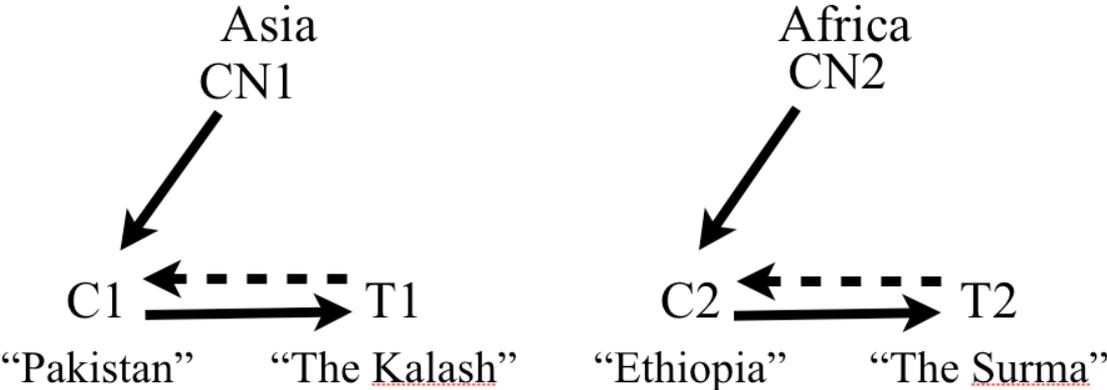


Figure 3. Correct responses out of 4 trials in the probes of each intraverbal in Condition 2 of Experiment 1. “PI” indicates the pre-intervention probe.

Condition 1



Condition 2

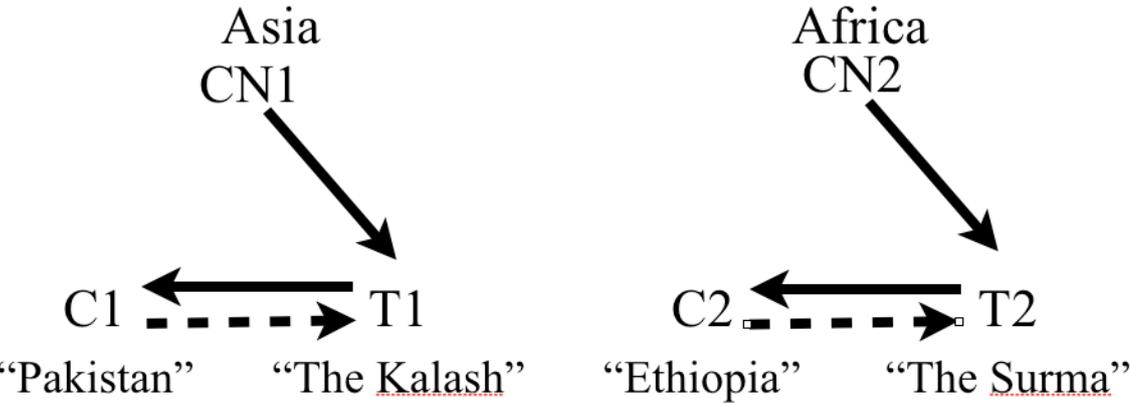


Figure 4. Taught (solid lines) and probed (dashed lines) relations in Experiment 2.

