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TEMPERAMENT OF CAPTIVE VINACEOUS-BREASTED AMAZON PARROT (*Amazona vinacea* KUHL, 1820) AND INDIVIDUAL DIFFERENCES IN THE RESPONSES TO ENVIRONMENTAL ENRICHMENT

Juiz de Fora
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Dissertação apresentada ao Instituto de Ciências Biológicas, Programa de Pós-Graduação em Ciências Biológicas: Comportamento e Biologia Animal da Universidade Federal de Juiz de Fora, como requisito para obtenção do grau de Mestre.

Orientadora: Professora Doutora Aline Cristina Sant'Anna

Coorientador: Professor Doutor Cristiano Schetini de Azevedo

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RESUMO

O temperamento está relacionado ao modo com que os animais respondem a novos ambientes, coespecíficos e a potenciais riscos como a predação. Assim, o conhecimento sobre essa característica em papagaios-do-peito-roxo (*Amazona vinacea*, N = 13) cativos pode ser utilizado para melhorar a qualidade de vida de animais em cativeiro e aumentar o sucesso dos programas de reintrodução. Portanto, os objetivos do presente estudo foram: a) investigar as relações entre temperamento, habilidade de voo e a reação dos animais à oferta de alimento pelo ser humano; b) avaliar se as respostas comportamentais ao enriquecimento ambiental diferem em relação ao temperamento e habilidade de voo. Foram realizados três testes de temperamento (teste do novo objeto, teste de reação à pessoa desconhecida e teste do potencial predador) e avaliações comportamentais através de um etograma, em duas fases: sem enriquecimento ambiental e com ambiente enriquecido. Além disso, testes de habilidade de voo e oferta de alimento também foram realizados para avaliar comportamentos considerados importantes para a sobrevivência na natureza. Quatro dimensões do temperamento foram descritas (‘vigilância’, ‘propensão ao risco’, ‘atividade’, ‘sociabilidade’). Houve efeitos significativos do enriquecimento ambiental para os comportamentos de repouso (P = 0,011), alimentação (P = 0,014), alolimpeza (P = 0,024) e interação com o ambiente (P = 0,001). Em relação aos efeitos do temperamento no comportamento dos papagaios, animais classificados como ‘vigilantes’ passaram menos tempo se alimentando (P = 0,03) no comedouro e interagindo com o ambiente (P = 0,006) do que aqueles classificados como ‘indiferentes’. Também observamos efeitos significativos da habilidade de voo no comportamento, papagaios com habilidade de voo reduzida passaram significativamente mais tempo em autolimpeza (P = 0,037), apresentaram menor frequência de vocalizações (P = 0,009) e tenderam menos a entrar em conflitos (P = 0,069) do que aqueles com alta habilidade de voo. Papagaios que voaram melhor tenderam a interagir mais (P = 0,061) com os itens de enriquecimento do que os com menor capacidade de voo. Assim, sugerimos que o desempenho de voo e o temperamento de animais em cativeiro sejam considerados ao planejar e executar técnicas de enriquecimento ambiental.

Palavras-chave: cativeiro, personalidade, propensão ao risco, reintrodução, vigilância.

ABSTRACT

Temperament is related to how animals respond to new environments, conspecifics and potential risks in their environment. Thus, knowledge about this trait can be used to improve the quality of life of captive wild animals, and to increase the success of reintroduction programs. Our subjects were 13 captive Vinaceous-breasted Amazon parrots (*Amazona vinacea*). The aims of our study were: a) to investigate the relationship of temperament with flight ability and animal's reaction to human presence when offered food; b) to evaluate if behavioral responses to environmental enrichment vary in relation to temperament and flight ability. Three temperament tests (novel object test, reaction to an unknown person and reaction to potential predator) were performed and behavioral evaluations using an ethogram were carried out, in two phases: unenriched and enriched. Furthermore, flight skill and food reward tests were also performed to assess behaviors considered important for survivorship in wild. Four temperament dimensions were described ('vigilance', 'risk-taking', 'activity', 'sociability'). There were significant effects of environmental enrichment on the behaviors of resting (P = 0.011), feeding (P = 0.014), allopreening (P = 0.024) and interaction with environment (P = 0.001). Regarding the effects of temperament on parrots' behaviors, animals categorized as 'vigilant' spent less time feeding (P = 0.03) on the feeder and interacting with environment (P = 0.006) than those categorized as 'indifferent'. We also found significant effects of flight skill on behaviors, animals with compromised flight ability spent significantly more time preening (P = 0.037), had lower frequency of vocalizations (P = 0.009) and tended to have fewer negative social interactions (P = 0.069) than those with high flight ability. Those individuals with better flight ability tended to interact more (P = 0.061) with the enrichment items than individuals with lesser flight ability. Thus, we suggest that flight performance and temperament of captive animals should be considered while planning and executing environmental enrichment techniques.

Keywords: captivity, personality, reintroduction, risk-taking, vigilance.

RESUMO PARA DIVULGAÇÃO CIENTÍFICA

Os animais possuem diferenças individuais comportamentais consistentes em diversas situações, caracterizadas como temperamento (ou personalidade). As dimensões do temperamento estão relacionadas ao modo como os animais reagem a mudanças em seu ambiente como itens de enriquecimento ambiental, a potenciais riscos como predadores e a outros indivíduos como coespecíficos e o ser humano. Por esse motivo, ter conhecimento dessas dimensões em papagaios-do-peito-roxo cativos candidatos a reintrodução, nos permite melhorar a qualidade de vida dos animais em cativeiro e aumentar o sucesso de programas de reintrodução. Nosso objetivo foi identificar as dimensões do temperamento em papagaios-do-peito-roxo cativos, além de investigar as relações entre temperamento, habilidade de voo e a reação dos animais à oferta de alimento pelo ser humano, e avaliar se as respostas comportamentais ao enriquecimento ambiental diferem em relação ao temperamento e habilidade de voo. Aqui, os papagaios se comportaram de maneira diferente com a inserção dos itens de enriquecimento ambiental no viveiro. Observamos que em um ambiente enriquecido, os animais ficaram menos em repouso, se alimentaram menos no comedouro e interagiram menos com os itens fixos do viveiro, e que os enriquecimentos ambientais físicos e alimentares oferecidos para os animais se mostrou eficiente, pois os papagaios ficaram menos inativos e optaram por se alimentar dos novos recursos inseridos no viveiro. Adicionalmente, encontramos quatro dimensões das várias que compõe o temperamento dos psitacídeos: (‘vigilância’, ‘propensão ao risco’, ‘atividade’, ‘sociabilidade’). Vimos que os papagaios com o perfil de temperamento ‘vigilante’ se alimentaram menos no comedouro e interagiram menos com o ambiente, do que aqueles classificados como ‘indiferentes’, e que os animais ‘propensos ao risco’ se envolveram mais em brigas. Também observamos que papagaios que voaram melhor interagiram mais com os itens de enriquecimento do que os com menor capacidade de voo. Assim, sugerimos que o desempenho de voo e o temperamento de animais em cativeiro sejam considerados ao planejar e executar técnicas de enriquecimento ambiental.

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CETAS – Centro de Triagem de Animais Silvestres

CEUA – Comissão de Ética no Uso de Animais

IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis

IEF – Instituto Estadual de Florestas

NOt - Novel object test

RPt – Reaction to potential predator

RUPt – Reaction to an unknown person

SUMÁRIO

CAPÍTULO 1

Introdução geral

A espécie *Amazona vinacea* (Kuhl, 1820), pertence à Ordem Psittaciformes, é conhecida popularmente como papagaio-do-peito-roxo e caracterizada pela coloração das penas arroxeado-vináceo na região do peito. Esta espécie é endêmica da Mata Atlântica, ocorrendo do sul da Bahia ao norte do Rio Grande do Sul e também no leste do Paraguai e na província de Misiones, Argentina (Sick, 1997). Devido ao tráfico ilegal e a fragmentação de seu hábitat natural, a espécie está ameaçada de extinção, sendo incluída na categoria 'vulnerável' no Brasil segundo a Instrução Normativa n° 444 (IBAMA) de 17 de dezembro de 2014, e no mundo pela BirdLife Internetional (2017) na categoria '*endangered*' com o *status* C2A(i), indicando que a população está em declínio continuado e restam menos de 2.500 indivíduos adultos na natureza. Por esse motivo, os indivíduos desta espécie são frequentes em órgãos de reabilitação de animais vítimas do tráfico, como os CETAS (Centro de Triagem de Animais Silvestres). Os animais que chegam ao CETAS são reabilitados e, quando estão saudáveis, são reintroduzidos em seu habitat natural ou são realocados para zoológicos, mantenedouros ou criadouros legalizados, se não possuírem condições de voltarem para natureza (Renctas, 2016).

No caso dos animais que serão mantidos em cativeiro, técnicas de enriquecimento ambiental podem ser utilizadas como ferramentas para melhoria do bem-estar de diversas espécies (de Azevedo et al., 2007). A inserção de novos itens físicos e alimentares em viveiros de psitacídeos cativos tem o potencial de promover a expressão de comportamentos naturais da espécie (van Zeeland et al., 2013a), bem como de aumentar a diversidade comportamental (Coulton et al., 1997). A disposição de enriquecimentos para essas aves cativas pode aumentar o nível de atividade geral (de Azevedo et al., 2016) e diminuir a incidência de comportamentos indesejáveis, tais como a automutilação e condutas repetitivas (van Hoek & King, 1997; Meehan et al., 2003a; 2004). No entanto, os impactos do enriquecimento no comportamento dos psitacídeos pode variar em função de características individuais dos animais.

As diferenças individuais no comportamento, consistentes ao longo do tempo e em distintas situações são conhecidas como temperamento (Réale et al., 2007), e já foram descritas em diversos táxons de aves e mamíferos (Gosling, 2001). Segundo McDougall et al. (2006) e Réale et al. (2007) tais diferenças podem ser caracterizadas principalmente

pelas seguintes dimensões (ou perfis): ‘ousadia’, ‘reatividade’, ‘exploração’, ‘atividade’, ‘sociabilidade’ e ‘agressividade’. Estes traços estão relacionados ao modo com que os animais respondem a potenciais riscos como predadores e humanos (Lopes et al., 2017), a novos estímulos no ambiente (Fox & Millam, 2007) e coespecíficos (Fox & Millam, 2014). Ter conhecimento dessas características individuais em animais silvestres cativos pode auxiliar no manejo, pois é possível adaptar os protocolos de enriquecimento ambiental em função dos diferentes perfis de temperamento, melhorando a qualidade de vida dos mesmos. Animais neofílicos por exemplo, tendem a se aproximar e explorar novos itens inseridos nos viveiros, diferente dos animais que possuem o perfil ‘neofóbico’ e permanecem distantes desses itens (Fox & Millam, 2004; 2007).