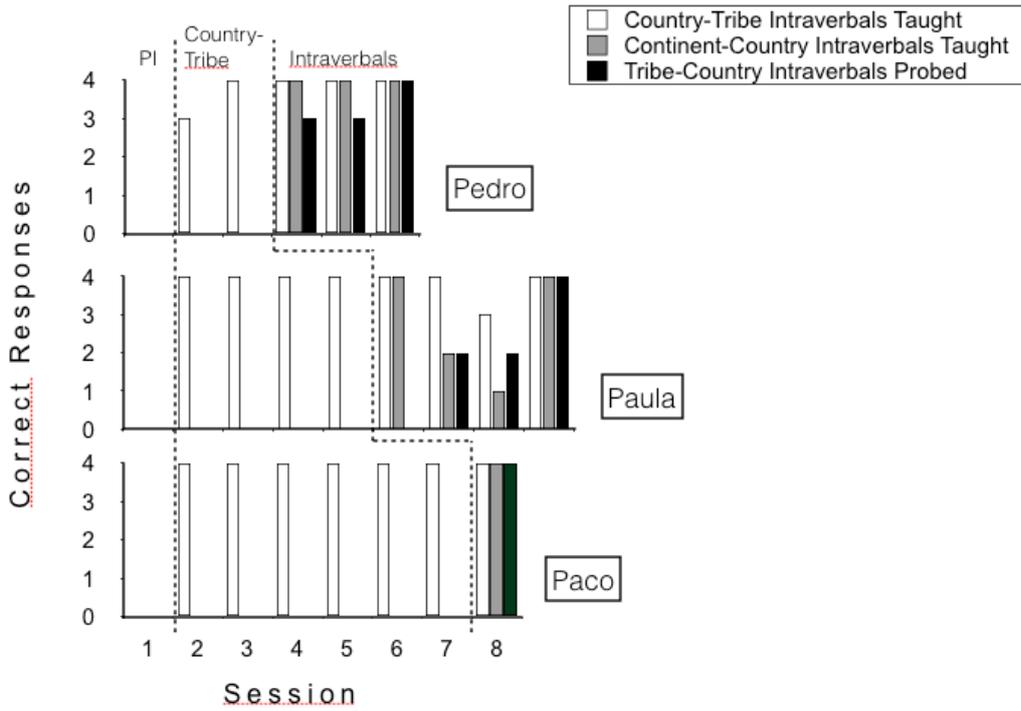


Figure 5. Correct responses out of 4 trials in the probes of each intraverbal in Condition 1 of Experiment 2. “PI” indicates the pre-intervention probe.

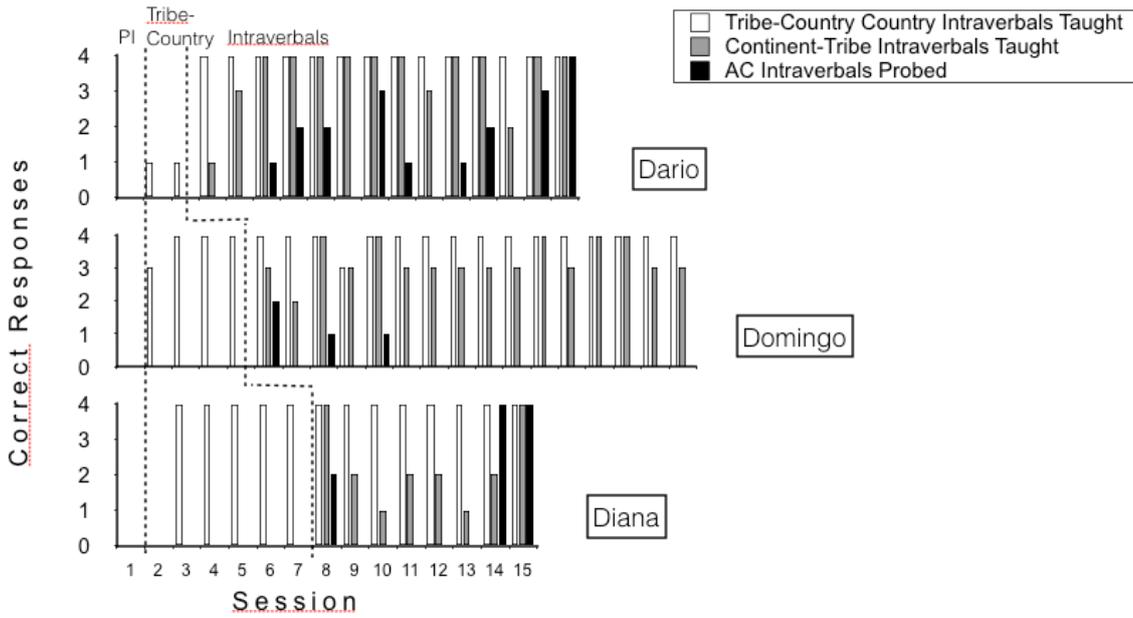


Figure 6. Correct responses out of 4 trials in the probes of each intraverbal in Condition 2 of Experiment 2. “PI” indicates the pre-intervention probe.