Quando os animais estão em cativeiro por um período e serão reintroduzidos na natureza, ter conhecimento dessas características individuais pode auxiliar também na escolha do grupo que será reintroduzido como observado por Lopes e colaboradores (2017). Os autores identificaram a dimensão ‘ousadia’ em papagaios-verdadeiros cativos que foram reintroduzidos posteriormente e observaram que após a soltura, papagaios ‘tímidos’ interagiram mais com seu parceiro e com papagaios nativos do que os ‘ousados’ (Lopes te al., 2017). Além disso alguns estudos sugerem que selecionar para reintrodução um grupo misto, composto por animais com diferentes estilos de temperamento é importante para estabilidade do grupo na natureza (Bolnick et al., 2003; Sih & Watters, 2005; Watters & Meehan, 2007), pois se todos os animais do grupo se comportam da mesma maneira e uma drástica mudança ambiental que esse perfil não está adaptado ocorre, a população recém reintroduzida pode não perdurar (Watters et al., 2003).

Estudos prévios indicam que diversas espécies de psitacídeos diferem consistentemente quanto à ‘neofobia’ (Fox & Millam, 2004; Coutant et al., 2018), ‘ousadia’ ou ‘predisposição ao risco’ (Lopes et al., 2017; Paulino et al., 2018), ‘neuroticismo’ (Cussen & Mench, 2014; 2015), ‘vigilância’ e ‘atividade’ (Coutant et al., 2018). Embora muitas pesquisas tenham sido realizadas a fim de descrever o impacto de diferentes tipos de enriquecimento ambiental no comportamento de psitacídeos cativos (van Zeeland et al., 2013a; de Azevedo et al., 2016; Reimer et al., 2016), poucas consideraram aspectos do temperamento dos animais como importantes fatores intervenientes (Meehan & Mench, 2002; Meehan et al., 2003b; Fox & Millam, 2007; Cussen & Mench, 2015; Paulino et al., 2018). Até o presente momento, esse é o primeiro

trabalho que avalia o efeito do enriquecimento ambiental no comportamento dos animais, e ainda os aspectos do temperamento da espécie *Amazona vinacea.*

Revisão de literatura

Enriquecimento ambiental para psitacídeos

Animais silvestres quando mantidos em cativeiro se deparam com situações diferentes das que encontrariam em vida livre (Clubb & Mason, 2003; McPhee & Carlstead, 2010). A vida na natureza inclui vários estímulos para os animais (Watters & Meehan, 2007). Eles precisam buscar alimento, abrigo, parceiros e fugir de predadores (Snyder et al., 1996), o ambiente é imprevisível e os animais têm controle sobre ele (Mench, 1998). Por outro lado, quando mantidos em cativeiro, geralmente são alojados em ambientes monótonos e pobre em estímulos, são protegidos de potenciais predadores e interações competitivas, e também recebem o alimento em um horário fixo, muitas vezes peletizado (Griffin et al., 2000; Morgan & Tromborg, 2007; Vasconcellos et al., 2012). Tais implicações do cativeiro podem levar os animais a expressarem uma variedade de comportamentos inadequados, dentre eles excessivas reações de medo, tais como tentativas de fuga, pânico e agressividade (Mench & Blatchford, 2013), sinais estresse crônico, apatia, automutilação e estereotipias (Mason, 2010). Todos esses comportamentos são restritos a animais cativos e com problemas psicológicos graves, portanto, indicam que seu bem-estar pode estar seriamente comprometido (Mench & Blatchford, 2013).

Segundo Broom (1991), bem-estar é definido como o estado de um indivíduo em relação às suas tentativas de adaptar-se ao ambiente. O bem-estar de um dado animal pode ser considerado segundo três abordagens principais: *i*) o funcionamento biológico, o que inclui a saúde física, capacidade do animal de crescer e se reproduzir; *ii*) o segundo aspecto está relacionado aos seus sentimentos e emoções, e inclui os estados mentais do animal; e *iii*) a abordagem da vida natural, segundo a qual pode-se considerar que o bem-estar será melhor quanto mais próximo o animal estiver de seu ambiente natural, em condições próximas daquelas nas quais a espécie evoluiu (Fraser et al., 1997) A adoção destas abordagens pressupõe o reconhecimento de que animais não-humanos possuem não apenas uma dimensão física, mas também psicológica e, portanto, são capazes de experimentar estados emocionais positivos (como conforto, prazer e alívio), além de

estados emocionais negativos (como desconforto, medo, ansiedade, dor, sofrimento e irritação).

Nesse sentido, o enriquecimento ambiental surge como uma possível ferramenta para melhorar o bem-estar dos animais em cativeiro, consistindo em uma série de intervenções no ambiente físico ou social, que visam proporcionar melhores condições para o desempenho de suas necessidades etológicas (Young, 2003). A introdução de técnicas de enriquecimento ambiental vem apresentando efeitos positivos no bem-estar de diversas espécies ao longo dos anos (Shyne, 2006). Porém, de acordo de Azevedo e colaboradores (2007), entre os anos 1985-2004 apenas oito artigos científicos publicados em periódicos avaliaram a inserção de itens de enriquecimento ambiental nos viveiros de psitacídeos. Esta circunstância é confirmada pelo texto de King (1993), no início da década de 90. A autora questiona o foco dos programas de enriquecimento ambiental apenas para mamíferos, e a falta do fornecimento desses itens para aves e outras espécies de animais mantidos em zoológicos. A partir desta data o crescimento de pesquisas avaliando a interação de psitacídeos com o enriquecimento foi exponencial (Rodríguez-López, 2016).

Hoje, as pesquisas que investigam a utilização desta ferramenta para psitacídeos cativos apresentam diferentes enfoques. Alguns dos trabalhos buscam avaliar a preferência dos animais por distintos tipos de enriquecimento, utilizando testes de escolha (Kim et al., 2009; Webb et al., 2010; Rozek et al., 2010). Porém, a maioria das pesquisas investigam a relação entre enriquecimento ambiental e a ocorrência de comportamentos anormais (van Hoek & King, 1997; Meehan et al., 2003a, 2004; de Andrade & de Azevedo, 2011;) e a influência do mesmo no comportamento dos psitacídeos (van Hoek & King, 1997; de Azevedo et al., 2016).

Os testes de escolha são utilizados como uma maneira de se conhecer as preferências dos animais mantidos em cativeiro (Coulton et al., 1997), proporcionando um bem-estar animal positivo (Vasconcellos et al., 2012). Estudos investigando a preferência de papagaios-do-mangue (*Amazona amazonica*) cativos por distintos tipos de enriquecimento podem proporcionar resultados interessantes. Kim et al. (2009) observaram a preferência destes papagaios entre cor, tamanho e consistência de dois itens de enriquecimento ambiental físicos. Quando apresentaram aos papagaios cubos de madeira e anéis de acrílico, eles demonstraram mais interesse pelos objetos de madeira (principalmente nas cores amarelo e laranja). A preferência dos papagaios da espécie *A.*

amazonica entre cordas de sisal com diferentes espessuras também já foi investigada (Webb et al., 2010) e, aparentemente, as fêmeas escolheram interagir com cordas mais finas e ambos os sexos preferiram cordas novas em comparação com cordas desgastadas. Por sua vez, quando disponibilizadas rações peletizadas com diferentes dimensões para papagaios-do-mangue, os mesmos preferiram rações com dimensões maiores das que são indicadas para eles (Rozek et al., 2010). Segundo os autores, os 'pellets' maiores aumentaram o tempo gasto pelos animais com a manipulação do alimento.

As condições estressantes do cativeiro podem afetar o bem-estar dos psitacídeos, levando ao aparecimento de comportamentos anormais (Morgan & Tromborg, 2007). A inserção dos enriquecimentos nos viveiros desses animais aumenta a complexidade do ambiente (Meehan & Mench, 2008) e tem o potencial de ajuda-los a enfrentar esses problemas (Mason et al., 2007). Portanto, outro enfoque das pesquisas trata-se da avaliação do efeito do enriquecimento ambiental na ocorrência (van Hoek & King, 1997; Meehan et al., 2004), redução e/ou evitação (Meehan et al., 2003a; de Andrade & de Azevedo, 2011; Telles et al., 2015) de diferentes comportamentos anormais comuns em psitacídeos. Os enriquecimentos ambientais físicos e alimentares se mostraram eficientes na redução do comportamento de arrancamento de penas em indivíduos das espécies *Psittacara leucophthalmus* (Telles et al., 2015) e *Amazona amazonica* (Meehan et al., 2003a). Meehan et al. (2004) observaram que esses dois tipos de enriquecimentos também podem reduzir ou evitar estereotipias. Os achados de Polverino et al. (2015) corroboram os resultados anteriores, onde periquitos da espécie (*Melopsittacus undulatus*) reduziram significativamente a expressão de estereotipias orais e motoras quando foram expostos a parceiros sociais.

Foram investigados também os efeitos do fornecimento de novos itens de enriquecimento alimentar e físico para psitacídeos cativos com resultados promissores, indicando que o comportamento dos animais foi modificado de maneira positiva (Millam et al., 1995; Assis et al., 2016; de Almeida et al., 2018). Van Hoek & King (1997) reportaram que as tiribas-de-barriga-vermelha (*Pyrrura perlata perlata*) mantidas em ambiente enriquecido apresentaram maior nível geral de atividade. De Azevedo e colaboradores (2016) observaram em araras-azuis (*Anodorhynchus leari*) que o enriquecimento físico não apenas aumentou o nível geral de atividade dos animais como também promoveu a expressão de comportamentos naturais da espécie. Em relação ao enriquecimento alimentar, van Zeeland et al. (2013a) constataram que sementes dentro

de rolos de papelão com mel dobraram o tempo gasto por papagaios-cinzas (*Psittacus erithacus erithacus*) em atividades relacionadas ao forrageio (123 min/dia), em relação à fase não enriquecida (47 min/dia). Porém, mesmo que o enriquecimento tenha aumentado consideravelmente o tempo gasto com o forrageio em cativeiro, a fração do orçamento temporal gasto forrageando ainda permaneceu muito abaixo daquela descrita para psitacídeos em vida livre (4 a 6 horas diárias) (Cubas et al., 2014).

Embora os estudos presentes na literatura revelem o sucesso do fornecimento de enriquecimento ambiental para psitacídeos cativos, nenhum deles avaliou as respostas comportamentais de papagaios da espécie *Amazona vinacea*. Sabe-se que características espécie-específicas podem afetar o modo como os animais reagem ao ambiente físico e social e, portanto, os estudos sobre o enriquecimento ambiental deveriam ser realizados com o maior número possível de grupos taxonômicos, a fim de se evitar extrapolações equivocadas.

Temperamento em psitacídeos

O temperamento pode ser definido como diferenças individuais comportamentais que são consistentes ao longo do tempo e em distintas situações (Réale et al., 2007), também descrito por diversos autores como personalidade (Gosling & John, 1999), *coping styles* (Koolhaas et al., 1999) ou *behavioral syndromes* (Sih et al., 2004). As dimensões do temperamento podem influenciar a susceptibilidade dos animais ao estresse, além da ocorrência e gravidade dos efeitos comportamentais induzidos pelo ambiente, as quais podem apresentar profundas variações interindividuais (Carere et al. 2010; Cussen & Mench, 2015). O temperamento de animais não-humanos tem sido estudado ao longo dos anos em uma ampla gama de grupos taxonômicos, principalmente, em mamíferos e aves (Gosling, 2001). Porém, as pesquisas investigando tal fenômeno em psitacídeos são recentes e indicam que o temperamento desse grupo de aves apresenta distintas dimensões/componentes, as quais variam em função da espécie e do tipo de metodologia utilizada (Fox & Millam, 2004; Cussen & Mench, 2015; Lopes et al., 2017; Coutant et al., 2018; Paulino et al., 2018).

Uma abordagem comumente utilizada na avaliação do temperamento de psitacídeos se baseia na exposição dos animais a um novo elemento em seu recinto (geralmente um novo objeto), o que permite classificá-los quanto à resposta a novidade. Indivíduos que apresentam reações de exploração e curiosidade são considerados ‘neofílicos’ enquanto

os que revelam-se aversivos e amedrontados, como 'neofóbicos' (Feenders et al., 2011). Em uma pesquisa com papagaios-do-mangue (*Amazona amazonica*), Fox & Millam (2004) observaram diferenças individuais consistentes nos papagaios quando expostos a uma novidade, e as relacionaram com a condição de manejo dos animais. Os papagaios criados apenas por humanos foram menos aversivos ao novo item do que os indivíduos que haviam sido criados pelos pais.

O temperamento dos psitacídeos também é frequentemente avaliado quanto à dimensão de 'timidez – ousadia' (do inglês '*boldness*'), a qual prediz as respostas comportamentais dos animais quando colocados em situações de risco e desafio, por exemplo, a exploração de um novo ambiente, o risco de predação e a competição por recursos (Réale et al., 2007). As pesquisas investigando esta dimensão abrangem psitacídeos de várias espécies, tais como o papagaio-verdadeiro (*Amazona aestiva*) (de Azevedo et al., 2017; Lopes et al., 2017), papagaio-chauá (*Amazona rhodocorytha*) (Paulino et al., 2018), calopsita (*Nymphicus hollandicus*) (Fox & Millam, 2014) e o periquito-monge (*Myiopsitta monachus*) (Kerman et al., 2016). Van Zeeland et al. (2013b) aplicaram três testes comportamentais padronizados (teste do novo objeto, de contenção e de campo aberto) em papagaios-cinzas (*Psittacus erithacus*) e caracterizaram os animais com dois extremos: 'ousados' onde os animais foram propensos ao risco e 'tímidos' quando eles sem comportaram de maneira aversiva ao risco. Os autores observaram que as aves com o comportamento de arrancamento de penas apresentaram maiores níveis de atividade e foram caracterizadas pelo perfil 'ousado', enquanto as aves 'tímidas' não apresentaram tal comportamento e foram menos reativas em um manejo aversivo.

Estudos mais recentes identificaram outras dimensões que também compõem o temperamento dos psitacídeos. Os perfis de 'neuroticismo' e 'extraversão' foram identificados em papagaios-do-mangue (*Amazona amazonica*) por Cussen & Mench, (2014), através de uma análise qualitativa do temperamento. Os papagaios foram caracterizados com diversos adjetivos, representando os dois extremos das dimensões, dentre eles: 'medroso', 'tímido' e 'não sociável' para os animais com o perfil 'neuroticismo', e 'ativo', 'impulsivo', 'persistente' para o perfil 'extraversão'. Outro exemplo são os achados de Coutant et al. (2018), onde cinco testes comportamentais padronizados foram realizados com o objetivo de identificar diferenças individuais consistentes em três espécies de papagaios cativos (*Psittacus erithacus*, *Amazona aestiva*,

Amazona autumnalis). A dimensão do temperamento nomeada pelos autores como 'ansiedade/vigilância' foi caracterizada a partir de comportamentos que indicavam estados de alerta frente aos estímulos apresentados aos animais. Por sua vez, a dimensão 'curiosidade/ neofilia' foi caracterizada pelos comportamentos de interação com o novo objeto e com o humano desconhecido no teste de recompensa. E, por último, foi identificada uma dimensão de 'atividade', a qual incluiu os componentes de movimentação dos animais nos cinco testes.

A identificação das diferenças individuais em animais silvestres em cativeiro, através de testes comportamentais padronizados ou de observações comportamentais, pode auxiliar na melhoria da qualidade de vida dos animais dentro dos recintos e, para uma posterior soltura, estarem aptos a viverem na natureza. Porém, para que a avaliação do temperamento seja incorporada em programas de bem-estar e conservação de psitacídeos em cativeiro, ainda são necessários estudos adicionais que auxiliem na padronização metodológica e na elucidação das dimensões principais do temperamento de cada espécie.

Relação entre temperamento e enriquecimento ambiental para psitacídeos

Poucas pesquisas investigam a influência do temperamento no sucesso dos programas de enriquecimento ambiental (Rodríguez-López, 2016). Os estudos presentes na literatura nos indicam que a inserção de novos itens alimentares e físicos nas gaiolas de papagaios-do-mangue (*Amazona amazonica*) afeta o comportamento dos animais caracterizados como 'neofóbicos' e 'neofílicos' de maneira diferente (Meehan & Mench, 2002; Fox & Millam, 2007). Meehan & Mench (2002) observaram que papagaios mantidos em ambientes enriquecidos apresentaram menos respostas de neofobia em relação ao novo objeto e ao avaliador em um teste de recompensa. Além disso, os animais mantidos sem acesso aos enriquecimentos foram menos agressivos e interagiram mais com o ser humano em comparação com os animais que passaram pela fase enriquecida. Por sua vez, Cussen & Mench (2015) avaliaram a relação entre as dimensões do temperamento 'neuroticismo'/ 'extraversão' com o desenvolvimento de comportamentos anormais nos papagaios-do-mangue. Segundo as autoras, papagaios que apresentaram o perfil mais extrovertido desenvolveram menos estereotipias durante a privação do enriquecimento, em comparação com seu extremo oposto.

A avaliação da rotatividade dos itens de enriquecimento, e não apenas seu simples fornecimento, também foi avaliada na redução da neofobia em *A. amazonica* por Fox &

Millam (2007). Foi observado que as aves com acesso a diversos enriquecimentos apresentaram latências menores para se alimentar na presença de um novo objeto do que as aves que receberam itens sem variação, ou seja, a rotação frequente e enriquecimento ambiental é mais eficaz na redução da neofobia do que o simples fornecimento dos itens.

As diferenças individuais também foram investigadas em papagaios-chauá (*Amazona rhodocorytha*) por Paulino e colaboradores (2018). Os autores identificaram duas dimensões de temperamento através de uma avaliação qualitativa do comportamento (QBA) e as relacionaram comportamentos exploratórios dos animais em um ambiente enriquecido. O enriquecimento ambiental aumentou a expressão de comportamentos exploratórios, porém os animais com temperamento 'pró-ativo', caracterizados por apresentarem altas cargas para os adjetivos 'nervoso, inquieto, irritado', interagiram mais com o ambiente, em comparação aos menos 'pró-ativos' ('relaxado' e 'satisfeito').

Portanto, avaliar as respostas comportamentais individuais de psitacídeos cativos frente à disponibilidade de itens de enriquecimento ambiental se torna necessário para o sucesso dos programas de enriquecimento, tendo em vista que as mudanças ambientais nos ambientes de cativeiro influenciam cada indivíduo de forma distinta (Carlstead et al. 1999).

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CAPÍTULO 2

TEMPERAMENT IN CAPTIVITY, ENVIRONMENTAL ENRICHMENT AND RESPONSE TO HUMANS IN AN ENDANGERED PARROT SPECIES

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Abstract

Temperament is related to how nonhuman animals respond to new environments, conspecifics and potential risks in their environment. The study aimed: (a) to investigate the relationship of temperament with flight ability and reaction to human presence when offered food in captive Vinaceous-breasted Amazon parrots (*Amazona vinacea*); (b) to evaluate if behavioral responses to environmental enrichment vary in relation to temperament and flight ability. Three temperament tests were performed and behavioral evaluations of parrots (N = 13) using an ethogram were carried out, in two phases: unenriched and enriched. Flight skill and food reward tests were performed to assess behaviors considered important for survivorship in wild. Four temperament dimensions were described ('vigilance', 'risk-taking', 'activity', 'sociability'). Parrots categorized as 'vigilant' spent less time feeding on the feeder and interacting with environment. Animals with compromised flight ability spent more time preening, had lower frequency of vocalizations, tended to have fewer negative social interactions and interacted less with the enrichment than individuals with better flight ability. Thus, flight performance and temperament of captive parrots should be considered while planning and executing environmental enrichment techniques.