## **4. Discusión de resultados**

### **4.1. Discusión general**

El primer objetivo de esta tesis fue estudiar si se producía la emergencia de intraverbales basadas en relaciones de equivalencia de estímulos a partir de la enseñanza de otras intraverbales más simples. Los estudios de los dos primeros artículos muestran que la enseñanza de intraverbales simples, Ejemplares y Categorías, facilita la emergencia de intraverbales basadas en relaciones de equivalencia tanto en adultos como en niños. La enseñanza de los Ejemplares en adultos parece tener un mayor efecto que la enseñanza de las Categorías mientras que los niños necesitan aprender tanto los Ejemplares como las Categorías para producir la emergencia de todas las intraverbales. Con los datos obtenidos en estos dos artículos y los datos obtenidos por Pérez-González et al. (2008) y Carp y Petursdottir (2012) parece claro que existe una relación entre la edad, entendida como la acumulación de experiencia que da lugar a nuevos aprendizajes debido la correlación entre el tiempo y las interacciones del individuo con su entorno, y las relaciones que es necesario aprender para producir la emergencia de las intraverbales basadas en relaciones de equivalencia. En los estudios citados y la presente tesis, el porcentaje de niños de 6 años que mostró la emergencia de las intraverbales después del aprendizaje de las intraverbales básicas A-B y B-C ha sido del 6% (1 de 15 niños en los estudios de Pérez-González et al., 2014, y en el Segundo Artículo de esta tesis), en los niños de entre 6 y 7 años ha sido el 33% (3 de 9 niños en el estudio de Carp y Petursdottir, 2012) y en adultos ha sido el 66% (4 de 6 adultos en el Primer Artículo de esta tesis). En los casos en los que no se produjo la emergencia de las intraverbales, el 0% de los niños y el 100% de los adultos mostraron la emergencia después del aprendizaje de los Ejemplares. Finalmente el 88% de los niños mostraron la emergencia cuando aprendieron los Ejemplares y las Categorías. Es decir, los datos indican que los niños necesitan aprender la simetría entre Ejemplar y Categoría (responder “Roma” cuando se les pregunta por una ciudad y responder “Ciudad” cuando se les pregunta qué es Roma). Este hallazgo se ha identificado en otros procesos relacionados; por ejemplo en procesos de emergencia de discriminaciones condicionales basadas en respuestas de selección ante estímulos complejos (Pérez González, 1994).

Los datos de estos artículos muestran que hay una serie de intraverbales basadas en relaciones de equivalencia que tienen mayor dificultad para emerger tras aprender las intraverbales AB y BC. Las intraverbales que tardan más en emerger son las

intraverbales simétricas B-A y la equivalencia C-A. En ambas intraverbales la respuesta es el estímulo A. Estos resultados se observan tanto en niños como en adultos y se produce de una forma sistemática. Cuando enseñamos a los participantes las relaciones A-B y B-C, no se les enseña a responder ante el estímulo A. Esta variable puede ser la que explique por qué los Ejemplares tienen mayor efecto en la emergencia de intraverbales en adultos. La enseñanza de los Ejemplares da la oportunidad a los participantes de responder el estímulo A, mientras que la enseñanza de las Categorías no lo hace.

El segundo objetivo de esta tesis fue estudiar si se produce la emergencia de intraverbales basadas en la relación de simetría a partir del aprendizaje de tectos basados en discriminaciones condicionales y la enseñanza de tectos simples y otras intraverbales. Este objetivo se analizó en el Artículo Tercero donde el 100% de los niños que aprendieron a responder a tectos basados en discriminaciones condicionales mostró la emergencia de las intraverbales simétricas. El 71,4% de los niños que aprendieron el tacto simple y la intraverbal simétrica a la que queríamos que emergiera mostraron la emergencia de la intraverbal simétrica. Estos datos muestran que ambos aprendizajes ayudan a producir la emergencia de intraverbales simétricas pero que el aprendizaje de tectos basados en discriminaciones condicionales produce la emergencia de las intraverbales simétricas en niños de forma más efectiva y rápida. Las intraverbales utilizadas en el Experimento 1 del Tercer Artículo fueron intraverbales complejas. Entonces, los niños tienen que atender a la combinación de dos estímulos para poder dar una respuesta correcta; por ejemplo, deben responder a las palabras habladas “País” y “Kalash” ya que si solo atienden a la palabra “país” pueden dar respuestas erróneas como “Etiopía” (algo similar ocurre si sólo atienden a la palabra “Kalash”). Los tectos enseñados también son complejos ya que para responder correctamente los niños debían atender tanto a la foto como a las palabras “País” o “Tribu”. La presentación de los ensayos de aprendizaje de tectos en este estudio consistían en responder discriminaciones condicionales porque los niños debían atender a la combinación de dos estímulos en todos los ensayos para dar una respuesta correcta. Por otro lado, en los ensayos de aprendizaje del Experimento 2, los niños no necesitaban atender a la combinación de dos estímulos para dar una respuesta correcta. Por ejemplo, cuando los niños respondían al Tacto P-A, solo necesitaban atender a la imagen para dar una respuesta correcta porque el estímulo contextual siempre era “Dime el país”. Cuando tenían que responder a la Intraverbal A-B los niños solo

necesitaban atender a la palabra “Pakistán” o “Etiopía” para dar una respuesta correcta porque el estímulo contextual era siempre “Dime la tribu de”. Es posible que los niños que mostraron la emergencia en esta condición sí estuvieran atendiendo a la combinación de los estímulos presentes, pero no podemos asegurarlo; por lo tanto, si responder a discriminaciones condicionales durante las fases de enseñanza no está garantizado, algunos niños pueden no aprender a responder bajo el control de los estímulos adecuados y la emergencia de la intraverbal simétrica es menos probable.

Finalmente, en el Artículo Cuarto estudiamos si el aprendizaje de un tacto y una intraverbal cuya respuesta era la misma que la respuesta de la intraverbal simétrica que queríamos que emergiera, después de enseñar una intraverbal y probar su simetría, producía la emergencia de la simetría de la intraverbal. Los datos de este trabajo indicaron que no hubo diferencias cuando enseñamos tactos o intraverbales con la misma respuesta; es decir, parece que enseñar operantes cuya respuesta era la misma que la respuesta de la intraverbal que queríamos que emergiera fue la variable que produjo la emergencia y no el tipo de operante que se enseñó (si se presenta o no una imagen). Uno de los hallazgos de los Artículos Tercero y Cuarto consistió en que se observaron diferencias en los resultados cuando se enseñaron las intraverbales en una u otra dirección. El 90% de los niños que aprendieron la intraverbal B-C (País-Tribu) mostraron la emergencia de la intraverbal simétrica mientras que solo el 66% de los niños que aprendieron la intraverbal C-B (Tribu-País) mostraron la emergencia. La razón no está clara, pero estos resultados son coherentes con otros obtenidos en estudios sobre Categorías y Ejemplares donde se observó que las Categorías emergen después de el aprendizaje de los Ejemplares y que no se produce la emergencia de los Ejemplares a partir de las Categorías (Pérez-González et al., 2015). Si analizamos las intraverbales utilizadas en los Artículos Tercero y Cuarto podemos identificar que la Intraverbal B-C eran Ejemplares ya que se preguntábamos por la tribu de un país, en un país puede haber varias tribus (ejemplares), mientras que en la intraverbal C-B preguntábamos por el país de una tribu y una tribu suele pertenecer solo a un país (categoría). No está clara la razón por la que se produce este fenómeno, posiblemente sea por que el nombre que hace relación a la categoría está presente en todas las intraverbales relativas a esa categoría, mientras que el nombre del ejemplar no lo está (ver análisis de control multiple divergente Axe, 2008, Michael, Palmer y Sundberg, 2011, and Sundberg y Sundberg, 2011). Por otro lado, los niños respondieron con menos errores ante los ensayos de prueba y enseñanza de la intraverbal Tribu-País que en los ensayos de la

intraverbal País-Tribu; es posible que las intraverbales que se aprenden con menos errores tengan mayor probabilidad de emerger.

## **5. Conclusiones**

### **5.1. Hallazgos**

Con los experimentos realizados en estos 4 artículos podemos llegar a las siguientes conclusiones en relación a la emergencia de intraverbales:

Primero, se ha demostrado que algunos adultos muestran la emergencia de intraverbales complejas sin la necesidad de la enseñanza de Ejemplares y Categorías, pero otros necesitan enseñanzas adicionales para producir la emergencia.

Segundo, la enseñanza de las Categorías facilita la emergencia de las intraverbales complejas en adultos. Esta emergencia se produce cuando la enseñanza de las Categorías se realiza después de haber enseñado las relaciones A-B y B-C y haber pasado por ciclos de pruebas de las nuevas relaciones. La enseñanza de las Categorías justo después de la enseñanza de las relaciones A-B y B-C no produce la emergencia de intraverbales complejas.