Keywords*:* *Amazona vinacea*, flight ability, human-animal interaction, personality, reintroduction in wild.

Introduction

Several factors must be considered for the maintenance of birds in captivity aiming for their reintroduction (Seddon et al., 2012). The captive environment may lead to a reduction in animals' behavioral plasticity due to the lack of stimuli (Watters & Meehan, 2006). Thus, environmental enrichment can be used as an alternative to increase the diversity of behavioral repertoire of the species (Meehan et al., 2003; 2004; Young, 2003). Although several studies have been carried out describing the impact of different environmental enrichment types on the behavior of captive parrots (Webb et al., 2010; van Zeeland et al., 2013; De Azevedo et al., 2016), few of them considered aspects of birds' temperament as an important trait (Meehan & Mench, 2002; Fox & Millan, 2007; Cussen & Mench, 2015; Paulino et al., 2018).

Animal temperament is usually defined as behavioral differences that are consistent over time and across distinct situations (Réale et al., 2007). Temperament may be crucial for the survival and reproduction of wild animals in reintroduction programs (Lopes et al., 2017), since this trait is directly connected with animals' responses to a novel environment or potential risks such as predators, humans or conspecifics (McDougall et al., 2006).

Another important trait to be considered in reintroduction programs involving birds is their flight ability, since searching for food, shelter and flight from predators require flying in wild (Seidensticker & Forthman, 1998). Thus, it is expected that bird candidates for reintroduction in to wild need to successfully perform these activities to survive when free-living (Nunes, 2004; Hess et al., 2005). In addition, to reduction in flight ability, it is common that captive parrots also reduce their reactivity to humans. Animals associate humans with food supply, that is, as a positive stimulus, thereby reducing their fear responses (Jones, 1995). These positive social interactions may be beneficial, providing a positive welfare for animals that will remain in captivity for the rest of their lives (Morgan & Tromborg, 2007). However, for individuals who are candidates for reintroduction, the reduction of fear of humans should not occur, to avoid the risk of birds being illegally trapped and hunted.

Amazona vinacea (Kuhl, 1820) is included in the Order Psittaciformes, popularly known as Vinaceous-breasted Amazon parrot. The species is endemic to the Brazilian Atlantic rainforest with distribution limited to mixed ombrophilous forest (Collar, 1997). According to IUCN the species is threatened by destruction of its natural habitat,

persecution as a crop pest and illegal animal trade, leading to hunting and trapping. Thus, Vinaceous-breasted Amazon parrot has been included within the 'endangered' category, status C2A(i), and it is estimated that there are less than 2,500 individuals in wild (BirdLife International, 2017). All these reasons mean that *A. vinacea* is frequently received in the Brazilian Wild Animals Triage Centers.

Despite the importance of animal temperament and flight ability in reintroduction programs and welfare in captivity, for South American psittacids we have found few published studies focusing on these traits (Fox & Millan, 2004, 2007; Kerman et al., 2016; De Azevedo et al., 2017; Lopes et al., 2017; Coutant et al., 2018; Paulino et al., 2018). Therefore, to the best of our knowledge, this is the first study relating temperament, behavioral responses to enrichment, flight ability and response to humans in captive *Amazona vinacea*. Thus, the aims of the present study were: a) to investigate the relationship of temperament with flight ability and animal's reaction to human when offered food; and b) to evaluate if behavioral responses to environmental enrichment differ in regard to their temperament and flight ability.

Material and methods

Ethical Note

This study was approved by Ethics Committee on Animal Use / CEUA – UFJF, protocol number 30/2017, by the State Forest Institute (*Instituto Estadual de Florestas,* IEF/Juiz de Fora), authorization 034/2017, and by the Brazilian Institute for the Environment and Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis*, IBAMA/Juiz de Fora), process number: 02555.1000180/2017-34.

Study area, animals and procedures

All animals came from the Wild Animals Triage Centre (*Centro de Triagem de Animais Silvestres*, CETAS), and were under the supervision of IEF/IBAMA entities – Juiz de Fora, Brazil. Five males and eight females (adult individuals) of the *Amazona vinacea* species were used and identified by numbered leg-rings. The birds were assigned to CETAS mainly because of illegal wildlife trade and, for this reason, information such

as age, history and precise time in captivity are unknown. It is known that all of them were in captivity for at least one year under CETAS responsibility.

Behavioral evaluations were carried out in a private rural property, which is part of the Wild Animal Release Area Project (*Área de Soltura de Animais Silvestres*, ASAS) of IEF/IBAMA entities – Juiz de Fora, Brazil. This property is located in the state of Minas Gerais, and is in the range of natural occurrence of Vinaceous-breasted Amazon parrot. After finishing the data collection CETAS conducted the process of parrots' reintroduction in the area of study for those with adequate flight ability and healthy (n = 4) and the other parrots remained in captivity.

During the study, the animals were kept in a wire mesh maintenance aviary (10 m long, 4 m wide and 3 m tall), which had fixed and mobile perches, a covered feeding area and three extra feeders, which were hung on the mesh. For behavioral observations and temperament tests, parrots were transferred to an experimental aviary, which was 8 m long, 4 m wide and 3 m tall, had four perches (two fixed and two mobile) and a covered feeding area. The animals were fed twice a day (morning and afternoon) with fruit, vegetables, extruded feed, seeds of sunflower and *Araucaria angustifolia,* and the water was provided *ad libitum*. Small cuts in different positions at the distal end of the tail feathers, associated with non-toxic marking on the chest and back (marking stick, Walmur Instrumentos Veterinários Ltda®) were used to facilitate individual identification during behavioral evaluations.

The study was divided in three parts: (a) temperament assessment using behavioral tests; (b) behavioral observations using an ethogram to assess the effect of physical and foraging environmental enrichment; and (c) assessment of flight skill and animal's reaction to human when offered food, considering behaviors important for parrots' survivorship in wild (Figure 1 and 2).

Temperament tests		**Behavioral observations** (for each group)		**Additional tests**	
Unknown person Novel object	Potential predator	Unenriched phase	Enriched phase	Flight skill	Food reward
1st and 2nd days	4th and 5th days	7 days	7 days	1 day	1 day

Figure 1. Diagram of the data collection, showing the three parts of the study.

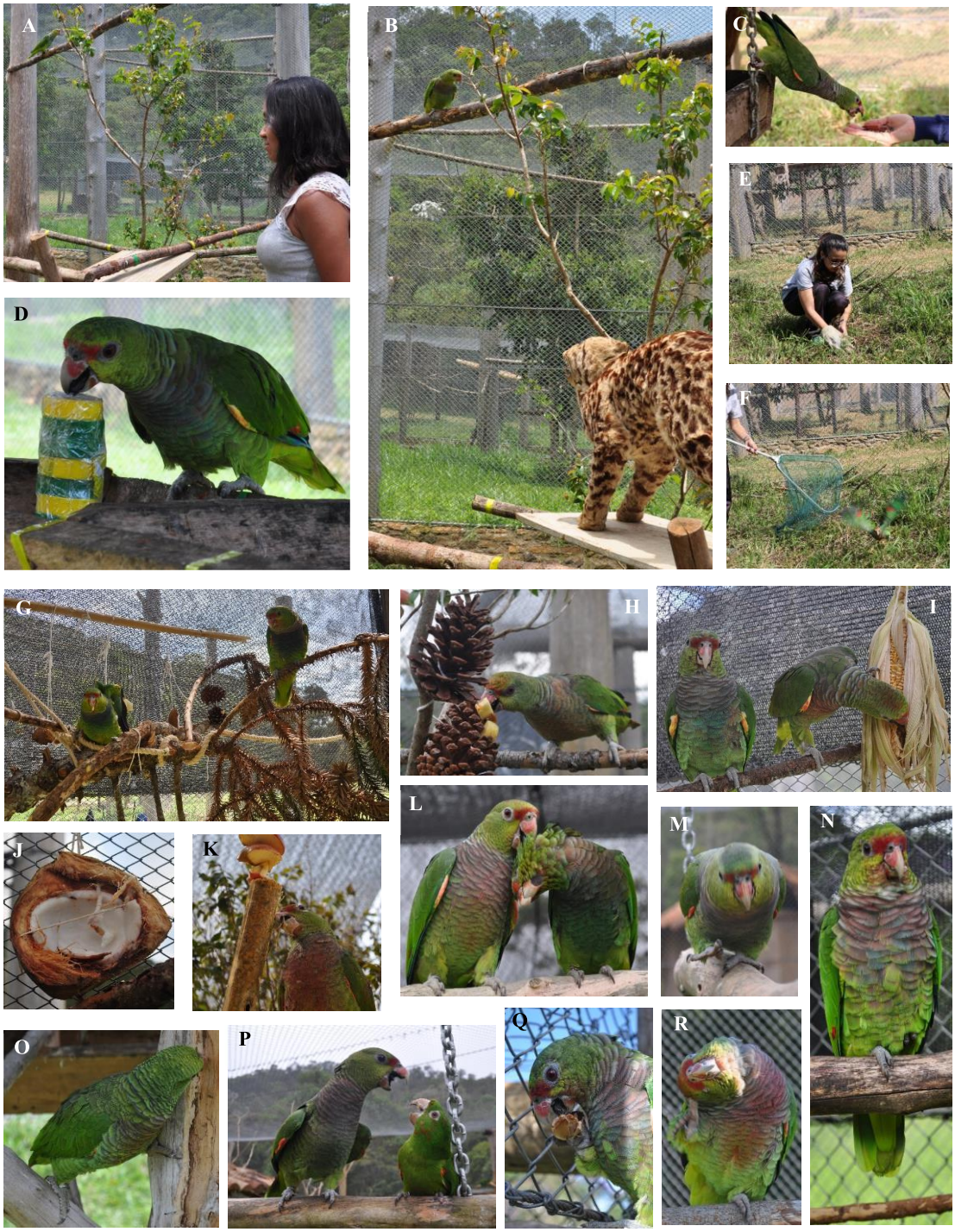

Figure 2. Procedures performed and behaviors recorded in the present study, where: a) Reaction to unknown person; b) Reaction to potential predator; c) Food reward test; d) Novel object test; e, f) Flight skill test; g) Physical enrichments; h) Pine cones with fruits; i) Corn; j) Whole coconuts; k) Bamboo and apple string; l) Allopreening; m) Locomotion; n) Resting; o) Interaction with environment; p) Negative social interaction; q) Feeding; r) Preening.

Temperament tests

Three behavioral tests were performed: reaction to an unknown person (RUPt), reaction to potential predator (RPt) and novel object test (NOt). To perform all tests each group of parrots were transported from maintenance to experimental aviary (around a 30 m-distance) within a bird cage. Then each parrot was individually introduced in the experimental aviary, being positioned on a pedestal (40 cm long x 30 cm wide), located in the central area of the experimental aviary. Connected to the pedestal there were four perches (two of them 1 m long, one 2 m long, and one 3 m long) on which visible marks were made at 30 cm intervals. The parrots remained for 10 min of habituation prior to the tests beginning. Each test had five minutes duration and the parrots behaviors were video recorded. After finishing the experimental procedures, they returned to their maintenance aviary. The procedures used for the three tests are briefly described bellow:

1. RUPt (adapted from Kalin et al., 1998): an unknown person entered in the aviary and remained standing and immobile at a 50 cm-distance from the central pedestal. After five minutes this person moved slowly towards the animal and tried to touch it three times consecutively. Flight distance were recorded, defined by the maximum distance (in cm) that the animal allowed the observer to approach it before exhibiting any withdraw reaction.
2. NOt (adapted from Fox & Millan, 2007): the same person entered in the aviary and positioned a colored stick with yellow and green stripes on the feeder, which was empty. After the person exited, the test started, and behaviors were recorded.
3. RPt: a taxidermized model of a predator, the ocelot (*Leopardus pardalis*), was used for this test, as previously validated by Lopes et al. (2017). The person entered in the aviary carrying the predator model and positioned it above the central pedestal. After the person exited, the test started, and behaviors were recorded. The predator remained motionless, without association with any other aversive stimuli (e.g. aversive sounds or chase).

The reaction to an unknown person and novel object tests were performed on the same day and after a two-days interval to the reaction to a potential predator. A single observer registered parrots' behaviors using focal sampling and instantaneous recordings, with 20 s intervals (Martin & Bateson, 2000). The behavioral categories analyzed in the three tests were: locomotion, inactive, alert, preening and distance from the stimuli (novel object, person and predator model), measured by duration (in seconds), and vocalization

by frequency (vocalizations / min). For the novel object test, the latency to touch the object and frequency of tactile interactions (occurrences / min) were also recorded. Moreover, in reaction to unknown person, the latency to react and flight distance were recorded.

Behavioral responses to environmental enrichment

For the behavioral observations the animals were assigned into three groups, with four (groups A and B) and five (group C) individuals per group. The criteria used for grouping the parrots was keeping together the paired individuals and randomly assign the pairs to groups, composing all mixed-sex groups. The observations consisted of two phases: unenriched – behavior of each group was observed in conventional conditions; enriched environment – behavior was registered after the introduction of physical and feed environmental enrichment items. The following food based items were available: bamboo and apple string: apple and bamboo pieces were tied to a sisal rope and hung on the aviary mesh; pine cones with fruits: fruit pieces were positioned inside pine cones (strobiles of *Pinus ellioti*) and hung near the perches; coconuts: coconut cross-sections showing the outer husk, inner nut shell, and white coconut meat were hung near the perches; maize cob: whole cobs (grain, rachis and husk) hung near the perches. As physical enrichment, natural perches were installed (sisal ropes and branches from native trees).

Each group was observed separately for seven consecutive days in the unenriched phase and another seven days during the enriched phase, in a total of 14 days of behavioral observations per group. The observations occurred from 07:00 to 09:00 a.m. and from 03:00 to 05:00 p.m., these periods being identified as peaks of activity for parrots (Gilardi & Munn, 1998). A single observer registered parrots' behaviors using scan sampling with instantaneous recordings, with two minutes intervals (Martin & Bateson, 2000). The behavioral categories recorded (adapted from Queiroz et al., 2014) are described in Table 1.

Table 1. Ethogram of the behaviors analysed in unenriched and enriched environments for Vinaceous-breasted Amazon parrots (*Amazona vinacea*), N = 13. Adapted from Queiroz et al. (2014).

Behavior category (variable recorded)	Description
Resting (% of the observation time)	The parrot remains in a neutral posture, standing still, standing on the ground, on the mesh or on the perches with open eyes; or sleeping, when the bird, with its eyes closed, might turn its head to the side of the body and nestles its beak in the feathers.
Preening (% of the observation time)	The beak is used for the cleaning of the feathers, the individual approaches the beak to some part of the body and pulls the feather, smoothing it; or when scratching, with the head turned to the side and with one of the legs up, using the two anterior digits; taking a shower in the water trough; stretching (in resting position the bird stretches one of the legs or the wings); yawning (still, the bird opens and closes the beak).
Locomotion (% of the observation time)	Moving sideways or frontally; walking on the ground or on the perches; climbing the mesh or the ceiling; or when it flies.
Allopreening (% of the observation time)	A bird smooths and cleans the feathers of different parts of the body of another bird.
Negative social interaction (occurrences / min)	Fights (when a bird opens its beak, vocalizes and pecks some part of the body of another bird); threat of pecking or 'kicking', that is, non-tactile interaction (a bird threatens to peck or kick the other bird, but does not in fact peck nor kick).
Feeding (% of the observation time)	Feeding from the food available in the feeder.
Interaction with environmental enrichment (% of the observation time)	Bird approaches and touches with the beak or feet the physical or the food based environmental enrichment items (corn, apple string, pine cone and coconut).
Interaction with environment (% of the observation time)	Pecking or handling perches, mesh, sheets, or any object inside the area, except for environmental enrichment items.
Vocalization (% of the observation time)	Any type of sound emission by the animal when it vocalizes; sings; except human vocalizations.
Abnormal behaviors (occurrences / min)	Repetitive behaviors (stereotypies); bird repetitive pecking at the mesh or walking from one side to the other (Pacing); bird pulling off its feathers.
Imitation of human sounds (occurrences / min)	The birds vocalized by emitting sounds that imitate human speech (human whistle or words).

Flight skill and food reward tests

Those tests were performed to assess behaviors regarded as important for parrots candidates to reintroduction, considering that the ideal condition is the animal presenting high flight skill and do not accept food from humans (i.e. refuse the food offered and remained distant). The flight skill test was performed once on each animal individually. The parrot was positioned on one edge of the maintenance aviary, on the ground, and then stimulated to flight by the person using a capture net. The test started, when the bird took off the ground and was encouraged to fly during a period of 4 min or until it showed signs of fatigue (panting, with open beak). In cases that the parrot did not take-off the ground after three attempts, the test was ended. Flight ability was assigned in scores from 1 to 4 (adapted from Pedroso, 2013): 1 - Does not take-off the ground and does not fly, or flies for very short distances in an inconstant rhythm and does not maintain height; 2 - Takes-off the ground, flies in inconstant rhythm and does not maintain height; 3 - Flies in constant rhythm and maintains height; and 4 - Flies in constant rhythm, maintains height and stays out of human reach for four minutes.

The food reward test was performed in the maintenance aviary, with all of the animals on the same day, early in the morning, prior to the first daily feeding. An unfamiliar person entered into the aviary with *Araucaria angustifolia* and sunflower seeds in hands, approached each animal, extended their arm and offered the food to each parrot individually, staying with the hand at a minimum distance of 10 cm away from the tested animal. The following scores were used (adapted from Pedroso, 2013): 1 - Accept the food; and 2 - Refuse the food (flying away or not from the human).

Statistical analyses

Basic descriptive statistics, such as means, standard deviations, coefficient of variation, minimum and maximum values were calculated for each behavioral variable obtained, additionally Kolmogorov-Smirnov tests were used to check for normality. Then, a Factor Analysis was applied to the following variables of the three temperament tests in a single matrix: $inactive_{RUPt}$, $inactive_{NOt}$, $inactive_{RPt}$, $alert_{RUPt}$, $alert_{NOt}$, $alert_{RPt}$, $preening_{RUPt}$, $preening_{RPt}$, $vocalization_{RUPt}$, $latency_{RUPt}$, $distance_{NOt,}$ flight distance and touch novel object. In this analysis, thirteen of the original behavioral variables were included so that the number of columns did not exceed the number of lines (Budaev, 2010). Factor Analysis is a method that combines all the variables in a data matrix to

identify associations among them and, based on the results, generates indices that are the factors describing the variation present in the data (Manly, 2008). The first and second factors (factor 1 and factor 2) represent the greatest proportion of data variation (higher eigenvalues), and therefore the scores received for each animal in these axes were defined as the main temperament dimensions. The animal scores in factors 1 and 2 were then categorized to express the temperament styles found, according to the scores (positive or negative values) on each temperament dimension (axis). In factor 1 the temperament index was characterized as 'vigilance' dimension, and the animals categorized as 'vigilant' (score > 1), 'intermediate' (-1 < scores < 1) and 'indifferent' (score < -1); and in factor 2, the index was characterized as the 'risk-taking' dimension, and the animals were classified as 'risk prone' (score > 1), 'intermediate' (-1 < score < 1) and 'risk averse' (score < -1).

A second Factor Analysis was carried out with the variables extracted from the behavioral observations of the animals in the enriched environment (using the variables resting, preening, feeding, locomotion, allopreening, interaction witch environment, interaction with enrichment, negative social interaction, vocalization and imitation of human sounds). This Factor Analysis was also used to identify temperament dimensions of the parrots, since it is possible to assess animals' individuality by using behavioral observations of the animals in their daily routine (Manteca & Deag, 1993; McDougall et al., 2006). The first two components obtained were either considered as temperament dimensions, characterized as 'activity' (factor 1) and 'sociability' (factor 2), and the individuals were later categorized according to the scores within the respective temperament dimensions as described above.