Tercero, la enseñanza de los Ejemplares tiene un efecto muy poderoso en la emergencia de las intraverbales complejas en adultos. Sin embargo, el aprendizaje de las Categorías parece no ser tan efectivo.

Cuarto, enseñar los Ejemplares sin las Categorías no tiene efecto en la emergencia de intraverbales complejas en niños con edades comprendidas entre los 6 y 7 años. Parece que la mayoría de niños necesitan la enseñanza tanto de los Ejemplares como de las Categorías para producir la emergencia de las intraverbales complejas.

Quinto, para producir la emergencia de intraverbales complejas en niños es necesario enseñar los Ejemplares, las Categorías y las relaciones A-B y B-C desde el principio. La enseñanza de las Categorías después de varios ciclos de prueba tras la enseñanza de los Ejemplares y las relaciones A-B y B-C parece dificultar la emergencia de las intraverbales complejas en niños.

Sexto, después de analizar los resultados obtenidos en estos dos estudios y los obtenidos por Pérez-González et al. (2008) y Carp y Petursdottir (2012) se puede concluir que parece haber una clara relación entre el número de relaciones que es necesario aprender y la edad, entendida como la correlación entre el tiempo y el número de interacciones con el entorno que ha experimentado la persona en ese tiempo que

pueden dar lugar al aprendizaje de habilidades prerequisites para la emergencia de intraverbales, en la emergencia de intraverbales complejas.

Séptimo, las relaciones que tardan más en emerger son aquellas cuya respuesta es el estímulo que nunca ha sido enseñado como respuesta a otra relación. Por ejemplo, cuando enseñamos a los niños a responder “Dime el país de Roma/Lima” y “Dime el continente de Italia/Europa” en el Primer Artículo, las relaciones cuya respuesta era “Roma/Lima” fueron las que tardaron más en emerger y no siempre emergieron.

Octavo, la enseñanza de tectos basados en discriminaciones condicionales produce la emergencia de intraverbales simétricas en niños de entre 6 y 7 años. El procedimiento de tectos basados en discriminaciones condicionales muestra mayor efectividad que la enseñanza de un tacto y la intraverbal simétrica a la intraverbal que se prueba

Noveno, la enseñanza tanto de tectos como de intraverbales cuya respuesta es la misma repuesta que la de la intraverbal que queremos que emerja facilita la emergencia de las intraverbales simétricas (83% de los niños muestran la emergencia en ambos casos). Los datos del último artículo muestran que la emergencia de las intraverbales simétricas depende de que los niños aprendan a responder la respuesta de la intraverbal que queremos que emerja y no tanto del tipo de operante que utilizemos para enseñarlo (estímulo verbal o estímulo visual como estímulo antecedente).

Con los datos obtenidos en estos experimentos parece claro que: (a) la enseñanza de los Ejemplares y Categorías, junto con las relaciones A-B y B-C son necesarias para producir la emergencia de todas las intraverbales basadas en esquemas de equivalencia de estímulos en niños, (b) el efecto de la enseñanza de los Ejemplares tiene un claro efecto, mientras que la enseñanza de las Categorías no lo tiene para producir la emergencia de intraverbales basadas es esquemas de equivalencia de estímulos en adultos, (c) tanto el aprendizaje de tectos e intraverbales con la misma respuesta que la intraverbal que queremos que emerja como la enseñanza de tectos basados en discriminaciones condicionales producen la emergencia de intraverbales simétricas en niños. Ambos aprendizajes han mostrado ser efectivos, pero el aprendizaje de tectos basados en discriminaciones condicionales ha mostrado una eficacia mayor, del 100% ante el 83% del aprendizaje de tectos e intraverbales con la misma respuesta. Este dato indica que el hecho de aprender a responder operantes cuya respuesta es la misma que la respuesta de las intraverbales que queremos que emerjan a la vez que

aprender estas relaciones atendiendo a la combinación de dos estímulos, produce un incremento sustancial en la emergencia de las intraverbales simétricas y complejas.