To evaluate the association between the dimensions identified in the two Factor Analyses Pearson Correlation Coefficients were estimated via PROC COR of SAS (SAS Inst. Inc., Cary. NC, version 9.3). In turn, to assess the relationship of these dimensions with the scores obtained in flight skill and food reward tests, linear mixed models were fitted, using PROC MIXED of SAS. Models included the scores of parrots in each temperament dimension as dependent variable, the fixed effects of flight skill and food reward scores and the random effect of group. The association between the scores of flight skill and food reward was also assessed using the chi-square test in contingency table (PROC FREQ).

Regarding the effects of temperament, flight skill and food reward test on the parrots' behavioral responses to enrichment, initially, an exploratory analysis of the behavioral observations data (resting, preening, feeding, locomotion, allopreening, interaction with environment, interaction with enrichment and each item, negative social interaction and vocalization) was performed to assess whether behaviors varied throughout the days. As no significant effects of day were observed, in the subsequent analyses the means of the 7 days of observation were used, to obtain a single value per animal. To evaluate the effects of environmental enrichment (unenriched *vs.* enriched), temperament dimensions ('vigilance' and 'risk-taking' dimensions) and their interaction on the behavioral responses of parrots, linear mixed models were fitted via PROC MIXED of SAS. The behaviors were included as dependent variables (resting, preening, feeding, locomotion, allopreening, interaction with environment, negative social interaction and vocalization). Environmental enrichment (unenriched *vs.* enriched) and one of the temperament dimensions ('vigilance': '*indifferent*', '*intermediate*' and '*vigilant*' or 'risk-taking': '*risk averse*', '*intermediate*' and '*risk prone*') were included as fixed effects, in addition to the random effects of group and animal (SUBJECT) as repeated measure within the phase (REPEATED command). The same statistical models were performed for flight skill (1 to 4) and food reward (1 and 2) scores, replacing the temperament dimensions as fixed effects. All P-values were assumed as significant when < 0.05, and as a trend when < 0.10.

Results

Characterization of the parrots' temperament, flight skill and food reward tests

In the Factor Analysis applied to the three temperament tests, the first two factors had eigenvalues above 1.0 and, together, explained 55.12% of the variation in the data set. Factor 1 was categorized as 'vigilance', corresponding to 33.55% of the total variance in the data set. The variables with highest positive loadings in factor 1 were $alert_{RPt}$, $alert_{RUPt}$ and $alert_{NOt}$, the variables with higher negative loadings were $inactive_{RPt}$ and $inactive_{RUPt}$ (Table 2). Factor 2 explained 21.57% of the variation observed, the variables with the highest positive loadings were touch novel object and $vocalization_{RUPt}$, and with negative loadings were $preening_{RUPt}$ and $preening_{RPt}$, which expressed the variation of the animals in distance from the stimuli, and could be interpreted as the 'risk-taking' dimension (Table 2, Figure 3).

Table 2. Loadings of variables in the first two factors (factor 1 - 'vigilance' and factor 2 - 'risk-taking'), eigenvalue and % of total variance, obtained from temperament tests with Vinaceous-breasted Amazon parrots (*Amazona vinacea*), N = 13.

Behavior	Vigilance	Risk-taking
$Alert_{NOt}$ †	**0.71**	0.21
$Alert_{RPt}$ †	**0.85**	0.16
$Alert_{RUPt}$ †	**0.78**	0.11
$Distance_{NOt}$	0.40	-0.55
Flight distance	0.39	-0.48
$Inactive_{NOt}$	-0.41	-0.47
$Inactive_{RPt}$	**-0.82**	0.28
$Inactive_{RUPt}$	**-0.62**	-0.30
$Latency_{RUPt}$	0.53	0.16
$Preening_{RPt}$	-0.37	**-0.68**
$Preening_{RUPt}$	-0.20	**-0.71**
Touch novel object	-0.28	**0.76**
$Vocalization_{RUPt}$	0.35	**0.74**
Eigenvalue	4.36	2.80
Variance (%)	33.55	21.57

† NOt: novel object test; RPt: reaction to predator test; RUPt: reaction to an unknown person test.

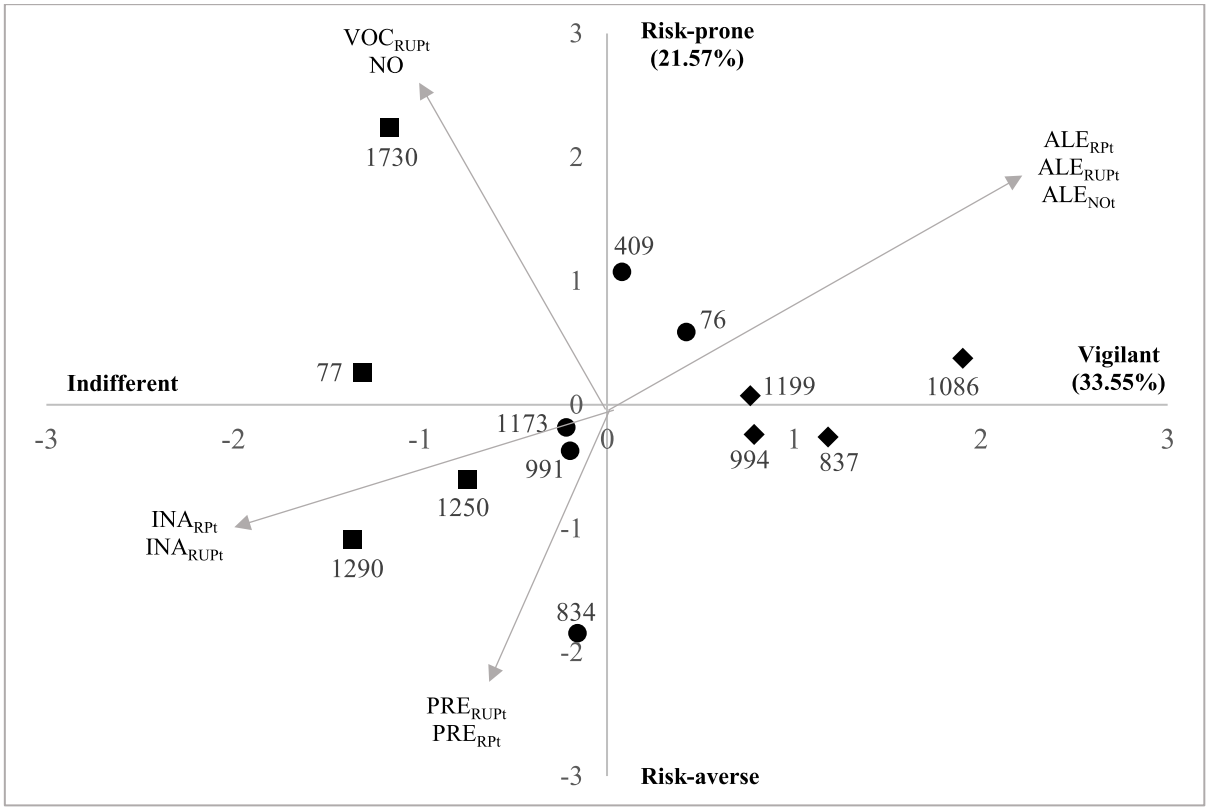

Figure 3. Distribution of the Vinaceous-breasted Amazon parrots (*Amazona vinacea,* N = 13) in the two temperament dimensions (axis x = 'vigilance' and axis y = 'risk-taking') described using behavioral standardized behavioral tests. Where: the numbers represent the leg-rings of individuals; INA = inactive; PRE = preening; ALE = alert; VOC = vocalization; NO = touch novel object; NOt = novel object test; RPt = reaction to predator test; RUPt = reaction to unknown person test ♦: vigilant; ●: intermediate; ■: indifferent.

In the second Factor Analysis, applied to the behavioral observations in the enriched environment, the first two factors had eigenvalues above 1.0 and, together, explained 65.01% of the variation in the data set. Factor 1 corresponded to 49.05% of the total variance in the data set, and presented highest positive loadings for locomotion, imitation of human sounds, vocalization and interaction with enrichment, and negative for resting and preening, which can be interpreted as the 'activity' dimension (Table 3). Factor 2 explained 15.96% of the data variation, the variables with the highest positive loadings were negative social interaction and allopreening, and of highest negative loadings was feeding and interaction with environment, which can be interpreted as the 'sociability' dimension (Table 3, Figure 4).

Table 3. Loadings of variables in the first two factors (factor 1 - 'activity' and factor 2 'sociability'), eigenvalue and % of total variance, obtained from behavioral observations in enriched environment with Vinaceous-breasted Amazon parrots (*Amazona vinacea,* N = 13).

Behavior	Activity	Sociability
Allopreening	0.30	**0.68**
Feeding	0.05	**-0.80**
Imitation of human sounds	**0.83**	-0.02
Interaction environmental enrichment	**0.68**	0.55
Interaction with environment	-0.14	**-0.73**
Locomotion	**0.88**	0.13
Negative social interaction	0.38	**0.78**
Preening	**-0.60**	-0.14
Resting	**-0.74**	-0.27
Vocalization	**0.80**	0.33
Eigenvalue	4.91	1.60
Variance (%)	49.05	15.96

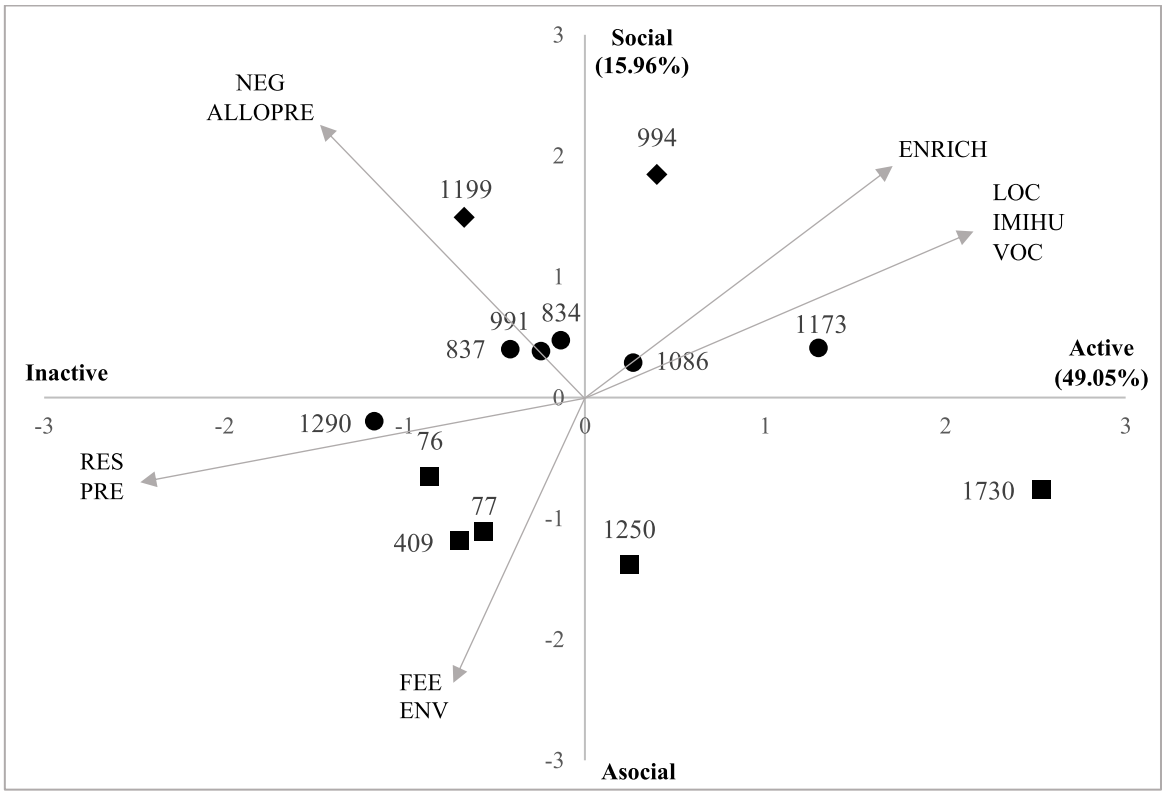

Figure 4. Distribution of the Vinaceous-breasted Amazon parrots (*Amazona vinacea,* N = 13) in the two temperament dimensions (axis x = 'activity' and axis y = 'sociability') described using behavioral observations in enriched environment. Where: the numbers represent the leg-rings of individuals; VOC = vocalization; IMIHU = imitation of human sounds; LOC = locomotion; ENRICH = interaction with enrichment; NEG = negative social interaction; ALLOPRE = allopreening; PRE = preening; RES = resting; ENV = interaction with environmental; FEE = feeding; ♦: social; ●: intermediate; ■: asocial.

Regarding the association among the four temperament dimensions, significant correlation between ‘sociability’ and ‘vigilance’ ($r = 0.55$, $N=13$, $P = 0.05$) were found. This result suggests that vigilant parrots were also more sociable.

Most of the evaluated parrots (69.23%) accepted food from an unknown a person’s hand (score 1) and 30.77% of them rejected the food. While for the flight ability, 38.46% of the parrots showed good skill (score 4), 15.38% scored 3 and 46.16% demonstrated reduced flight skill (scores 1 and 2).

Regarding the relation between temperament with flight skill and food reward tests, we found that animals with better flight ability were more active during behavioral observations (relation between ‘activity’ dimension and flight skill, $F_{3,8} = 4.78$, $P = 0.034$), since animals with score 4 had higher values (0.94 ± 0.32) of activity score than those with score 1 (-0.61 ± 0.41), score 2 (-0.67 ± 0.41) and score 3 (-0.45 ± 0.51), which did not differ between each other.

Effects of environmental enrichment, temperament, flight skill and food reward tests on parrot behavior

There were no significant interactions between environmental enrichment and temperament on any of the evaluated behaviors ($P > 0.05$), neither interactions between enrichment with flight skill ($P > 0.05$) nor with food reward ($P > 0.05$) scores. There were significant effects of enrichment on the behaviors: resting ($F_{1,19} = 7.97$, $P = 0.011$), feeding ($F_{1,19} = 7.32$, $P = 0.014$), allopreening ($F_{1,19} = 5.94$, $P = 0.024$) and interaction with environment ($F_{1,19} = 14.33$, $P = 0.001$). All these behaviors had shorter durations for enriched phase compared to unenriched (Figure 5).

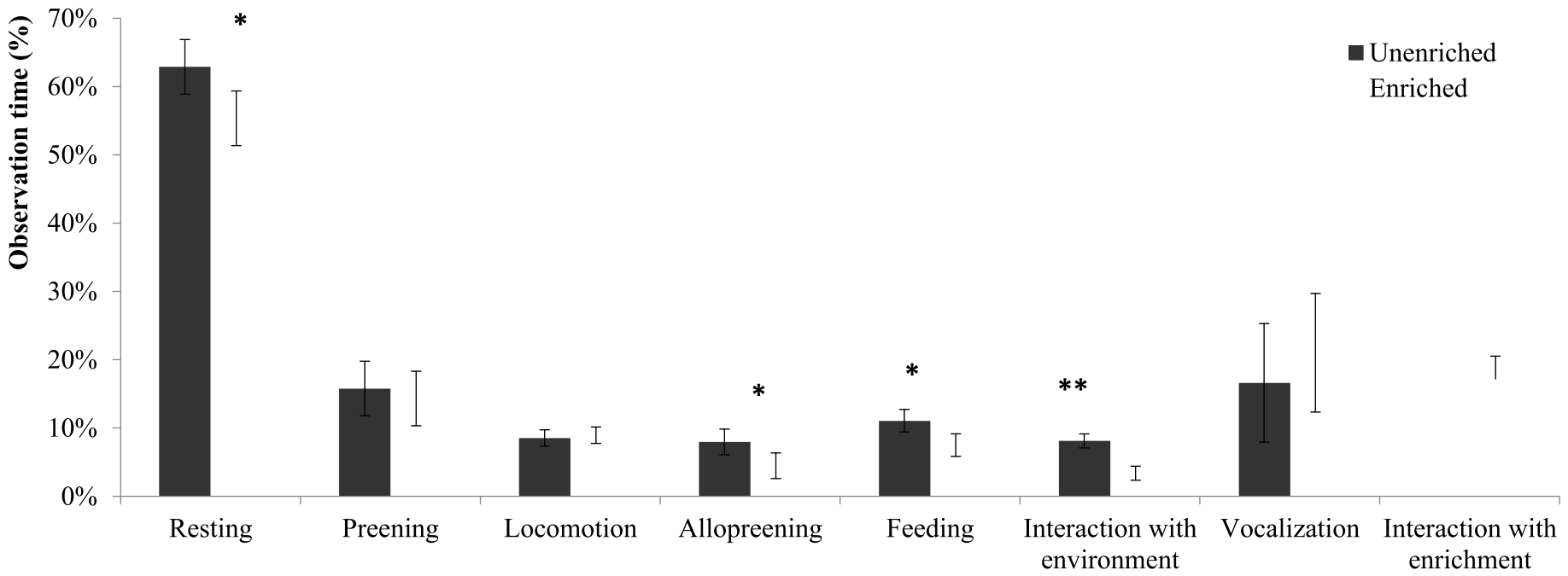

Figure 5. Estimate means (± standard error) of the behaviors expressed during the unenriched and enriched phases for Vinaceous-breasted Amazon parrots (*Amazona vinacea,* N = 13). Where: * $P < 0.05$, ** $P < 0.01$.

The ‘vigilance’ axis had significant effects on the behaviors of feeding ($F_{2,19}$ = 4.35, P = 0.03) and interaction with environment ($F_{2,19}$ = 6.80, P = 0.006). In this dimension, a trend for resting behavior ($F_{2,19}$ = 2.80, P = 0.08) was also observed (Table 4). Animals categorized as ‘vigilant’ spent less time feeding on the feeder and interacting with environment than parrots categorized as ‘indifferent’ profile. Both ‘vigilant’ and ‘intermediate’ animals spent more time in resting than the ‘indifferent’ individuals (Table 4).

Furthermore, there was no significant effect of the ‘risk-taking’ axis on the behaviors evaluated. We only observed a trend on negative social interaction behavior ($F_{2,19}$ = 2.79, P = 0.08) (Table 4). Therefore, animals characterized as ‘risk prone’ and ‘intermediate’ tended to be more involved in agonistic interactions than ‘risk aversive’ ones.

Table 4. Estimated means (± standard error) of the behaviors with significant difference as a function of the temperament dimensions found with the behavioral tests (‘vigilance’ and ‘risk-taking’).

Behavior / Temperament	Resting	Feeding	Interaction with environment	Negative social interaction
Vigilant	0.60 ± 0.04^{ab}	0.06 ± 0.02^{a}	0.05 ± 0.01^{a}	-
Intermediate	0.62 ± 0.03^{b}	0.11 ± 0.01^{b}	0.03 ± 0.01^{b}	-
Indifferent	0.55 ± 0.03^{a}	0.10 ± 0.01^{b}	0.09 ± 0.01^{b}	-
Risk prone	-	-	-	0.24 ± 0.80^{ab}
Intermediate	-	-	-	0.76 ± 0.80^{a}
Risk averse	-	-	-	-0.91 ± 0.96^{b}

[a, b] values followed by different letters in the same column differ statistically (P <0.05; Tukey test).

The behaviors that varied as a function of flight skill were preening ($F_{3,17}$ = 3.53, P = 0.037), vocalization ($F_{3,17}$ = 5.31, P = 0.009) and negative social interaction ($F_{3,17}$ = 2.84, P = 0.069). Animals with compromised flight ability (scores 1 and 2) spent more time in preening, had lower frequency of vocalizations and fewer negative social interactions than score 4 (Table 5). For the food reward test, the behaviors with significant differences were vocalization ($F_{1,21}$ = 6.10, P = 0.022) and a trend for negative social interaction ($F_{1,21}$ = 3.80, P = 0.065). Thus, animals that accepted the food (score 1), vocalized more and tended to show more negative interactions than those which refused

the food (score 2) (Table 5). In addition, parrots' interactions with environmental enrichment items varied according to the flight skill ($F_{3,8}$ = 3.71, P = 0.061). Animals with better flight ability (score 4: 0.27 ± 0.04) interacted more with the enrichment items than individuals with compromised flight ability (scores 1 and 2: 0.08 ± 0.05 for both).

Table 5. Estimate means (± standard error) of the behaviors with significant difference as a function of the flight skill and food reward tests.