## **5.2. Futuras líneas de investigación**

Primero, debido a que existe un porcentaje de niños y adultos que producen la emergencia de las intraverbales basadas en esquemas de equivalencia de estímulos sin la necesidad de aprender los Ejemplares ni las Categorías, resulta interesante identificar qué variables hacen que se produzca esta diferencia. Una posible vía de investigación puede analizar el hecho de que los participantes realicen la ecoica de los estímulos A (en la enseñanza de la relación A-B) y de los estímulos B (en el aprendizaje de la relación B-C). Por ejemplo, si cuando a un niño se le enseña la relación A-B “Dime el país de Roma”-“Italia”, tras presentar la instrucción el niño, de forma encubierta o no, repite la palabra “Roma”, antes de dar su respuesta, esto podría facilitar la emergencia de las relaciones B-A y C-A atendiendo a la hipótesis de que aprender a responder la respuesta de la intraverbal que queremos que emerja facilita dicha emergencia.

Segundo, con la misma finalidad que el punto anterior, puede ser posible que la experiencia previa ante el aprendizaje de relaciones similares pueda ser la causa que justifique que ciertos adultos y algunos niños muestren la emergencia sin la necesidad de la enseñanza de Ejemplares y Categorías.

Tercero, hasta el momento solo se ha analizado el aprendizaje del tacto e intraverbal para facilitar la emergencia de intraverbales. Es posible que enseñar otras operantes cuya respuesta sea la misma que las intraverbales queremos que emerjan facilite dicha emergencia. Es decir, es importante identificar si el efecto de enseñar otras operantes como la ecoica o el mando producen el mismo efecto en la emergencia de intraverbales simétricas.

Cuarto, en combinación con el punto anterior, sería muy interesante comparar el efecto de enseñar otras operantes con la misma respuesta que las intraverbales cuya emergencia se estudia y cuyos procedimientos de enseñanza no impliquen responder atendiendo a discriminaciones condicionales con la enseñanza de las mismas operantes cuyo procedimiento de enseñanza implique responder atendiendo a discriminaciones condicionales. Este tipo de estudios proporcionaría más información sobre la relevancia o no de enseñar a responder a discriminaciones condicionales en la emergencia de intraverbales complejas.

Quinto, hasta ahora solo se ha evaluado el efecto de la enseñanza de tactos basados en discriminaciones condicionales en la emergencia de intraverbales simétricas. Un siguiente paso sería analizar el efecto de la enseñanza de tactos basados en discriminaciones condicionales en la emergencia de intraverbales basadas en esquemas de equivalencia de estímulos. Es decir, ante la misma imagen (P1) enseñamos las relaciones “Dime el país”-“España (A1)”, “Dime la ciudad”-“Madrid (B1)” y “Dime el monumento”-“La Cibeles (C1)”. Después ante la imagen P2 enseñamos las mismas relaciones con los estímulos “Francia (A2)”, “París (B2)” y “La torre Eiffel (C2)”; entonces, es posible, basándonos en los datos del Experimento 1 del Tercer Artículo, que las relaciones B-A, C-B, A-C y C-A emerjan tras enseñar solo estas relaciones.

Sexto, es importante replicar todos estos estudios con más participantes para poder extrapolar los hallazgos y también sería necesario replicar los estudios con niños con dificultades de aprendizaje e identificar cuáles son las habilidades prerequisites que los niños deben mostrar antes de iniciar programas cuyo objetivo sea la emergencia de intraverbales.

### **5.3. Aplicaciones**

Los hallazgos de esta tesis nos permiten entender mejor los procesos implicados en la emergencia de intraverbales complejas y simétricas tanto en adultos como en niños. Este trabajo demuestra que la emergencia de intraverbales no se produce de una forma directa e inmediata y que es un proceso que implica la adquisición de varias habilidades para poder producirse. Este trabajo muestra una serie de aprendizajes que son necesarios para producir la emergencia de intraverbales y el desarrollo de nuevo lenguaje. Estos hallazgos permiten diseñar procedimientos eficaces que ayuden a los niños a producir la emergencia de intraverbales complejas dentro de contextos académicos o para poder comprender diferentes situaciones sociales. Si estos hallazgos se replican con niños con autismo y otros trastornos del desarrollo, sus implicaciones serán muy importantes para el diseño de curricula de enseñanza de capacidades para producir la emergencia de intraverbales en los casos en los que esta capacidad no esté presente. Conseguir producir la emergencia de intraverbales complejas en niños con autismo y otros trastornos del aprendizaje es un hito muy importante para que pueden comprender y controlar mejor su contexto a través del desarrollo y la producción de nuevos episodios de lenguaje.

## 6. Referencias

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