Score	Flight skill			Food reward	
	Preening	Vocalization	Negative social interaction	Vocalization	Negative social interaction
1	0.15 ± 0.04[a]	0.18 ± 0.06[b]	0.94 ± 0.60[b]	0.32 ± 0.04[a]	1.35 ± 0.74[a]
2	0.12 ± 0.04[a]	0.12 ± 0.06[b]	0.68 ± 0.60[b]	0.15 ± 0.06[b]	0.07 ± 0.74[b]
3	0.09 ± 0.04[ab]	0.28 ± 0.07[ab]	2.46 ± 0.74[ab]	-	-
4	0.04 ± 0.04[b]	0.40 ± 0.05[a]	2.51 ± 0.47[a]	-	-

[a, b] values followed by different letters in the same column differ statistically (P <0.05; Tukey test).

Discussion

Individual differences in the behavior of Vinaceous-breasted Amazon parrots were identified through standardized behavioral tests and behavioral observations of the animals in an enriched environment, confirming our hypothesis. The individuality of the parrots was characterized along the temperament dimensions of 'activity', 'sociability', 'vigilance' and 'risk-taking'. Other hypothesis tested was whether the effects of environmental enrichment on behavior would differ depending on the temperament of the animals. We thus tested the interaction between environmental enrichment and temperament on the behaviors of the animals, and found that environmental enrichment and temperament affected, although independently, the behavior of Vinaceous-breasted Amazon parrots.

The physical and foraging environmental enrichment items stimulated exploration and activity behaviors in the Vinaceous-breasted Amazon parrots, with reduction of feeding from the feeder, interaction with the environment, resting and allopreening behaviors in the enriched phase. One may assume that the birds fed less from the feeder in enriched environment because they consumed the foraging enrichment items, giving them the opportunity to explore the site to obtain other food sources. This result

corroborates the findings by Coulton et al. (1997) in a study that evaluated the effect of foraging enrichment on the behavior of parrot species. Additionally, the parrots spend less time in allopreening interacted less with the environment; that is, with physical structure of the aviary (perches, feeder and mesh) in the enriched phase, which possibly occurred because animals began to explore the physical enrichment items available. In general, free-living parrots spend most of the time (from 4 to 6 hours in a day) involved in foraging activities and the interaction with the vegetation (Cubas et al., 2014). The supply of physical and foraging enrichment for captive parrots has proven to be effective in meeting such needs, as shown by van Zeeland et al. (2013) for grey parrots.

Regarding the temperament dimensions, Vinaceous-breasted Amazon parrots differed in terms of activity and sociability based on behavioral variation in enriched environment. Parrots with 'active' profiles were characterized by higher levels of locomotion, interaction with environmental enrichment and vocalization behaviors. In its turn, animals with an 'inactive' profile spent longer in resting and preening. The 'activity' dimension was also reported in the study by Coutant et al. (2018), who found that more active animals had greater movement component (distance walked) in the novel environment, unknown person test and play tests.

Parrots characterized as 'social' expressed allopreening (*i.e.* positive) as well as negative social interactions during the observations in the enriched environment, while the other extreme of this trait (regarded as 'asocial' parrots) showed higher frequency of interaction with the environment and feeding on the feeder. Therefore, individuals on one extreme directed their behaviors to the members of the group, as affiliative and agonistic interactions, and the other directed towards the environment. Similar results were found by Fox & Millan (2010; 2014), who described the 'affiliative' dimension in cockatiels (*Nymphicus hollandicus*) based on adjectives 'sociable' (appears to like the company of others) and 'warm' (seeks or elicits bodily closeness, touching).

Regarding the associations between the temperament dimensions, 'sociability' was related to 'vigilance', indicating that the social animals were more vigilant as well. Thus, we can infer that these related dimensions may be fitted into the concept of behavioral syndromes, as described by Sih et al. (2004). Parrots characterized as 'vigilant' were distinguished by alertness behaviors when exposed to the stimuli of the temperament tests (novel object, unknown person and a potential predator), while those classified as 'indifferent' were inactive in the unknown person test and in the potential predator test.

In a recent study with *Psittacus erithacus* parrots and two species of the *Amazona* genus, the 'vigilance / anxiety' dimension was also found (Coutant et al., 2018). Those results suggest that the 'vigilance' trait is a characteristic that stands out in the temperament of parrots, especially of the genus *Amazona,* characterized by traits of inactivity and attention in vigilant psittacids (Coutant et al., 2018; present study). Vigilance dimension affected the Vinaceous-breasted Amazon parrots' behaviors and their pattern of interaction with environment, since animals characterized as 'vigilant' spent less time interacting with the environment, feeding on the feeder, and more time resting during behavioral observations. Thus, for the 'vigilance' dimension, extreme individuals (highly vigilant) were not positively responsive to traditionally used enrichment items and require future research to test any unconventional strategies to effectively enrich their enclosures.

Another temperament dimension found in the Vinaceous-breasted Amazon parrots was 'risk-taking', which includes responses to risky and novel situations (Réale et al., 2007). Parrots 'prone to risk' had neophilic responses (Fox & Millam, 2004) and vocalized in the unknown person test. In contrast, 'risk averse' parrots remained distant from the stimuli tested and displayed more preening when exposed to unknown person and potential predator. We can argue that the 'risk-taking' dimension found in this study might be equivalent to the 'shy – bold' axis described by Lopes et al. (2017) in captive Blue-fronted Amazon parrots (*Amazona aestiva*). Individuals considered as 'bold' were characterized by interact with the novel object and, in contrast, individuals with a 'shy' profile were characterized by submission and avoidance behaviors (Lopes et al., 2017). In our study, parrots characterized as 'risk prone' expressed more negative social interaction than 'risk aversive' ones during behavioral observations. Due to the characteristics previously described for animals within the 'bold / shy', 'risk prone / risk averse' profiles (Verdolin & Haper, 2013; Cole & Quinn, 2014; Paulino et al. 2018), we might summarize that Vinaceous-breasted Amazon parrots with 'risk prone' profile can be characterized by bolder and aggressive behaviors.

In regard to the implications of such findings to reintroduction programs, for animals to be released in wild, adequate anti-predatory responses are fundamental, enabling them to recognize and respond to predators, to increase the chance of survival (Griffin et al., 2000). Therefore, behavioral responses to predators are essential for this success, because they are triggered when the predator is detected, avoiding the risk of

attacks (Lima & Dill, 1990). Individuals with higher levels of 'boldness' and 'risk propensity' may not present sufficient caution in the presence of a predator, since it is known that animals prone to risks are more susceptible to predation (Bremner-Harrison et al., 2004; Møller, 2008). However, this condition can be reverted by antipredation trainings, as shown by De Azevedo & Young (2006) for captive rheas (*Rhea americana*). Training sessions with potential predators altered the levels of boldness of these animals, as rheas who initially behaved as 'bold' in temperament tests became more cautious ('shy') after training. Shyer individuals tend to be more vigilant, thus, we might speculate that the parrots characterized as 'vigilant' in the present study would be less vulnerable to the risk of predation and to be illegally captured by traffickers when included in reintroduction programs, because they were more alert in the presence of the model of predator and of an unknown person than the animals classified as 'indifferent' to those stimuli. But this hypothesis remains to be tested under real world conditions.

The reduction of reactivity to humans and flight performance are also cause of concern in reintroduction programs (Collar, 2006; Zamboni et al., 2017) and were found in part of the parrots of the present study. Most of the animals accepted the food offered by the human, which may have been a consequence of learning through operant conditioning with positive reinforcement (Skinner, 1953). Regarding the flight ability of parrots, a wider range of responses were found in the studied animals (from unable to flight to good flight ability). Often, birds kept in captivity encounter situations that restrict or limit them to fly (Hesterman et al., 2001; Engebretson, 2006). One of the factors that may reduce flight performance is the small size of the aviaries, preventing the birds of exercising flight (Tregaskes et al., 2015). For example, Hess et al. (2005) investigated flight characteristics and predator avoidance behavior in hand-reared Attwater prairie-chickens (*Tympanuchus cupido*) and found that captive-bred birds flew considerably shorter distances than wild birds. They credited this fact to insufficient flight exercise of the hand-reared birds. Since previous records of the birds in the present study were unknown, we do not know if the reduced flight ability of some parrots is due to the time in captivity or any other unrevealed metabolic condition (Larcombe et al., 2015).

We found that Vinaceous-breasted Amazon parrots, which flew in constant rhythm, maintained height and kept out of the reach of the evaluator (score 4) were characterized by the 'active' temperament profile, what was expected. The animals with this profile vocalized more, got involved in more conflicts and interacted more with the enrichment items available in the aviary. In turn, animals with reduced flight ability

(scores 1 and 2) spent more time in preening and were characterized by the inactive temperament profile. This result indicates that environmental enrichment techniques must take into account the temperament profile of the targeted individuals, especially their level of vigilance and activity, in addition to their flight ability.

We initially hypothesized that behavioral consequences of captivity would be closely associated, thus individuals with worse flight ability would be those more prone to accept food offering. However, our results did not reveal a very close relationship between flight skill and food reward tests, in other words, the two changes promoted by the period in captivity affected parrots independently. The authors who investigated flight ability in several species of birds (Carrascal & Polo, 2006; Costantini et al., 2012; Tobalske et al., 2017) did not consider the individual response to food offering. Thus, our study is the first to suggest that the various consequences of captivity may affect the animals in a distinct way and, therefore, its impacts occur independently in each individual.

Conclusion

In the present study we described two temperament dimensions in Vinaceous-breasted Amazon parrots (*Amazona vinacea*), extracted from standardized behavioral tests ('vigilance', 'risk-taking') and two dimensions obtained by behavioral observations in enriched environment ('sociability' and 'activity'). The results highlighted the importance of including the temperament assessment for animal candidates for reintroduction programs, enabling the improvement of the quality of life in captivity and indicating how these animals would respond in wild. We found that environmental enrichment and temperament affect behaviors of captive parrots. Moreover, the flight performance influences parrots' behaviors in general and, consequently, their level of interaction with the enrichment. Parrots with reduced flight skill were less prone to use the foraging and physical enrichment items available. Our results show the importance of considering aspects of parrots' temperament and flight performance during the development and application of environmental enrichment techniques.

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